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Research on Green Development Efficiency of Logistics Industry based on Unexpected Output SBM Model

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Abstract

Based on the concept of green development, construct a green development efficiency index system for the logistics industry, and use the super-efficiency SBM model of unexpected output to measure the green development efficiency of logistics in 30 provinces, municipalities and autonomous regions in China from 2015 to 2019. The results show that the green development efficiency values vary greatly among regions, and the overall efficiency level is not high, showing a spatially "Eastern> Central> Western" state; the overall green development efficiency of logistics is on the rise.

Keywords

Logistics Green Development; Logistics Efficiency; SBM Model.

1. Introduction

With the increasing speed of economic development and increasingly fierce market competition, the tertiary industry, as an important indicator of a country's economic development, has become increasingly prominent. As an important part of the tertiary industry, the logistics industry has received more and more attention from various countries. China's investment in the development of the logistics industry has gradually increased, mainly in terms of manpower, finance and energy. The efficiency research of the logistics industry plays a vital role in promoting the further growth of the national economy. But at the same time, while striving to speed up the development of the logistics industry, we cannot ignore the negative impact of the development of the logistics industry on the environment. Therefore, this paper conducts a systematic study on the green development efficiency of logistics. In order to promote China's green development.

2. Literature Review

2.1. Main Research Methods

At present, the methods of efficiency measurement in academia include the super-efficiency SBM model. For example, Zhiwang Qian and Lin Sun (2021) used the SBM model to measure the logistics efficiency of the Pearl River Delta region and analyzed its influencing factors[1]; Yuhong Wang and Qi Liu (2017) measured the logistics efficiency of the Yangtze River Economic Zone based on the Super-SBM model, and concluded that the overall evolution of logistics efficiency in the Yangtze River Economic Zone is divided into three types: high, medium, and low. Secondly, data envelopment analysis (DEA) is also the most commonly used method in efficiency measurement [2]. For example, Bo Wang (2019) conducted a comprehensive evaluation of China: regional logistics efficiency along the "Belt and Road" based on the three-stage DEA model, and found that the "Belt and Road" "The development of the logistics industry in the regions along the route is clearly lagging behind other regions"[3]. Xinyue Zhang used DEA-Malmquist index model to analyze the static and dynamic aspects of logistics efficiency in the Beijing-Tianjin-Hebei region [4].

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2.2. Selection of Green Logistics Efficiency Index

From the perspective of indicator selection, scholars mostly consider manpower, material resources, and resources as input indicators, and industrial added value and freight turnover as output indicators. Yan Yi (2020) selected the number of employees, investment in fixed assets, per capita road area, highway mileage, grade highway mileage, and the number of trucks as input indicators, total freight volume, freight turnover, The industrial added value is the expected output indicator, and the original carbon dioxide emission is the undesired output indicator[5]. After considering the above indicators, Jingshi He et al. (2021) added the comprehensive total mileage of transportation lines as the input indicator, and the carbon emission of the logistics industry was an undesired output[6].

3. Research Methods and Indicator Selection

3.1. Research Methods

Through combing the literature, it is found that the main method selected for efficiency measurement is the DEA model, and the SBM model uses relatively few. The characteristic of DEA is that it is suitable for comprehensive evaluation of multi-input and multi-output effectiveness, and the characteristic of SBM model is that it can take undesired output into consideration. Therefore, after comprehensively considering the advantages of both, this article selects the SBM super-efficiency model as the method of measuring the green development efficiency of logistics in this article. The main calculation formula is as follows:

$$\begin{cases} min\rho_{SE} = \dfrac{1+\frac{1}{m}\sum_{i=1}^{m} s_i^- / x_{ik}}{1-\frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_{rk}} \\ s.t.\sum_{j=1,j\neq k}^{n} X_{ij}\gamma_j - S_i^- \leq x_{jk} \\ \sum_{j=1,j\neq k}^{n} X_{rj}\gamma_j + S_i^+ \geq y_{jk} \\ \gamma, S^-, S^+ \geq 0 \\ i = 1, 2, \ldots,; j = 1, 2, \ldots, n\ (j \neq k) \end{cases} \quad (1)$$

Among them, represents the efficiency value, x represents the input factor, and y represents the output factor: m and s respectively represent the number of input and output indicators: k represents the production period; i and r respectively represent the input-output decision-making unit; s^+ and s^- Respectively represent the slack of input and output; r represents the weight vector.

3.2. Indicator Selection

3.2.1. Input Indicators

When calculating the efficiency of the logistics industry, the input indicators can be considered from the aspects of manpower, capital, energy and infrastructure. Specifically, manpower input can be measured by the number of employees in the transportation, warehousing, and postal industries; capital investment is represented by fixed asset investment in the transportation, warehousing, and postal industries; energy is measured by the total energy consumption of the logistics industry; highway mileage is used and the number of trucks to measure the infrastructure investment in the logistics industry.

3.2.2. Output Indicators

The calculation of green development efficiency of logistics must consider both expected output and undesired output. Expected output includes freight volume and cargo turnover in the logistics industry. At the same time, the added value of the transportation, warehousing, and

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postal industries will be used as output indicators for the logistics industry. The undesired output of the logistics industry mainly refers to the carbon dioxide and other gases emitted by the fossil energy used in the transportation of goods, which cause pollution to the environment. Therefore, while calculating the green development efficiency of the logistics industry, carbon dioxide can be used as the logistics industry Unexpected output, but the total amount of carbon dioxide cannot be obtained directly from the yearbook. The specific calculation formula is as follows:

$$CO_2 = \sum_{i=1}^{n} E_i * CEF_i * NCV_i * COF_i \tag{2}$$

In the formula, E_i is the i-th energy consumption, NCV_i is the average low calorific value of the i-th energy, CEF_i is the carbon emission coefficient of the i-th energy, and COF_i is the carbon oxidation factor. All data coefficients are from the "2006 IPCC Guidelines for National Greenhouse Gas Inventories".

The input-output indicators are shown in the following Table1:

Table 1. The input-output indicators

First level indicator	Secondary indicators
Manpower input	Number of employees
Capital investment	Fixed asset investment
Energy input	Total energy consumption
Infrastructure investment	Highway mileage
	Number of trucks
Expected output	Freight volume
	Freight turnover
	Industry added value
Undesired output	Carbon dioxide emissions

3.3. Data Sources

The above data comes from the statistical yearbooks of various provinces and cities, as well as the "China Energy Statistical Yearbook" and "China's Tertiary Industry Statistical Yearbook", which are authoritative.

4. Empirical Results and Analysis

4.1. National Overall Calculation Results

Using the super-efficiency SBM model, the green development efficiency value of logistics in 30 provinces in China from 2015 to 2019 was calculated through DEA solver pro5.0. The specific efficiency value, average efficiency value and ranking of each province and city are shown in Table 2.

From the table, we can get: ① Overall, from 2015 to 2019, the green development efficiency value of each region will fluctuate slightly, and most regions show a slight upward trend. The national average efficiency is 0.51, which is at a medium level. ②From a regional perspective, the seven provinces and cities of Tianjin, Hebei, Inner Mongolia, Shanghai, Zhejiang, Anhui, and Ningxia ranked first, with a logistics green development efficiency value of 1, indicating that the green development level of logistics in these regions is at a relatively high level, and investment and expected output Is in a reasonable state between output and undesired output. Qinghai, Jilin, and Heilongjiang provinces have relatively low green development efficiency averages of

0.15, 0.14, and 0.11 respectively, and the efficiency values fluctuate little in five years, indicating that the green logistics development efficiency of these three provinces is insufficient and there is a large room for improvement.

Table 2. Efficiency values and rankings by region

	2015	2016	2017	2018	2019	Mean	Rank
Beijing	0.19	0.19	0.19	0.18	0.20	0.19	15
Tianjin	1.00	1.00	1.00	1.00	1.00	1.00	1
Hebei	1.00	1.00	1.00	1.00	1.00	1.00	1
Shanxi	0.42	0.46	1.00	1.00	1.00	0.78	4
Neimenggu	1.00	1.00	1.00	1.00	1.00	1.00	1
Liaoning	0.51	1.00	1.00	1.00	1.00	0.90	3
Jilin	0.12	0.12	0.14	0.16	0.15	0.14	19
Heilongjiang	0.10	0.11	0.12	0.14	0.09	0.11	20
Shanghai	1.00	1.00	1.00	1.00	1.00	1.00	1
Jiangsu	0.36	0.36	0.37	0.38	0.46	0.39	9
Zhejiang	1.00	1.00	1.00	1.00	1.00	1.00	1
Anhui	1.00	1.00	1.00	1.00	1.00	1.00	1
Fujian	0.35	0.40	0.43	0.44	0.46	0.41	8
Jiangxi	0.30	0.33	0.53	0.62	0.43	0.44	6
Shandong	0.36	0.39	0.48	0.45	0.44	0.42	7
Henan	0.31	0.35	0.36	0.40	0.39	0.36	10
Hubei	0.26	0.27	0.31	0.36	0.36	0.31	12
Hunan	0.35	0.36	0.58	0.51	0.39	0.44	6
Guangdong	0.77	0.91	1.00	0.96	0.94	0.92	2
Guangxi	0.26	0.28	0.33	0.37	0.37	0.32	11
Hainan	0.36	0.36	0.39	0.42	0.79	0.47	5
Chongqing	0.20	0.21	0.23	0.28	0.26	0.24	13
Sichuan	0.17	0.17	0.18	0.20	0.21	0.19	15
Guizhou	0.14	0.15	0.21	0.24	0.26	0.20	14
Yunnan	0.13	0.14	0.17	0.19	0.18	0.17	17
Shanxi	0.23	0.28	0.30	0.32	0.39	0.31	12
Gansu	0.16	0.17	0.19	0.23	0.20	0.19	15
Qinghai	0.18	0.14	0.10	0.19	0.12	0.15	18
Ningxia	1.00	1.00	1.00	1.00	1.00	1.00	1
Xinjiang	0.14	0.16	0.16	0.24	0.22	0.18	16

The broken line chart of the average green development efficiency of logistics in various regions is shown in Figure 1. It can be clearly seen from the figure that the green development efficiency of logistics in various regions is in a state of imbalance, and there is a large difference between the lowest efficiency value and the highest efficiency value. The logistics industry has developed rapidly, and many efforts have been made to develop green logistics, and great achievements have been made. However, the development level of green logistics efficiency in some areas is not high, indicating that these areas have not reached a relatively high level of input and output. A reasonable level is embodied in a large amount of redundant element inputs and insufficient expected output. Therefore, these regions need to reconsider their own conditions and propose more effective input-output plans.

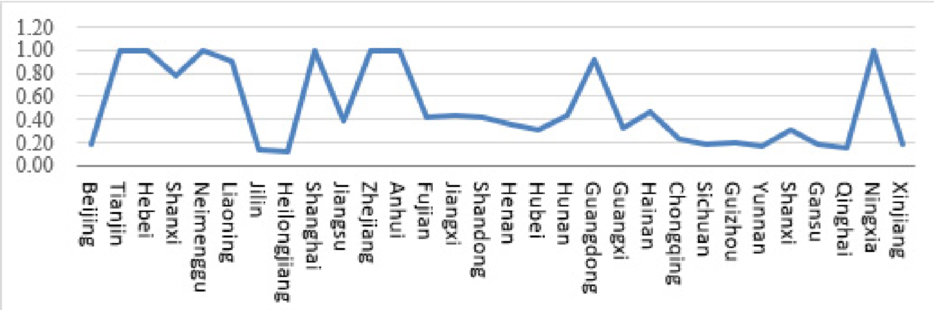

Figure 1. Average value of logistics green development efficiency by region

4.2. Analysis of Regional Characteristics

Figure 2 shows a histogram of the green development efficiency values of logistics in the eastern, central, and western regions. It can be seen from the figure that, as a whole, the green development efficiency values of logistics in the eastern region are on the rise from 2015 to 2019. The region was on the rise in 2015-2018, and there was a slight decline in 2019, and the eastern region>the central region>the western region. Compared with the national average, the eastern region has always been higher than the national average, and the central region has gradually caught up to and surpassed the national average through the efforts of these years, while the western region still lags behind the national average. The main reason is that because the eastern region of China has a high level of economic development and logistics development is also at a relatively high level, the country has invested more in human resources, resources, and infrastructure in the eastern region, and output has also increased. Most of the provinces and cities in the region are energy-consuming provinces, with more carbon dioxide emissions compared to other regions. At the same time, their economic development level is inferior to the eastern region, so the efficiency of green logistics development is relatively low; the western region is vast and has economic development. The level is low, the population is small, and the investment is small. Compared with other cities, the development efficiency is also lower. However, the momentum of development in recent years is faintly increasing, indicating that green development has attracted more and more attention.

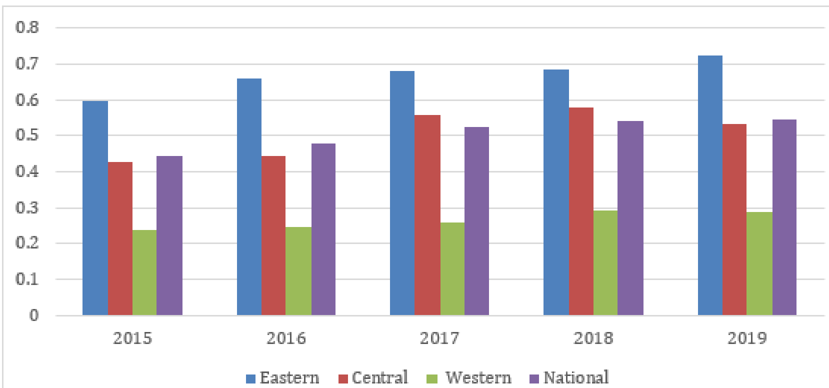

Figure 2. Efficiency value of logistics green development in eastern, central and western regions

5. Conclusions and Suggestions

5.1. Conclusion

In this paper, by constructing a green logistics development efficiency index system, and based on the SBM model, the green logistics efficiency of 30 provinces, municipalities and autonomous regions in China is measured from 2015 to 2019. The calculation results show that:

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①From a static perspective: the green development efficiency values vary greatly among regions, the overall efficiency level is not high, and the regions are in a state of imbalance, and the pattern of "Eastern>Central>Western" is shown spatially, Consistent with China's economic development pattern, and with obvious spatial differences.

②From a dynamic perspective: China's logistics green development efficiency is on an upward trend from 2015 to 2019. The seven provinces of Tianjin, Hebei, Inner Mongolia, Shanghai, Zhejiang, Anhui, and Ningxia are in a relatively optimal state throughout the year. The green development efficiency of logistics in most of the remaining cities It is also gradually increasing because of the gradual improvement of the efficiency of green technology, and people have gradually realized the importance of the green development of logistics to the sustainable development of China.

5.2. Suggestions

Through the measurement of China's logistics green development efficiency and the analysis of the measurement results, the following suggestions can be made:

① Promote advanced technology. Technological progress is the main factor that promotes the green development of logistics. Therefore, the application of advanced technologies such as RFID and the Internet of Things has been vigorously promoted to improve the information and standardization level of the logistics industry. Reasonable integration and formulating reasonable laws and regulations that can promote the effective development of the logistics industry is the only way for the green development of the logistics industry.

② Promote the integration of logistics and manufacturing. Vigorously promote the development of new business formats such as "logistics + commerce", "logistics + finance" "logistics + e-commerce", encourage and promote the transformation of logistics enterprises to manufacturing, and provide production-oriented enterprises with a series of factory entry-production-sales-recycling Services to improve the level of supply chain management.

References

[1] Zhiwang Qian, Lin Sun. Analysis of Logistics Efficiency and Influencing Factors in the Pearl River Delta Based on the Super-efficiency SBM Model[J]. Technology and Industry, 2021, 21(10): 8-13. (In Chinese).

[2] Yuhong Wang, Qi Liu. Research on the Logistics Efficiency Measurement of the Yangtze River Economic Zone Based on the Super-SBM Model[J]. East China Economic Management, 2017, 31(05): 72-77. (In Chinese).

[3] Bo Wang, Honghui Zhu, Lin Liu. Comprehensive Evaluation of Regional Logistics Efficiency Along My Country's "One Belt One Road"--Based on the Three-stage DEA Model[J]. East China Economic Management, 2019, 33(05): 76-82. DOI :10.19629/j.cnki.34-1014/f.180523017. (In Chinese).

[4] Xinyue Zhang. Research on the Evaluation of Logistics Efficiency in Beijing-Tianjin-Hebei Region Based on DEA-Malmquist Index Model [J]. Modern Business, 2019(24): 16-17. DOI: 10. 14097/ j.cnki. 5392/2019.24.006. (In Chinese).

[5] Yan Yi. Green Efficiency and Regional Spatial Characteristics of My Country's Logistics Industry--SBM Model Based on Undesired Output[J]. Business Economics Research, 2020(20): 104-107. (In Chinese).

[6] Jingshi He, Shufeng Wang, Lan Xu. Research on Green Logistics Efficiency and Influencing Factors of My country's Three Bay Area City Clusters Under Carbon Emission Constraints[J]. Railway Transport and Economy, 2021, 43(08): 30-36. (In Chinese).