ISSN: 2688-9323

Evaluation of Economic Index System based on Sustainable Development

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Abstract

In today's raging era, sustainable economic development has become the most concerned existence of governments around the world. As an economic region in the Yangtze River Delta, Bengbu's economic development is extremely slow, so this time I chose to obtain the required data from the China Statistics Bureau and some CNKI, analyze the current economic situation of Bengbu, and then establish a PCA-DEA model with multiple indicators To evaluate the output and input of Bengbu in recent years, it is found that the technical benefits, scale benefits and comprehensive benefits of Bengbu City have increased year by year. Bengbu's comprehensive technical efficiency for sustainable development is at a medium level.

Keywords

Sustainable Development; PCA-DEA Composite Evaluation Model; Sustainable Economic Development.

1. Introduction

"Bengbu lives" was originally a homophonic stalk of a city out of the circle, but I didn't expect that Bengbu's economic development would really "be overwhelmed". On January 17, 2021, a report was posted on the official website of the Bengbu Municipal Government in Anhui Province, which mentioned that the industrial transformation and upgrading of Bengbu was not fast and so on. Specific indicators show that the planned GDP growth rate of Bengbu at the beginning of the year was 8.5%, but the actual completion of the year was 0. This is not a good phenomenon. These phenomena indicate that there may be some problems in the economic development of Bengbu City, and these problems may lead to negative growth in Bengbu's future economic situation. Therefore, it is very important to establish a sustainable economic development system this time. It can not only describe the current shape of Bengbu's economy, but also explore the existing problems of Bengbu's economy, and provide ideas for the sustainable development of Bengbu's economy in the future.

Based on the existing research results and the three core concepts of "economy, sustainability, and development capability", evaluation indicators including economic development, environmental development, resource development, social development, population development, labor development, and capital investment development were constructed. system. In the evaluation method, PCA-DEA model is selected, and the sustainable economic development system of Bengbu is built.

ISSN: 2688-9323

2. PCA-DEA Method and Index Evaluation System

2.1. Application of PCA-DEA Method in Evaluation Problems

The PCA model is also known as principal component analysis. By comprehensively evaluating the selected indicators, the original information is synthesized, and then the principal components are given weights according to the variance contribution rate of each variable. Finally, the required Calculated, and then get the final score, so as to make a comprehensive evaluation.

The DEA model was first proposed by American operational research scholars Charnes\Coopor and Rhodes in 1978. The CCR model in DEA is named after their initials. DEA is an effective method based on the frontier production function and takes the multi-input and multi-output decision-making unit (DMU) as the analysis object to evaluate the efficiency. Calculating its indicators can get comprehensive efficiency, scale efficiency and technical efficiency.

Due to the construction of the sustainable economic development system of Bengbu City this time, suggestions are put forward on how to realize the sustainable economic development system of Bengbu City. In the system, the technical efficiency of Bengbu City is more valued, and the PCA-DEA model can just see the technical efficiency. At the same time, the weighting of the DEA model is avoided, and the two have a double evaluation of the sustainable economic development of Bengbu City.

2.2. Index Screening Principles

Principles of scientificity and rationality: In the construction of the evaluation system of sustainable economic development capability, the principle of scientificity and rationality must be adhered to this time, proceeding from the objective reality of economic development, and selecting projects that can reasonably reflect the sustainable economic development capability of Bengbu City. index of.

The principle of pertinence and representativeness: This paper selects representative first-level input and output indicators from seven aspects of economy, society, resources, environment, population, labor force and capital investment, and then selects more detailed second-level indicators to achieve Improve the purpose of data screening and construction of evaluation index system.

The principles of availability and simplicity: This article takes Bengbu's economic sustainable development capacity as the analysis object, and the relevant data comes from the National Bureau of Statistics and some related papers and documents, so as to ensure the authenticity and reliability of the data source and make the conclusion more credible.

2.3. Index Selection

Taking the realization of urban sustainable development as the overall goal, considering the operability of data collection in actual operation, this time we refer to Wen Shilong’s thesis. He divides urban sustainable development into five levels for analysis. This time, they choose On the basis of some revisions, the index factors that affect the overall goal are summarized into seven levels, namely: economic development level, environmental development level, resource development level, social development level, population development level, labor development level and capital investment development level.

This paper selects the above seven levels for analysis, and extracts 33 indicators based on these seven levels, and then builds an evaluation index system suitable for the DEA model.

2.4. Construction of Evaluation System

Using the premise of the DEA model, the first step divides these indicators into two categories: input indicators and output indicators; the second step divides the two categories of indicators

ISSN: 2688-9323

according to their respective levels. Build the 4 levels of development as input indicators, and build the remaining 3 levels as output indicators.

The specific sustainable development capability evaluation index system is as follows:

Table 1. Sustainable Development Indicators

Level 1 indicators	Level 2 indicators	Level3 indicators
put in Index X	Labor Development Index X1	Total number of scientific research personnel (10,000 people) x1
		Total social practitioners x2
	Environmental Development Indicators X2	Total waste water discharge x3
		Sulfur dioxide emissions x4
		Inhalable particles x5
		Total industrial waste gas emissions x6
		Average sound level of road traffic noise x7
		The average sound level of environmental noise in the central urban area x8
		General industrial solid waste generation x9
		Hazardous waste generation x10
	Resource Development Index X3	Total water supply x11
		LPG sales x12
		Average energy consumption per person x13
		Primary energy production x14
	Fund investment development indicator X4	General public budget expenditure x15
		Government fund expenditure x16
		Research and experimental development expenditure x17
output Index Y	Social Development Index Y1	Engel coefficient y1
		Per capita consumption expenditure of all residents y2
		The per capita disposable income of all residents y3
		Hospital beds per thousand population y4
		Heating area y5
		Number of gas users y6
		Number of public transport vehicles in operation at the end of the year y7
		Urban green area y8
	Population Development Index Y2	Permanent population y9
		Natural population growth rate y10
		Per capita years of education y11
	Economic Development Index Y3	Total GDP y12
		Per capita GDPy13
		Primary industry growth rate y14
		Secondary industry growth rate y15
		Growth rate of the tertiary industry y16

ISSN: 2688-9323

3. Research Methods

3.1. Standardized Processing

Based on the above, the evaluation system was constructed and the data was obtained from EPS. However, due to the different dimensions selected by different indicators, the impact of these indicators is also different, which will affect the accuracy of the analysis results. Therefore, it is necessary to standardize the data.

The processing steps are as follows:

Standardization: with data x=(x1,x2,...xn).

$$y_i = \frac{X_i - \bar{X}}{S_i}, S_i = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X})^2}$$

After the above processing, the difference between dimensions can be removed, which can make the conclusion more scientific and effective.

3.2. Principal Component Analysis

The main idea of factor analysis is dimensionality reduction. Starting from studying the internal relationship between indicators, some variables with the same information can be attributed to a small number of irrelevant factors. The general model representation is:

$$Xi=ai1F1+ai2F2+ai3F3+ai4F4+...+ainFn+i$$

In the above formula, Xi represents the original variable; F1, F2, F3, ... Fn represents the common factor, i is the special factor of Xi; aij is the factor loading, which can show that the i-th factor is on the j-th factor The load of not only reflects the dependence of Xi on Fj, but also shows the relative importance of Xi on Fj.

The variance contribution rate of the sample can also be obtained through the SPSS26.0 software, which reflects an explanation of the original variables by the common factor. It is generally considered that the contribution rate reaches 80% this time.

Therefore, this time, SPSS software was used to conduct principal component analysis on the seven sub-indices based on the evaluation system built earlier. The first index X1 contained fewer variables. After processing, it was found that the cumulative contribution rate of the corresponding first principal component 92.92%, can be used as an analysis, so the first principal component of the sub-index X1 can be recorded as X1' as its comprehensive evaluation index.

$$X1'=0.519x1+0.519x2$$

With the same method, the comprehensive index of each indicator can be obtained, and the detailed data is as follows:

ISSN: 2688-9323

$$X_1^{'}=(F_1)_{x1}=0.519X_1+0.519X_2$$

$$X_2^{'}=(F_1)_{x2}+(F_2)_{x2}=0.654X_3+1.055X_4+1.047X_5-1.054X_6+0.058X_7+1.031X_8+0.479X_9+1.019X_{10}$$

$$X_3^{'}=(F_1)_{x3}+(F_2)_{x3}=-0.006X_{11}+0.188X_{12}+0.69X_{13}+0.753X_{14}$$

$$X_4^{'}=(F_1)_{x4}=0.955X_{15}-0.536X_{16}+0.975X_{17}$$

$$Y_1^{'}=(F_1)_{y_1}=-0.101y_1+0.137y_2+0.145y_3+0.134y_4+0.138y_5-0.142y_6-0.132y_7+0.145y_8$$

$$Y_2^{'}=(F_1)_{y_2}=0.921y_9-0.486y_{10}+0.873y_{11}$$

$$Y_3^{'}=(F_1)_{y_3}+(F_2)_{y_3}=0.757y_{12}-0.658y_{13}-1.155y_{14}+1.1y_{15}+1.022y_{16}$$

Figure 1. Comprehensive index data of each indicator

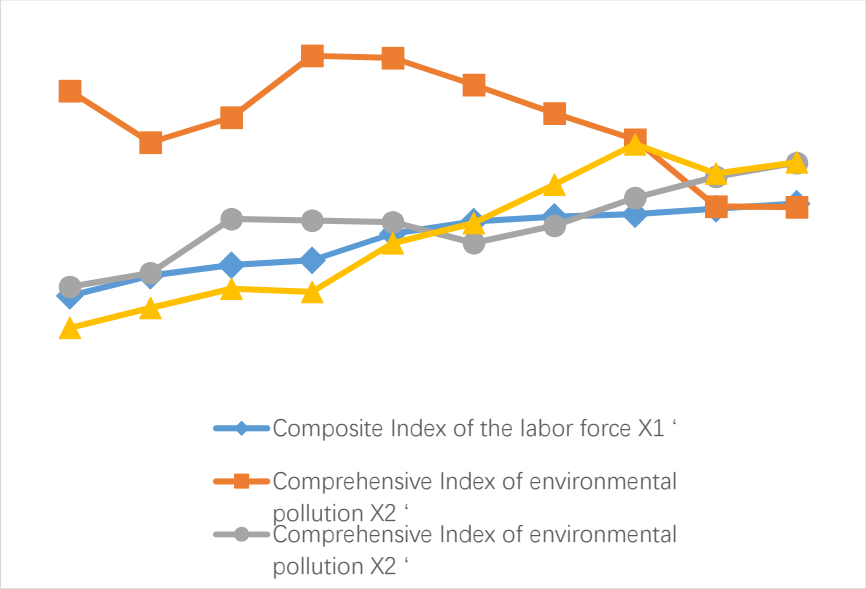

Figure 2. Comprehensive Index of Input Indicators

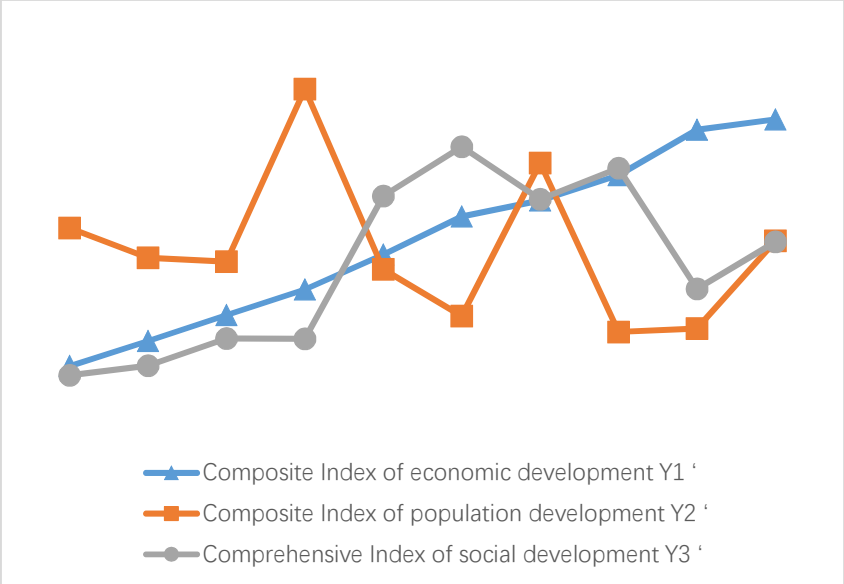

Figure 3. Composite Index of Output Indicators

ISSN: 2688-9323

From the above two figures, we can know that the comprehensive index of environmental pollution and the comprehensive index of population development in Bengbu generally show a decreasing trend year by year, and the environmental pollution index rose slightly from 2013 to 2014. In recent years, the Bengbu municipal government will pay attention to Concentrating on environmental improvement and governance, the above two composite indexes also declined. The labor composite index, capital investment composite index, economic development composite index, resource development composite index and social development composite index generally increased year by year during the 10 years. Social development and resource development fluctuate from time to time and are extremely unstable, which may be related to Bengbu's current policies. Although the annual development is not extremely stable, from the perspective of comprehensive index, the overall sustainable development ability of Bengbu City has shown a healthy development in the past 10 years.

3.3. Basic Principle of DEA Method

DEA method is divided into CCR model and BCC model. CCR can calculate the efficiency score of each production unit, and can obtain the contribution of each input element to efficiency. Therefore, this paper selects the CCR model in DEA for analysis, and the model for judging its effectiveness is as follows:

$$\min[\theta - \varepsilon(\sum_{r=1}^{t} S_r^+ + \sum_{i=1}^{m} S_i^-)$$

$$\sum_{j=1}^{n} X_{ij}\lambda_j + S_i^- - \theta X_{ij0} = 0$$

$$\sum_{j=1}^{n} Y_{ij}\lambda_j - S_r^+ - y_{rjo} = 0$$

$$\lambda_j \geq 0, S_r^+ \geq 0, S_i^- \geq 0$$

This paper selects the ten years of Bengbu City from 2011 to 2020 as the decision-making unit. This time, the comprehensive index of input and output in this decade has been calculated by the method of principal component analysis, so there is no need to carry out weighted analysis on it. The DEA-CCR model was explored.

From the perspective of the comprehensive technical efficiency level of sustainable development in Bengbu City, although it basically did not reach 1 in 2011-2020, the maximum number is greater than 0.9, and the overall comprehensive technical efficiency of sustainable development is not very low. There are 7 years in which the comprehensive technical efficiency of sustainable development is greater than 0.9, and 3 years in which the efficiency is less than 0.9, and 2015 and 2016 did not reach 0.8. Judging from the efficiency value calculated by the DEA-CCR model, it shows that in order to improve the comprehensive technical efficiency in the past two years, it is necessary to rationally allocate production resources and allocate employees in the production process, so as to achieve efficient use of resources as much as possible.

Scale efficiency can reflect whether the DMU is in the best state. If DMU=1, it is in the best state of scale. If DMU is greater than 0 and less than 1, it is considered not to be optimal. The scale efficiency of Bengbu City is above 0.9 except in 2015 and 2016 (Table 2). Among them, the seven years of 2011, 2013, 2014, 2015, 2016, 2017, and 2019 showed a trend of increasing returns to scale. It shows that the increase of input is less than the increase of output, so these 7 years have the potential to expand the scale. At present, there is no place in Bengbu that is decreasing

ISSN: 2688-9323

in scale, so it is not necessary to control the expansion of scale, but should vigorously accelerate the scale development to achieve the purpose of increasing the efficiency of sustainable development.

The most direct manifestation of technical efficiency and scale efficiency deviating from the optimal state is the emergence of redundant input and insufficient output. In order to change from invalid DEA to effective DEA, it is necessary to greatly improve the efficiency index of social development, and secondly, reduce some input in environmental pollution. In the case of constant output, increase its input, or in the case of constant input, increase its output.

Table 2. Solution results of DEA-CCR model

Item	Technical benefit TE	Scale benefit SE(k)	Comprehensive benefit OE(θ)	Effectiveness	Type
2011	0.993	0.992	0.985	Non-dea efficient	Increasing returns to scale
2012	1	1	1	DEA IS EFFECTIVE	A fixed reward for scale
2013	0.987	0.978	0.965	Non-dea efficient	Increasing returns to scale
2014	0.948	0.912	0.864	Non-dea efficient	Increasing returns to scale
2015	0.935	0.841	0.786	Non-dea efficient	Increasing returns to scale
2016	0.915	0.85	0.778	Non-dea efficient	Increasing returns to scale
2017	0.953	0.98	0.934	Non-dea efficient	Increasing returns to scale
2018	1	1	1	DEA IS EFFECTIVE	A fixed reward for scale
2019	0.973	0.957	0.93	Non-dea efficient	Increasing returns to scale
2020	1	1	1	DEA IS EFFECTIVE	A fixed reward for scale

4. Conclusion

Through the comprehensive evaluation system of Bengbu's economic sustainable development ability, it is found that Bengbu's environmental pollution and population have gradually declined in recent years, which may be because Bengbu has taken the following measures to focus on rectification of environmental problems: 1) Start the work plan of Bengbu City's carbon peak and the preparation of Bengbu's "14th Five-Year Plan" to deal with climate change; 2) Complete the "one factory, one policy" rectification plan; 3) Carry out the investigation and treatment of sewage entering the river; 4) Construction land access Linkage management.

These measures have achieved good results. Therefore, in the process of sustainable economic development in Bengbu, we must continue to maintain it. The comprehensive index of resource development generally shows an upward trend year by year, which is attributed to the fact that the Bengbu municipal government has focused on environmental improvement and governance in recent years. However, for the development of Bengbu, the annual development

ISSN: 2688-9323

is extremely unstable. The composite index of population development and the composite index of social development fluctuated greatly.

The economic development index of Bengbu City shows an upward trend year by year, but it has achieved zero growth in 2021, indicating that there are problems and it does not meet the sustainable development system of Bengbu City.

Then this time, a data envelopment analysis model was established and solved. Judging from the solution results, the city's technical benefits, scale benefits, and comprehensive benefits showed a downward trend from 2011 to 2016, and then increased year by year from 2016 to 2020. . This may be the wrong policy adopted by the early government, and then redeemed through amendments. Bengbu's comprehensive technical efficiency for sustainable development is at a medium level, and most of it is greater than 0.9 and less than 1 in 2011-2021. efficiency.

In the future, our city should support the market-based policy of sustainable anti-war goal construction, reduce or cancel subsidies by creating market policies, clarify property rights, privatization and decentralization; it should also support sustainable development participation policies, and guide citizens through education Participate in the construction of ecological civilization to communicate and improve the public opinion supervision mechanism. With the joint participation of the government, enterprises and society, the policy objectives of sustainable development will be achieved.

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