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Research on Eco-efficiency Evaluation in Beijing-Tianjin-Hebei Region

Lihui Zhou[1,*], Bo Zhang[2], Yufeng Li[1] and Honglian Wang[1]

[1]College of science, north China university of science and technology, Tangshan 063210, China

[2]Hebei academy of social sciences, Shijiazhuang 050051, China

Abstract

In this paper, panel data from 13 prefecture-level cities in Beijing-Tianjin-Hebei region from 2009 to 2018 were selected for analysis. First of all, through the python network data capture technology, collect and screen the ecological efficiency evaluation index information, and combined with Pearson-related tests, excluding low correlation indicators, get the ecological efficiency indicator evaluation system of this paper. Secondly, the bootstrap-DEA model was used to conduct static and dynamic evaluation of the ecological efficiency in the beijing-tianjin-hebei region. And the results show that the level of ecological efficiency development in Beijing-Tianjin-Hebei area is seriously unbalanced, Beijing and Tianjin have been in the advantage, and the efficiency value of Qinhuangdao, Tangshan, Baoding and Changzhou in Hebei Province are high. Finally, from the ecological efficiency evaluation results, sum up the previous research results, and make targeted recommendations.

Keywords

Beijing-Tianjin-Hebei Region, Eco-efficiency, Bootstrap-DEA model.

1. Introduction

As early as 2005, Xi Jinping put forward the scientific conclusion that "green waters and green mountains are the gold and silver mountains" [4]. The 19th national congress of the communist party of China also pointed out in the report that we must practice the concept that green mountains and clear waters are the gold and silver mountains. However, the development mode of economic growth at the expense of the environment for a long time in the Beijing-Tianjin-Hebei Region has led to the decline of the ecological environment quality in the region, and the ecological environment problem has become an urgent issue in the region [5].

From the aspect of ecological environment pressure, the accelerated economic development will inevitably cause serious ecological problems. The Beijing-Tianjin-Hebei region, as one of the important economic circles with rapid economic development, has an inevitable ecological environment problem [6], and the task of ecological management is particularly arduous. From the experience of development, it is not sustainable to develop the economy at the expense of the ecological environment. To develop the ecological economy, promote green development and improve ecological efficiency are the most fundamental ways.

In this paper, the ecological efficiency of the Beijing-Tianjin-Hebei region was studied. Combining with the ecological efficiency theory, python network data capture technology and bootstrap-dea model method were used to study the ecological efficiency and its influencing factors in the Beijing-Tianjin-Hebei region.

2. Research on Eco-efficiency Concept and Method

The concept of eco-efficiency originally belongs to the biological category, which refers to the energy conversion Efficiency of adjacent nutrient levels in the energy flow of the ecosystem.

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Schaltegger and Sturn (1990) first introduced it into the field of economics and defined it as the ratio between output and environmental impact in economic production activities [7]. Ecological efficiency combines economic production with environmental factors, which has extremely important policy implications (sustainable development, circular economy, green economy transformation), and has become the most important reference for many countries and regions in the world to formulate economic and environmental development strategies.

At present, DEA method is the most widely used among the data envelopment methods used to evaluate ecological efficiency in academic circles. However, for regions with unbalanced development, the traditional DEA method fails to effectively rank and compare the efficiency values, which may lead to deviations. The small number of research areas may also lead to the underestimation of standard errors and even clustering [8]. The Beijing-Tianjin-Hebei region is located in the central region of bohai sea. It was found that Bootstrap-DEA model has not been used to evaluate the ecological efficiency of this region. The Bootstrap-DEA model can make up for the deficiency of traditional DEA model by correcting the estimation bias of ecological efficiency and providing the confidence interval of ecological efficiency measurement. Therefore, this paper established an ecological efficiency evaluation index system based on Bootstrap-DEA model to study the influencing factors of ecological efficiency in the Beijing-Tianjin-Hebei region.

3. Eco-efficiency Evaluation of Beijing-Tianjin-Hebei Region

3.1. Construction of Eco-efficiency Index System in the Beijing-Tianjin-Hebei Region

references at a time may be put in one set of brackets [3, 4]. The references are to be numbered in the order in which they are cited in the text and are to be listed at the end of the contribution under a heading References, see Table 1.

At present, in the actual research, there is no unified index system. Therefore, in accordance with the principle of ecological efficiency, this paper applies python network data capture technology. Firstly, "eco-efficiency evaluation" is used as the keyword to search knowledge in CKNI, and "title, author, tutor, abstract" is crawled and saved by crawler. 536 literatures were collected, and 172 literatures related to regional ecological efficiency were preliminarily selected through extensive reading of titles. Through the analysis of the abstract and the paper, a total of 87 indicators were found. After frequency statistics of 87 indicators, it is screened and concluded that the input indicators include environmental input and energy input (environmental pollution factor is considered as input [8, 9]), and the output is regional GDP, which is set as the eco-efficiency evaluation index system in this paper:

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Table 1: The index system of Eco-Efficiency evaluation

index	category	specific indicators constitute	description
Input Indicators	Environmental Pollution	Waste Water Discharge	Wastewater Discharge(X_1),Chemical Oxygen Demand(X_2)
		Emissions	SO_2(X_3),Soot Emission(X_4)
		Solid Waste Emissions	Industrial Solid Waste Emissions(X_5)
	Resource Consumption	Energy Consumption	Total Energy Consumption(X_6)
		Water Consumption	Total Urban Water Use(X_7)
		The Land Use	Building Area(X_8),Cultivated Area(X_9)
	Human Input	Human Consumption	Employment(X_{10})
Output Indicators	Economic Factors	Total Economic Development	GDP of the Beijing-Tianjin-Hebei Region (Y)

3.2. Data Sources

The data in this paper are mainly from the statistical yearbook from 2009 to 2018 and the statistical bulletins of various cities in Hebei province[1][2][3]. A total of 1,690 data from 11 indicators in 13 cities in theBeijing-Tianjin-Hebei Region for 10 years from 2009 to 2018 were used. The cities are Beijing, Tianjin, Shijiazhuang, Tangshan, Qinhuangdao, Handan, Xingtai, Baoding, Zhangjiakou, Chengde, Cangzhou, Langfang and Hengshui.

3.3. Empirical Analysis

3.3.1. Pearson Correlation Test of Input and Output Indicators

In the DEA model, the selected input and output indexes are required to meet the hypothesis of "order preservation", that is, when the input indexes increase, the output indexes cannot decrease [8]. Since the selected variables are all continuous variables, Pearson correlation coefficient method was used to test in this paper. The test results showed that except for the two variables of Soot Emission (X_4) and Cultivated Area (X_9), the correlation coefficients of other input variables and output variables of the Beijing-Tianjin-Hebei region's gross regional product (Y) were all positive and significant at the significance level of 5%. Therefore, in the evaluation of ecological efficiency, two variables with low correlation are excluded: Soot Emission (X_4) and Cultivated Area (X_9), so as to make DEA indexes meet the principle of "order preservation".

3.3.2. Empirical Analysis of Eco-efficiency

(1) Static analysis of Eco-efficiency

According to the requirements of the model and the data basis, the eco-efficiency values of 13 prefecture-level cities in the Beijing-Tianjin-Hebei region were estimated. The results are shown in Table 2:

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Table 2: Eco-efficiency of provinces and regions in 2018

region	the modified efficiency value of Bootstrap-DEA	ranking
Beijing	0.9935	1
Tianjin	0.9849	2
Shijiazhuang	0.7543	9
Chengde	0.5865	13
Zhangjiakou	0.6900	12
Qinhuangdao	0.9814	3
Tangshan	0.9723	4
Langfang	0.7862	8
Baoding	0.9487	5
Cangzhou	0.9264	6
Hengshui	0.8203	7
Xingtai	0.7001	11
Handan	0.7321	10

As can be seen from the above table:

The revised efficiency value of Beijing ranked first, because Beijing, as the capital city, is the national political, economic and cultural center. In the development process, Beijing has been adhering to the concept of "green, harmonious, ecological and environmental protection" for a long time. Secondly, Beijing has a high level of economic development, reasonable industrial setup, and the tertiary industry has an absolute advantage. At the same time, the secondary industry is dominated by technological innovation and advanced manufacturing.

Tianjin correction efficiency value is in the second place, compared with some cities in hebei province has obvious comparative advantage.

Except Qinhuangdao, Tangshan, Baoding and Cangzhou which were greater than 0.9, the modified efficiency values of 11 cities in Hebei province were all under 0.9, which were DEA invalid. This shows that the input is too much, can reduce the input to obtain constant output. From the perspective of city level, ecological poverty and poor ecological problems are interwoven in Langfang and Handan with low efficiency. Zhangjiakou ranks the second from the bottom. The problem of ecological efficiency stems from the low output, that is, the relatively backward level of economic development.

(2) Dynamic analysis of changes in Eco-efficiency

The Bootstrap-DEA ecological efficiency values of the Beijing-Tianjin-Hebei region over the years were calculated. Some data are shown in the following Figure 1.

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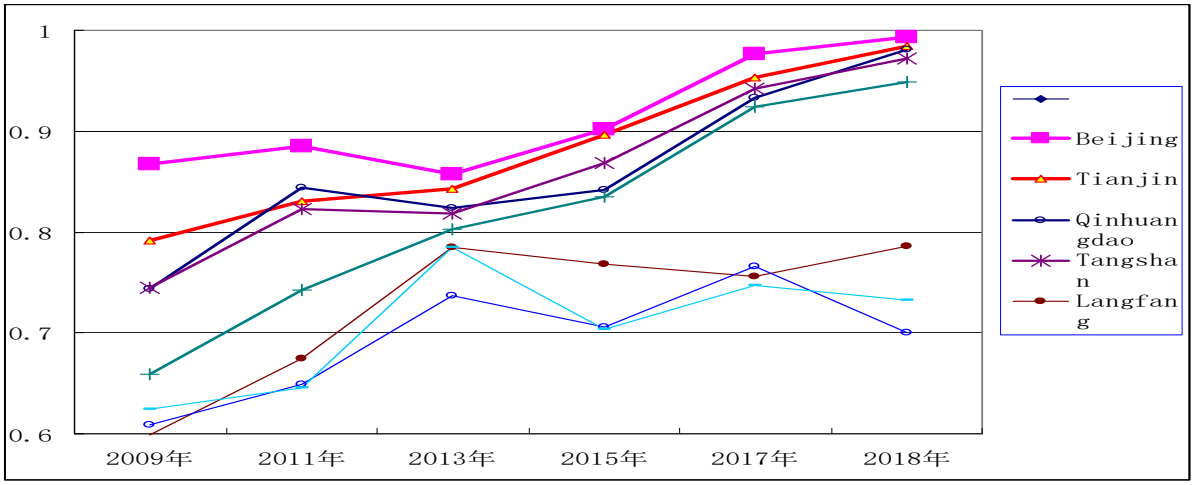

Figure 1: The line chart of the Bootstrap-DEA Eco-efficiency values of some cities

As can be seen from the figure above:

There was no difference between the Bootstrap-DEA ecological efficiency ranking of Beijing and Tianjin in 2018 and the mean ranking of all years, ranking first and second respectively. From 2009 to 2018, the eco-efficiency values of both regions showed an upward trend.

From 2009 to 2018, the eco-efficiency of 11 cities in Hebei province fluctuated to different degrees and then improved. From a regional perspective, the average ecological efficiency of Qinhuangdao, Tangshan, Baoding and Cangzhou over the years is still relatively high. The rapid progress in Baoding was attributed to the elimination of the "three top" enterprises by the environmental protection production requirements and the energy-saving and emission reduction mechanism, which increased from 0.6592 in 2009 to 0.9487 in 2018. Langfang, Handan and Zhangjiakou, which have low efficiency, are all short in terms of technical efficiency and scale gain, which is also caused by the unscientific proportion of investment in production. The difference of eco-efficiency value among different regions in Hebei province is the imbalance of the development of each region. The development of Beijing and Tianjin also has a significant driving effect on the improvement of eco-efficiency value in Hebei province.

4. Conclusion and Suggestions

Based on the resource, environment and economic statistics of 13 prefecture-level cities in the Beijing-Tianjin-Hebei region, the Bootstrap-DEA model was used to evaluate the eco-efficiency of the region. The main conclusions are as follows:

(1) Beijing's Bootstrap-DEA model ranked first in efficiency value, and the eco-efficiency value of Beijing showed an upward trend. With a high level of economic development and reasonable industrial setup, the tertiary industry occupies an absolute advantage in Beijing, while the secondary industry is dominated by technological innovation and advanced manufacturing.

(2) Tianjin's Bootstrap-DEA model correction efficiency value is in the second place, which has obvious comparative advantages compared with some cities in Hebei province.

(3) Except Qinhuangdao, Tangshan, Baoding and Cangzhou, which are above 0.9,the revised efficiency values of 11 cities in Hebei province are all below 0.9. Constant output can be obtained by reducing input. From the perspective of city level, ecological poverty and poor ecological problems are interwoven in Langfang and Handan with low efficiency. Zhangjiakou ranks the second from the bottom. The problem of ecological efficiency stems from the low output, that is, the relatively backward level of economic development.

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(4) There are obvious regional differences in eco-efficiency in the Beijing-Tianjin-Hebei region. One reason for the relatively low eco-efficiency is the scale of industry, which is still the main driving force of some cities in Hebei province.On the other hand, it is the type of industry. Cities with more developed heavy industry consume more resources and emit more pollution, such as Tangshan.

In view of the above conclusions, the following Suggestions are given:

(1). Optimize the industrial structure

Beijing should continue to give priority to the development of the tertiary industry, expand the development of the service industry featuring intellectual capital, and stick to innovation-driven development. Tianjin, as a port and gateway between Beijing and Hebei province, should strive to build a modern service industry and further improve the modern financial service system while persisting in the development of industry. Hebei province should adhere to the "agricultural security, industrial connotation, the expansion of the scale of the service industry" road.

(2) Improve the environmental protection capability of enterprises

The Beijing-Tianjin-Hebei region should strengthen the garbage classification, improve the garbage classification and recycling system, and promote the utilization of renewable resources into enterprises. Enhance the recycling channels and methods; strengthen the awareness of residents of environmental protection. Industries and enterprises should reasonably deal with the sulfur dioxide emissions, soot emissions and other pollutants generated in the later stage of the industry, and discharge them after reaching the standards. The government should strengthen environmental regulation, restrict industrial enterprises from the policy, and effectively improve environmental protection capacity.

(3). Promoting the recycling of resources

In order to promote the recycling of resources, the Beijing-Tianjin-Hebei region should strengthen the comprehensive utilization of industrial solid waste and agricultural waste. The system of ecological compensation should be established to ensure the principle of coordinated development between economic development and ecological environment, and the balance of interests involved in the economy should be considered and discarded.

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References

[1] Beijing bureau of statistics (NBS). http:// tjj. beijing. gov. cn/ tjsj/ yjdsj /GDP /2016 /201701 / t20170122_154002.html.

[2] Tianjin municipal bureau of statistics (NBS). http://www.stats-tj.gov.cn/Item/25858.aspx.

[3] Hebei province bureau of statistics (NBS). http://tjj.hebei.gov.cn/hetj/tjsj/jjnj/.

[4] Nie Xiaoyun. Research on the Open Sharing Mechanism of Eco-environmental Information in the Beijing-Tianjin-Hebei Region [D]. Yanshan university, 2019.

[5] Wang Shaojian, Fang Chuanglin, Wang Yang. Quantitative Measurement of the Interactive Coupling Relationship between Urbanization and Ecological Environment in the Beijing-Tianjin-Hebei Region [J]. Acta Ecologica Sinica, 2015, 35 (7) : 2244-2254.

[6] Schaltegger, S., Sturm, A. Okologische rationalitat[J]. Die Unternehmung, 1990, 4:273-290.

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[7] Han Yonghui. Study on the Performance Evaluation of Provincial Ecological governance in China [J]. Statistical Research,2017,34(11):69-78.

[8] Cheng Jinhua, Sun Qiong, Guo Mingjing, Xu Wenyun. Regional Differences and Dynamic Evolution of Eco-efficiency in China [J]. China Population, Resources and Environment, 2014,24 (01) : 47-54.