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Study on the Measurement and Evaluation of High-Quality Economic Development of the Yangtze River Economic Belt from the Perspective of Rural Revitalization

Zehua He [1, *], Chong Zhu [1], Yujie Zhang [2], Yide Shu [1]

[1] School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu 233041, China
[2] School of Business Administration, Anhui University of Finance and Economics, Bengbu 233030, China

*** Corresponding author:** Zehua He (Email: hezehua_aufe@163.com)

Abstract: The report of the twentieth CPC National Congress points out that high-quality development is the primary task in the comprehensive construction of a strong modern socialist country, and that comprehensively promoting rural revitalization is an important part of promoting high-quality development. The strategy of rural revitalization is a major strategic innovation for solving the "three rural issues" in the new era, which is of great significance in promoting urban-rural integration and regional coordinated development, and in pushing the economy to achieve effective qualitative improvement and reasonable quantitative growth. The Yangtze River Economic Belt has been an important economic center since ancient times, and has made great contributions to China's economic development, but there are still problems such as uneven development and disharmony in development. Based on this background, this project intends to, on the basis of the study of measuring and evaluating the high-quality economic development of the Yangtze River Economic Belt under the perspective of rural revitalization, firstly collect the panel data from 2011 to 2022 as the research samples, evaluate the Yangtze River Economic Belt region by using the entropy weighting method of TOPSIS and the Gini coefficient of Dagum, and then compute the index weights through the entropy weighting method, and then Using the original data and weight matrix to get the normalized evaluation matrix and TOPSIS evaluation. Secondly, based on the Gini coefficient, the regional differences in the level of rural revitalization of the Yangtze River Economic Belt are analyzed. Finally, based on the rural revitalization perspective to establish a comprehensive evaluation index, and then use the TOPSIS entropy weight method to evaluate the high-quality development of the Yangtze River Economic Belt. It provides reference opinions for promoting the Yangtze River Economic Belt in high-quality development.

Keywords: Yangtze River Economic Belt; TOPSIS; High-quality Development; Gini Coefficient of Dagum.

1. Introduction

On October 16, 2022, Xi Jinping, General Secretary of the Communist Party of China (CPC) Central Committee and President of the People's Republic of China (PRC), proposed at the 20th National Congress of the Communist Party of China (CPC) that it should accelerate the construction of a new development pattern and make efforts to promote high-quality development. Accelerating the construction of a new development pattern with the domestic macrocycle as the main body and the domestic and international double cycle promoting each other. Among them, comprehensively promoting the rural strategy is one of the important elements of high-quality economic development. The report points out that the most arduous and burdensome task in comprehensively building a modern socialist country remains in the countryside. It insists on prioritizing the development of agriculture and rural areas, on the integrated development of urban and rural areas, and on the smooth flow of urban and rural factors. The implementation of the rural revitalization strategy is of great significance in coordinating the coordinated development of regions and the integrated development of urban and rural areas. Through the implementation of the rural revitalization policy, the quality and effectiveness of the overall economic and social development will be improved. How to recognize the positive role of rural revitalization in the process of coordinated regional development requires systematic and scientific research.

The Yangtze River Economic Belt is one of the most important parts of China's geographic region, creating most of the gross domestic product despite occupying a small land area, attracting many foreigners to enter the domestic market, and possessing many innovative industrial highlands, advanced technologies, and patents. In 2018, the connotation of high-quality development of the economy was formally put forward, and in the previous stages of development, China's economy was indeed in a high-speed development stage, but it also brought a series of problems, such as uneven and insufficient development, and the environment and development are not coordinated. Only by upgrading the economic structure and transforming the mode of economic development can China's economy realize a "magnificent turn" from "high speed" to "high quality". Measuring and evaluating the high-quality economic development of the Yangtze River Economic Belt will, on the one hand, play a role in developing and perfecting the existing macroeconomic theories and political economy theories, and, on the other hand, contribute to the promotion of the "power change, efficiency change, and quality change" of economic development, and realize the "quality change of the economy," which is the theme of the 20th Party Congress, "to promote the realization of the quality of the economy". On the other hand, it is an important reference and practical value for promoting "power change, efficiency change and quality

change" in economic development, and for realizing the principle of "promoting the economy to realize effective quality improvement and reasonable quantity growth" mentioned in the 20th CPC National Congress.

High-quality development of the Yangtze River Economic Belt is necessary, as is urban-rural integration and coordinated regional development. High-quality economic development is rich in connotations, and how will the promotion of rural revitalization affect the high-quality development of the regional economy? Among the variables affecting the development level of rural revitalization, what positive effect will it have on the high-quality development of the Yangtze River Economic Belt? Therefore, the study of measuring and evaluating the economic high-quality development of the Yangtze River Economic Belt based on the perspective of rural revitalization is very necessary, and it also provides theoretical and practical significance for the future study of the impact of a certain policy on the regional economy.

Focusing on the research theme of this paper, the literature closely related to the research of this paper mainly consists of three categories: first, the level of development of rural revitalization as well as the construction and empirical evidence of the evaluation index system; second, the measurement and evaluation of the level of high-quality development of the regional economy; and third, the study of the measurement and evaluation of high-quality development of a region based on the perspective of a certain policy.

2. Literature Review

2.1. Development Level of Rural Revitalization as Well as Construction and Empirical Evidence of Evaluation Index System

In the face of this research content, there are a wide range of methods and previous research results that can be drawn on, which provide a strong theoretical support for this paper. The overall development level of rural revitalization in China is on an upward trend, showing the spatial and temporal non-equilibrium of high in the east and low in the west (Wang Li et al., 2022) [1]. The overall level of rural revitalization in China is low, and has improved significantly since the implementation of the rural revitalization strategy. The spatial difference in the level of rural revitalization shows a narrowing trend, but the overall difference is still obvious (Li et al., 2022) [2]. The number of rural resident population, expenditure on agriculture, forestry and water, and urbanization rate have a positive impact on the development level of rural revitalization, while the amount of fixed asset investment in rural households has a negative impact on rural revitalization (Guo, 2022) [3].

2.2. Measurement and Evaluation of the Level of High-Quality Development of Regional Economy

When studying the measurement and evaluation of the level of high-quality development of the regional economy, some scholars have found that the HM-GTWR model embedded in green GDP accounting measures GTFP results that are on average 0.1281 higher than those measured by the CD production function, indicating that the spatial-temporal spillover effect of factors in the context of integration has a positive impact on the GTFP of the cities in the Yangtze River Delta (Feng et al., 2022) [4]. Some scholars found that regional heterogeneity in the level of high-quality development of the Yangtze River Delta city cluster economy is obvious when using research that utilizes nonparametric kernel density estimation and GIS technology, with Shanghai having the highest level of high-quality development, followed by Zhejiang and Jiangsu, and Anhui having the lowest. Green development is the most important power source for the high-quality development of the Yangtze River Delta city cluster economy, and coordination, comprehensive quality and efficiency are also its advantageous dimensions, while innovation, openness and sharing are the shortcoming dimensions (Wu et al., 2021) [5]. The high-quality development of cities in the Yangtze River Economic Belt shows short-term fluctuating changes over time, but generally maintains a trend of steady growth. The development of cities in the upper, middle and lower reaches of the region is differentiated in time, and the growth rate varies in different years due to different development focuses, but the overall tendency is good. (Zhou et al., 2022) [6].

2.3. Research on the Measurement and Evaluation of High-Quality Development of a Region Based on the Perspective of a Certain Policy

In the study on the high-quality development of Hebei's economy based on the perspective of common wealth, it is found that the high-quality development of Hebei's economy has achieved certain results. From the perspective of comprehensive measurement, Hebei Province is in a stage of rise. (Zhang,2022) [7]. The high-quality development of Guizhou's forest economy has a positive effect on promoting the development and progress of Guizhou's economy and society, but it still needs scientific planning and reasonable construction of policy guarantee system (Pu.,2022) [8].

In summary, there is still room to expand the existing literature on the study of measuring and evaluating the high-quality development of the Yangtze River economic belt economy from the perspective of rural revitalization. First, in terms of research content, there is more literature focusing on the high-quality development of the Yangtze River Delta economy and less on the high-quality development of the Yangtze River Economic Belt. Second, from the perspective of research methodology, most of them adopt a single entropy weight method, and the interpretation of the connotation of high-quality economic development is too theoretical and single. Third, from the research direction, the research team evaluates the Yangtze River Economic Belt based on the perspective of rural revitalization, combining point and surface, and there are only a few related studies at present. The main marginal contributions of this topic are as follows: first, in terms of research content, it should focus on the rural revitalization perspective and re-build new evaluation indexes for high-quality economic development. Secondly, in terms of research method model selection, it adopts the use of collocation between models, using TOPSIS entropy weight method, Gini coefficient, regression model and spatial measurement model. Finally, in the research direction, based on the perspective of rural revitalization on the Yangtze River Economic Belt economic high-quality development to explore, to conclude how rural revitalization to promote the high-quality development of the Yangtze River Economic Belt economy, and what positive role to play.

3. Methodology

This paper focuses on the high-quality development of the economy of the Yangtze River Economic Belt under the perspective of rural revitalization, and carries out a systematic research in four dimensions: theoretical foundation, empirical analysis, convergence analysis, and pathway optimization. First, to build evaluation indexes for evaluating the level of rural revitalization, and to evaluate the level of rural revitalization of each region of the Yangtze River Economic Belt by using the TOPSIS entropy weight method; second, to take the high-quality development of the economy of each region of the Yangtze River Economic Belt as the research objective, and to analyze the differences in the level of economic development and the level of rural revitalization of each region by using the TOPSIS entropy weight method and the Gini coefficient, and other models; third, to build a new evaluation based on the rural revitalization indicators, and then measure and evaluate the economic development level of the Yangtze River Economic Belt. Fourth, the research objective is to optimize the development status and provide suggestions for high-quality economic development.

(1) Topsis entropy weight method

The selection of indicators for the level of rural revitalization as well as evaluation. In this paper, when selecting indicators, based on the strategy of rural revitalization, five first-level indicators of industrial prosperity, ecological livability, civilization, effective governance and affluent life are selected and evaluated by using TOSIS entropy weighting method, and the specific TOSIS entropy weighting method model is as follows:

Construct the evaluation matrix:

There are m evaluation indicators, n evaluation objects, X represents the original evaluation matrix of rural revitalization level:

$$\boldsymbol{X}=\begin{bmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix}$$

Data normalization:

In order to eliminate the effect of different indicator scales to get the normalization matrix M:

$$M=\begin{bmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix}$$

Normalize its matrix, the normalized matrix is denoted as Z, for each element in Z:

$$z_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$$

Define the maximum value:

$$Z^+=(Z_1^+,Z_2^+,\ldots\ldots,Z_m^+)$$

$$=(max\{z_{11},z_{21},\ldots z_{n1}\},max\{z_{12},z_{22},\ldots z_{n2}\},\ldots,max\{z_{1m},z_{2m},\ldots z_{nm}\})$$

Define the minimum value:

$$Z^-=(Z_1^-,Z_2^-,\ldots\ldots,Z_m^-)$$

$$=(min\{z_{11},z_{21},\ldots,z_{n1}\},min\{z_{12},z_{22},\ldots,z_{n2}\},\ldots,min\{z_{1m},z_{2m},\ldots,z_{nm}\})$$

Define the distance of the ith (i=1,2,3,...,n) evaluation object from the maximum value:

$$D_i^+=\sqrt{\sum_{j=1}^{m}(Z_j^+-z_{ij})^2}$$

Define the distance of the ith (i=1,2,3,...,n) evaluation object from the maximum value:

$$D_i^-=\sqrt{\sum_{j=1}^{m}(Z_j^--z_{ij})^2}$$

Calculate the score:

$$S_i=\frac{D_i^-}{D_i^++D_i^-}$$

According to this formula, Easy to get $0\le S_i\le 1$, and the larger the S_i the smaller the D_i^+.That is, the closer to the maximum value. Of course, in the process of selecting indicators, there are inevitably some special indicators that need our special treatment, for example, when studying the effect of soil pH on plant growth, we need to evaluate the soil quality in various places, then we have to select the PH value as an evaluation indicator, which can be regarded as a floating indicator (floating around a certain value, the closer the better); when studying various nutrients contained in the soil, here It can be considered as an interval indicator (within a certain interval is the best).

Intermediate indicators:

$$M=max\{|x_i-x_{best}|\},\widetilde{x_i}=1-\frac{|x_i-x_{best}|}{M}$$

Interval-type indicators:

$$M=max\{a-min\{x_i\},max\{x_i\}-b\}$$

$$\widetilde{x_i}=\begin{cases} 1-\frac{a-x}{M}, x<a \\ 1, \quad a\le x\le b \\ 1-\frac{x-b}{M} \end{cases}$$

In addition to defining the relevant indicators, we also need to take into account some interference factors, it is the influence of some interference factors, resulting in errors between the actual and theoretical, so we add the "Offset Factor" (Offset Factor) in the model, and use the capital letter O to indicate:

$$O=\frac{I_{ij}\omega_i}{\sum_{i=1}^{m} I_{ij}\omega_i}$$

(2) Gini coefficient (a measure of statistical dispersion)

The Gini coefficient is a statistical measure of the degree of inequality in the distribution of income or wealth, widely used in economics and sociology. Its value ranges from 0 to 1, with 0 indicating perfect equality and 1 indicating perfect inequality. The calculation of the Gini Coefficient is based on the cumulative distribution of individual incomes (or wealth), and reveals the degree of imbalance in the overall distribution by comparing the differences between individuals. In research, the Gini coefficient is used to analyze income or wealth disparities within different regions or groups. Higher Gini coefficients usually indicate a more unequal distribution, while lower Gini coefficients suggest a more balanced distribution. Such analysis helps to assess the fairness of a society, while providing an important reference for policy formulation to promote more balanced socio-economic development. In specific contexts, such as the study on the level of rural revitalization in the Yangtze River Economic Belt, the Gini coefficient is applied to reveal the differences in the level of rural revitalization among different regions. Through the comparison of Gini coefficients, readers are able to gain an in-depth understanding of the effectiveness of rural revitalization policies in different regions of the Yangtze River Economic Belt, and provide targeted recommendations and policy support for further promoting high-quality development.

For measuring and evaluating the high-quality development of the economy of each region of the Yangtze

River Economic Belt. The entropy weight method as well as the Gini coefficient are utilized to study regional differences and development levels, and the Gini coefficient model is as follows:

$$G_{nb} + G_w + G_t = 1$$

The Dagum Gini coefficient is calculated using the following formula:

$$G = \sum_{j=1}^{k}\sum_{h=1}^{k}\sum_{i=1}^{n_j}\sum_{r=1}^{n_h}\frac{|y_{ji} - y_{hr}|}{2n^2\overline{y}}$$

The regions are ranked according to the size of this index:

$$\overline{Y}_l \le \cdots \le \overline{Y}_h \le \cdots \le \overline{Y}_k$$

4. Results and Discussion

The specific steps of the analysis are as follows:

(1) Prepare the data and homogenize the trend with the magnitude problem.

(2) Confirm the weight of each indicator, you can use entropy weight method, custom weights (need to handle by yourself, you can use quantitative-AHP).

(3) Find the optimal and inferior matrix vectors (automatically processed by the system).

(4) Calculate the evaluation object and positive ideal solution distance D+ or negative ideal solution distance D-, respectively.

(5) Combine the distance values to calculate the composite degree score C value, and rank them to draw a conclusion.

The table 1 shows that the weight of rice field area is 1.817%, the weight of coal use is 13.303%, the weight of agricultural chemical oxygen demand emission is 6.459%, the weight of natural gas use is 1.598%, the weight of agricultural electricity consumption is 33.388%, the weight of rural water use is 5.166%, the weight of diesel use is 8.604% The weight of agricultural film use is 5.83%, the weight of animal husbandry head is 2.401%, the weight of poultry number is 3.832%, the weight of carbon emission is 6.856%, the weight of fertilizer use is 5.725%, the weight of pesticide use is 5.022%, where the maximum index weight is agricultural electricity consumption (33.388%) and the minimum value is natural gas use (1.598%).

Table 1. Calculation of indicator weights

Items	Information entropy value e	Information utility value d
Rice field area	0.877	0.123
Coal use	0.8951	0.265
Agricultural chemical oxygen demand emissions	0.820	0.28
Natural gas use	0.786	0.02
Agricultural electricity consumption	0.785	0.1235
Rural water consumption	0.647	0.124
Diesel use	0.793	0.127
Amount of agricultural film used	0.828	0.342
Number of animal heads in animal husbandry	0.707	0.13
Number of Poultry	0.852	0.088
Carbon emissions	0.715	0.085
Amount of fertilizer use	0.829	0.072
Amount of pesticide use	0.838	0.092

Table 2. Calculation of indicator weights

Index valuet	Positive ideal solution distance (D+)	Negative ideal solution distance (D-)	Overall score index
Wuhan	0.7680	0.5494	0.4170
Hefei	0.7641	0.5667	0.4258
Hangzhou	0.7679	0.5203	0.4039
Suzhou	0.7666	0.4977	0.3936
Nanjing	0.7773	0.4847	0.3840
Kunming	0.7891	0.4524	0.3644
Shanghai	0.7900	0.4421	0.3588
Nanchang	0.7870	0.4335	0.3552

The table 2 shows the preview results:

D+ and D- values, these two values represent the distance (Euclidean distance) between the evaluation object and the optimal or inferior solution (i.e., A+ or A-), respectively. The practical meaning of these two values is that the distance between the evaluation object and the optimal or inferior solution, the larger the value indicates the farther the distance, the larger the D+ value of the research object, the farther the distance from the optimal solution; the larger the D- value, the farther the distance from the inferior solution. The most understood research object is the one with the smaller D+ value and the larger D- value.

The comprehensive degree score C value, C = (D-) / (D+ + D-), is calculated by the formula in which the numerator is the D- value and the denominator is the sum of D+ and D-; the larger the D- value is relatively, the further the research object is from the worst solution, then the better the research object is; the larger the C value is, the better the research object is.

The table 3 is a preview of the results:

Positive and negative ideal solutions (not distance), these two values represent the maximum value or minimum value of the evaluation index (i.e. optimal solution or inferior solution), these two values are used to calculate the D+ or D- value, the size of these two values does not have much significance.

The results of the study on measuring and evaluating the high-quality economic development of the Yangtze River Economic Belt based on the perspective of rural revitalization show that in the analysis of the target cities (Wuhan, Hefei, Hangzhou, Suzhou, Nanjing, Kunming, Shanghai, and Nanchang), we used the TOPSIS entropy weighting method and the Gini coefficient to the level of rural revitalization and the quality of economic development in the region were comprehensively assessed.

First, through the TOPSIS entropy weight method, we derived the comprehensive evaluation results of the level of rural revitalization in different cities. This method integrates the weights of the indicators and ensures the scientific and objective nature of the evaluation. The results show that certain cities such as Hangzhou and Suzhou exhibit high

levels of rural revitalization, demonstrating their remarkable achievements in promoting rural economic development.

Table 3. Calculation of indicator weights

Item	Positive ideal solution	Negative ideal solution
Rice field area	0.99999991	9e-8
Coal use	1	0
Agricultural chemical oxygen demand emissions	1	0
Natural gas use	0.99999992	8e-8
Agricultural electricity consumption	1	0
Rural water consumption	0.99999994	6e-8
Diesel use	0.9999998	2e-7
Amount of agricultural film used	1	0
Number of animal heads in animal husbandry	1	0
Number of Poultry	0.99999999	1e-8
Carbon emissions	0.99999997	3e-8
Amount of fertilizer use	0.99999993	7e-8
Amount of pesticide use	0.99999928	7.2e-7

Second, the analysis of the Gini coefficient provides insight into the differences in income or wealth distribution within the target cities. Lower Gini coefficients usually reflect a relatively balanced distribution, while higher Gini coefficients imply a more unequal income distribution. In this regard, our study shows that there are some differences between cities, providing a basis for more targeted policies.

Taken together, this study provides a comprehensive assessment and analysis of rural revitalization in the Yangtze River Economic Belt, providing a scientific basis for relevant policy formulation and implementation. However, it should be noted that the study still has some limitations, such as data scope and timeliness, which need to be improved in further research. It is hoped that these findings will provide reference for target cities in their future high-quality development and prompt more interested parties to pay attention to and support the implementation of the rural revitalization strategy.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data Availability

The data used to support the findings of this study are included within the article.

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