



# Research on Circulation Efficiency of Logistics Industry in Bohai Rim Economic Zone -Based on DEA Model

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**Abstract.** As the Bohai Rim is a composite economic zone, it is important to analyze the opportunities and challenges facing the synergistic development of logistics and hinterland economy in the Bohai Rim. In this paper, through DEA model, the data related to the input and output of logistics circulation efficiency in the Bohai Rim Economic Zone in 2021 are analyzed horizontally, and the analysis concludes that the overall circulation scale efficiency in the Bohai Rim Economic Zone is good and the pure technical efficiency is weak, while the comprehensive efficiency development is jointly influenced by the pure technical efficiency and scale efficiency, indicating that there are problems of uncoordinated input and output and backward infrastructure in logistics circulation.

**Keywords:** Bohai Rim Economic Zone · Distribution efficiency of logistics industry · DEA model

## 1 Introduction

With the continuous promotion of the “Belt and Road” construction, the logistics industry has become an important booster for the economic development of the city region. The Bohai Sea region is rich in natural resources and has obvious location advantages. The Bohai Sea region is home to the Liaoning coastal port group, the Tianjin-Hebei port group and the Shandong peninsula port group, and has many well-developed ports such as Tianjin port, Qingdao port and Dalian port [1]. At the same time, the Bohai Sea region is a composite economic zone, including three sub-economic zones including Shandong Peninsula Circle, Beijing-Tianjin-Hebei Circle and Liaodong Peninsula Circle [2]. The Bohai Sea region has made significant contributions to China’s economic development and is an important growth pole of China’s economy, so it is important to analyze the opportunities and challenges facing the synergistic development of logistics and hinterland economy in the Bohai Sea region.

From the above analysis, it can be seen that at the level of analysis of circulation efficiency of logistics industry, how to construct a reasonable evaluation index system and how to evaluate reasonably and objectively becomes the focus of this paper’s research.

Based on this, this paper uses the DEA-BCC model from a static perspective to horizontally measure the circulation efficiency of the logistics industry in 2021, to find a breakthrough in the existing problems, and then to improve the circulation efficiency of the logistics industry.

## 2 Research Methodology

### 2.1 DEA Model

This paper uses the DEA-BCC model for empirical analysis, which is very effective for analyzing the relative effectiveness of similar sectors or units [3]. The DEA model uses a linear programming approach to analyze input-output indicators to derive the efficiency decomposition values of each decision making unit (DMU), which allows the degree of ineffectiveness of non-effective DMUs. In this paper, the BCC model in the DEA approach is used, which is based on the following principles [4]:

$$\left\{ \begin{array}{l} \max \frac{\sum_{s=1}^v q_s y_{sk_0}}{\sum_{m=1}^u p_m x_{mk_0}} = Q\bar{a}, \\ s.t. \frac{\sum_{s=1}^v q_s y_{sk}}{\sum_{m=1}^u p_m x_{mk}} \leq 1 \\ P \geq 0, Q \geq 0 \end{array} \right. \quad (1)$$

By taking the values of the above parameters, it can be calculated whether the  $k_0$ th DMU reaches DEA validity. Based on Eq. (1) validity judgment theorem. If there is an optimal value  $\theta^* = 1$ , its corresponding  $k_0$ th DMU is weakly DEA valid; if the optimal value  $\theta^* = 1$ , and there is an optimal solution, i.e., input slack variables  $S^- = 0$ , input-output variables  $S^+ = 0$ , corresponding to the  $k_0$ th DMU is DEA valid.

## 3 Indicator Establishment and Data Sources

In order to accurately measure the circulation efficiency of the logistics industry in the Bohai Economic Zone, this paper divides the efficiency evaluation system into two evaluation concepts: production input and production output, and the input variables are selected from the total length of postal routes ( $X_1$ ) and urban unit employment in the transportation, storage and postal industry ( $X_2$ ) and civilian cargo vehicle ownership ( $X_3$ ) as the sources of data; the output variables are selected from the turnover of goods ( $Y_1$ ) and the value added in the transportation, storage and postal industry ( $Y_2$ ) and freight volume ( $Y_3$ ) as the sources of data.

In order to ensure the authenticity and validity of the data, the data related to the seven provinces designed in the Bohai Sea Economic Zone in 2021 were selected, and the relevant data used in this paper were obtained from local statistical bureaus and the National Bureau of Statistics [5].

## 4 Static Analysis of Circulation Efficiency of Logistics Industry in Bohai Economic Zone 2021

### 4.1 DEA Model Static Analysis

DEA model uses input and output-oriented two, and this paper takes input radial as the hypothesis. Through DEAP 2.1 software, the static efficiency value of logistics circulation in Bohai Rim Economic Zone in 2021 can be derived.

1. Comprehensive efficiency analysis. As can be seen from Table 1, the three efficiency values of Tianjin, Hebei, Shanxi and Inner Mongolia are 1, reaching DEA effective, accounting for 57.14%, indicating that the logistics industry of these four provinces have reached the best configuration of production technology, returns to scale, etc. The non-DEA effective provinces accounted for 42.86%, and the later development should enhance the corresponding production efficiency while improving the revenue, improve the corresponding policies and institutional mechanisms, and expand the scale and scope of technology introduction, so as to achieve a double harvest of efficiency and effectiveness.
2. Pure technical efficiency. Pure technical efficiency is an important indicator to measure the transformation of circulation technology. The closer the value of the obtained production conditions and technical proficiency is to 1, the higher the efficiency of pure technical transformation is indicated. In the non-DEA effective (Table 1), the pure technical efficiency of Shandong Province is 1, located in the frontier of technical efficiency; Beijing and Liaoning's pure technical efficiency is located between [0.6–0.8] range, the pure technical efficiency of these two provinces still have more room for development, the use of appropriate management methods and technical means, it is possible to improve the efficiency of the logistics industry circulation in the region.
3. Scale efficiency. Scale efficiency is an important indicator to measure whether the inputs and outputs of the logistics circulation process can reach the optimal scale. The closer the value is to 1, the better the scale of inputs and outputs. The scale efficiency in the three provinces where non-DEA is effective lies between the range of [1.0–0.9], and the scale efficiency of these provinces, although not to the average value of 0.99, can be considered to continue to develop their transportation resources, infrastructure production, and make full use of their own advantages to explore the circulation potential and increase the scale of the regional logistics industry.

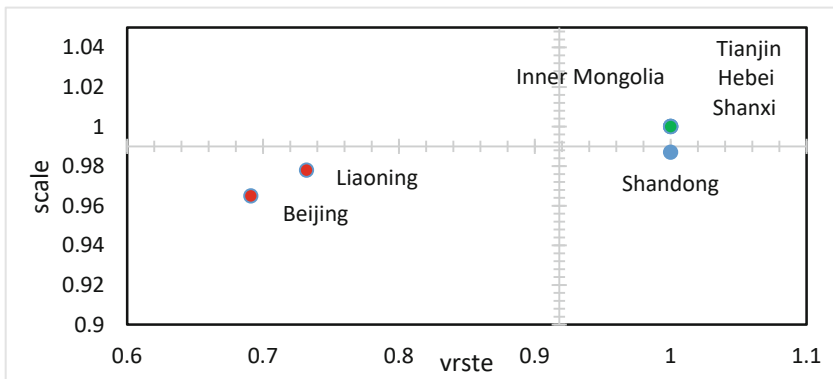
### 4.2 Decomposition of the Comprehensive Efficiency of Logistics Circulation in the Bohai Economic Zone in 2021

In order to more intuitively express the status of logistics circulation in the Bohai Economic Zone, according to the above Table 1, the quadrant of logistics circulation efficiency in the Bohai Economic Zone is drawn, with the average value (0.918, 0.99) as the central axis, Fig. 1 is divided into four types through the central axis, the first quadrant indicates the double-high type provinces, in which the double-high type provinces are Tianjin, Hebei, Shanxi and Inner Mongolia, and the two indicators of these four provinces

**Table 1.** 2021 Bohai Economic Zone logistics circulation efficiency values

DMU	crste	vrste	scale	
Beijing	0.666	0.691	0.965	irs
Tianjin	1	1	1	-
Hebei	1	1	1	-
Liaoning	0.716	0.732	0.978	drs
Shandong	0.987	1	0.987	drs
Shanxi	1	1	1	-
Inner Mongolia	1	1	1	-
Average value	0.91	0.918	0.99	

are higher than the average, indicating that these regions have the best performance in logistics circulation. These four provinces have two indicators higher than the average, indicating that these regions have the best performance in logistics circulation efficiency; corresponding to the first quadrant of double high type is the third quadrant of double low type, which includes Liaoning and Beijing, indicating that these two provinces have two indicators lower than the average, there is an obvious inequality between input and output, and should focus on coordinated development in the future development process. In quadrants two and four, the development trend is one high and one low. In the second quadrant, the high-low type is dominant, and the scale efficiency of this quadrant is dominant, but the pure technical production efficiency is at a disadvantage; in the fourth quadrant, the low-high type is only Shandong province, and the pure technical efficiency of Shandong province is above the average line and close to the average line of scale efficiency, which means that the two indicators of this province are well developed and have a lot of room for development. is expected to enter the double-high type team.



**Fig. 1.** Decomposition of logistics circulation efficiency in the Bohai Economic Zone in 2021

## 5 Research Conclusions

In this paper, the overall assessment of logistics circulation efficiency in the Bohai Economic Zone in 2021 is carried out through DEA static analysis, and the specific conclusions of this study are as follows: the development of logistics industry in the Bohai Economic Zone has good geographical advantages and circulation conditions, but due to the failure of pure technical efficiency or scale efficiency in some provinces and cities to be effectively transformed, there may be a situation of inequality between inputs and outputs, which gradually pulls down the comprehensive efficiency. Therefore, in the later development process should increase the investment in technology according to the local situation, and gradually realize the modernization of logistics circulation, thus providing strong support for the improvement of logistics circulation efficiency in the Bohai Economic Zone.

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