

On the Development of Science and Technology Finance and the Optimization of Regional Industrial Structure in Anhui

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Abstract

The "double carbon" target that China promised at the UN General Assembly in 2020 puts forward new requirements for the transformation and development of China's energy structure. As an important member of the Yangtze River Delta, Anhui Province lags behind Jiangsu, Zhejiang and Shanghai in terms of energy conservation and carbon reduction. Therefore, it is of great significance to measure the energy use efficiency of Anhui Province in recent years and analyze the influencing factors of energy use efficiency. This paper measures the energy use efficiency of Anhui Province through the single factor and data envelopment analysis of the total factor energy efficiency evaluation method. The empirical results show that: in recent years, the energy economic efficiency of Anhui Province is good, and it is necessary to maintain high energy use efficiency. In order to improve energy efficiency, energy conservation and emission reduction in Anhui Province to promote low-carbon projects, this paper puts forward relevant suggestions.

Keywords

Energy Efficiency; Total Factor Energy Efficiency; Data Envelopment Analysis.

1. Introduction

In recent years, extreme weather happens occasionally in the world, human survival is challenged, energy consumption is excessive, and countries around the world are actively promoting energy conservation and emission reduction to develop low-carbon economy. In 2020, China promised at the UN General Assembly to strive to achieve carbon peak by 2030 and carbon neutrality by 2060, which put forward higher requirements for the transformation and upgrading of the energy structure and energy conservation and emission reduction. In 2021, the State issued the Opinions of the Central Committee of the Communist Party of China and the State Council on Completely, Accurately and Comprehensively Implementing the New Development Concept and Doing a Good Job of Carbon Peak and Carbon Neutralization, which proposed to vigorously develop energy-saving and low-carbon buildings and accelerate the large-scale development of ultra-low energy consumption, near zero energy consumption and low-carbon buildings. In June 2022, the People's Government of Anhui Province issued the Implementation Plan for Energy Conservation and Emission Reduction in Anhui Province during the "Fourteenth Five Year Plan". In order to study the situation of energy conservation and carbon reduction in Anhui Province, from the perspective of new energy utilization, this paper analyzes the current situation and efficiency of new energy utilization in Anhui Province, as well as the influencing factors to promote the development of new energy, and puts forward specific countermeasures and suggestions that can promote the transformation and upgrading of energy structure, accelerate technological innovation and promotion, and optimize the

overall energy allocation, providing suggestions for energy conservation and carbon reduction in Anhui Province.

2. Literature Review

Under the background of the "double carbon" goal, He Chunguang et al. and Ding Han et al. studied the energy economic system efficiency of the power industry [1, 2]. Cai Xiaochun et al. mentioned that there are often two different methods for the evaluation of energy efficiency in domestic and foreign literature [3]. One is to use the single factor method, that is, to define energy utilization efficiency as the reciprocal of energy intensity, while energy intensity is the energy consumption per unit output or activity. The reduction of energy intensity means the improvement of energy utilization efficiency. The other is to adopt a multi factor approach, which considers the interaction between energy consumption and other factors of production, namely DEA model method. In the calculation of energy efficiency, Wang Li et al., Chen Jingquan et al. used StoNED to measure total factor energy efficiency, and used SEM Tobit regression model to study the driving factor effect of China's total factor energy efficiency [4, 5]. Finally, we will explore policy recommendations to improve total factor energy efficiency. In addition, Liu Zheng et al. studied the mechanism of China's energy efficiency from the perspective of population size and industrial structure, and concluded that the energy efficiency of China's provinces has significant spatial dependence [6].

Through combing the existing literature, it is found that many scholars have calculated the energy utilization efficiency in different regions of China, and most of them are total factor efficiency evaluations, including data envelopment analysis methods, factor decomposition methods, etc., but few scholars have measured and evaluated the energy efficiency of Anhui Province. In this paper, the single factor and total factor energy efficiency evaluation methods are used to evaluate the energy efficiency of Anhui Province, and according to the research results, suggestions are made to improve the energy use efficiency of Anhui Province.

3. Single Factor Energy Efficiency Evaluation

Energy consumption intensity refers to the amount of energy used per unit of GDP, generally in tons of standard coal/10,000 yuan. Energy consumption intensity refers to the energy consumption per unit economic output. The lower the intensity is, the higher the energy efficiency is. This value can reflect the economic efficiency of energy and is an important indicator to measure the energy utilization efficiency of a country. The gross output value and total energy production (10000 tons of standard coal) of Anhui Province in recent years are obtained from the statistical yearbook of Anhui Province, and the energy consumption intensity data in tons of standard coal/10000 yuan is obtained through calculation, as shown in Figure 1 below.

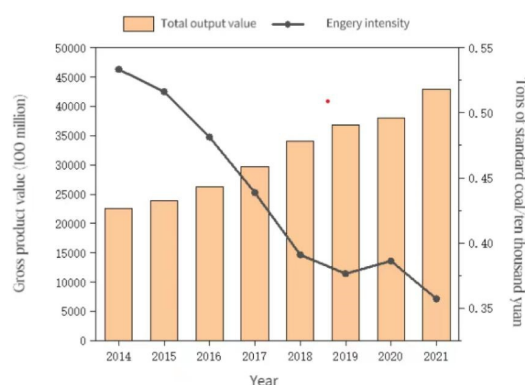


Figure 1. GDP and Energy Consumption Intensity of Anhui Province

It can be seen from Figure 1 that the GDP of Anhui Province has gradually increased in recent years, with a good economic development trend. However, the energy consumption intensity showed a downward trend in 2014-2019 and reached the lowest in 2019, indicating that the energy consumption per unit of GDP was gradually decreasing and the energy utilization efficiency was improved. Subsequently, there will be a small increase in the period from 2019 to 2020, and a decrease in the period from 2020 to 2021. In 2021, it will reach the lowest level in recent years, indicating that Anhui Province will have the lowest energy consumption intensity in 2021, that is, the highest energy efficiency utilization rate. It can be seen that the energy economic efficiency of Anhui Province is good in recent years, and it is necessary to maintain high energy efficiency.

4. All Factor Energy Efficiency Evaluation

4.1. Method Introduction

Data envelopment analysis (DEA) is a method of operational research and economic production boundary research. Its basic idea is to comprehensively analyze the input and output data of the production decision-making unit to obtain the relative indicators of each efficiency, and then rank the effective rate indicators to determine the relatively effective decision-making unit. At the same time, the projection method can be used to point out the reasons for non DEA effectiveness or DEA effectiveness, and the direction and extent of improvement, to provide management decision-making information for managers. There are many models for data envelopment analysis. The CCR model proposed by Charnes, Cooper and Rhodes has a clear idea, which transforms practical problems into linear programming problems. The model structure is simple and easy to understand. Therefore, this paper uses the CCR model to evaluate the total factor energy efficiency of Anhui Province.

The CCR model turns the problem into a linear programming problem. There are n decision making units (DMU), and each DMU has m inputs and s outputs.

Set X_{ij} ($i=1, 2, \dots, m; j=1, 2, \dots, n$) represents the i th input of the j th DMU, y_{rj} ($r=1, 2, \dots, s; j=1, 2, \dots, n$) represents the r -th output of the j th DMU, v_i ($i=1, 2, \dots, m$) represents the weight of the i th input, u_r ($r=1, 2, \dots, s$) represents the weight value of the r output. Vector X_j , Y_j ($j=1, 2, \dots, n$) represents the input and output vectors of decision unit j respectively, and v and u represent the input and output weight vectors respectively. The model of linear programming problem is as follows:

$$\begin{aligned} & \text{Min} \theta \\ \text{st. } & \begin{cases} \sum_{j=1}^n \lambda_j X_j \leq \theta X_{j_0} \\ \sum_{j=1}^n \lambda_j Y_j \geq Y_{j_0} \\ \lambda_j \geq 0, j = 1, 2, \dots, n \end{cases} \end{aligned} \quad (1)$$

The solution of the linear programming problem can be obtained by software programming.

4.2. Model Selection and Data Integration

Single factor energy efficiency only considers the relationship between energy and economy, and does not consider the influence of other factors. Considering the impact of energy type, labor input, asset input and economic development, the CCR model in data envelopment analysis is used to evaluate the total factor energy efficiency of Anhui Province. The selected input indicators are total energy consumption, number of employees, and direct investment from foreign countries, Hong Kong, Macao and Taiwan. Since the fixed asset investment data of Anhui Province over the years cannot be found, the data of direct investment from foreign countries, Hong Kong, Macao and Taiwan are used instead, and the output indicator is the GDP of Anhui Province. Due to the lack of historical data of individual indicators in the statistical

yearbook, the data is intermittent. The data obtained from the statistical yearbook of Anhui Province is shown in Table 1.

Table 1. Historical data of Anhui province

Year	Total energy consumption (10000 tons of standard coal)	Number of employees (10000 people)	Direct investment from foreign countries, Hong Kong, Macao and Taiwan(USD 10000)	GDP (100 million yuan)
2000	4878.82	3450.7	31847	3125.33
2005	6505.98	3669.7	68845	5675.85
2010	9414.00	4050	501446	13249.78
2014	12011.02	4311	1233978	22519.65
2015	12301.23	4342.1	1361945	23831.18
2016	12662.89	4361.6	1476712	26307.70
2017	13018.71	4377.9	1589652	29676.22
2018	13294.71	4385.3	1700160	34010.91
2019	13869.73	4384	1793674	36845.49
2020	14697.9	3243	1830542	38061.51
2021	15342.63	3215	1929728	42959.18

4.3. Empirical Analysis

Use Matlab programming to calculate the data, and get the energy use efficiency of Anhui Province over the years. The data is shown in Table 2 below.

Table 2. Evaluation results of total factor energy efficiency in Anhui

Year	2000	2005	2010	2014	2015	2016
Energy efficiency	1	1	0.888677	0.776531	0.760324	0.784944
Year	2017	2018	2019	2020	2021	
Energy efficiency	0.832371	0.913657	0.948768	0.931712	1	

According to the calculation results of energy use efficiency of Anhui Province over the years in Table 2, after considering the impact of energy types, labor input, asset input and economic development, it is estimated that the energy use efficiency of Anhui Province will be higher in 2000, 2005 and 2021, and higher in 2018, 2019 and 2020, all above 0.9, which indicates that the energy use efficiency of Anhui Province is gradually improving in recent years, We need to maintain and continue to improve energy efficiency.

5. Conclusion and Suggestions

According to the results of the single factor energy efficiency evaluation and the total factor energy efficiency evaluation of Anhui Province, combined with the actual development situation of Anhui Province, the article puts forward the following suggestions.(1) Optimize relevant policies. The government's policies and regulations on environmental pollution have an impact on energy efficiency. Appropriate policies and regulations will promote the use of advanced technology by enterprises and favor the use of clean energy, thus reducing pollution generation and emissions. At the same time, it will focus on strengthening pollution control, using new building materials and strengthening the training of green building practitioners.

(2) Improve the technical level. Improve technical level, upgrade equipment, introduce advanced technologies at home and abroad, adopt efficient and energy-saving equipment, increase investment in technical research, improve innovation level, develop technologies to reduce energy consumption and improve energy utilization efficiency, and upgrade equipment,

so as to reduce the generation and emission of pollutants from the source and improve energy utilization efficiency.

(3) Adjust the energy structure. In order to adjust the energy consumption structure, fossil energy is the main energy source at present, and the use of chemical energy such as petroleum and coal mine should be limited, and excessive exploitation and utilization should not be allowed. At the same time, renewable energy and clean energy, such as wind energy, water energy and solar energy, should be advocated. The development and promotion of new energy should be increased to increase the proportion of new energy consumption.

(4) Upgrade the industrial structure. At present, Anhui Province is dominated by the secondary industrial structure. Under the background of this industrial structure, there is a mode of production with high energy consumption. The industrial structure of Anhui Province needs to be upgraded urgently [7]. Anhui Province needs to promote the change of industrial structure, increase the proportion of the tertiary industry structure, establish a green industrial system, and comprehensively promote the work of carbon peaking and carbon neutralization.

(5) Establish the idea of energy conservation and emission reduction. The government needs to guide the people to increase the publicity related to green buildings, energy conservation and emission reduction, and low carbon, so that the people can truly understand low carbon from the perspective of long-term economic benefits, ecological benefits, etc. [8]. If the publicity expands the green building consumer market, real estate development enterprises will actively meet the needs of consumers, so as to vigorously develop green buildings, and achieve energy conservation and emission reduction.

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