Research on the Impact of Logistics Efficiency in Anhui Province Based on DEA-Malmquist Model

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Abstract: To improve the level of logistics efficiency in Anhui Province, an empirical study was conducted on the efficiency evaluation model of Anhui Province from 2013-2020 by using DEA-Malmquist model to construct an efficiency evaluation model of output index. The research results show that: the logistics development in Anhui Province from 2013-2020 is gradually developing for the better, and the development trend is steadily maintained, but the logistics efficiency in 2019-2020 suffers from the epidemic, which hinders the improvement of logistics efficiency in Anhui Province; the low logistics efficiency in Anhui Province is caused by the combination of pure technical efficiency failure and scale efficiency failure, and the inhibiting effect of scale efficiency is more obvious; the imbalance of logistics development exists between cities in Anhui Province.

Keywords: Logistics efficiency; DEA-Malmquist model; Anhui Province; technical efficiency

1 Introduction

The logistics industry is a combination of transportation, warehousing, communication, and other industries, which plays a vital role in social and economic development and improvement of people's living standard. With the selection of some cities as national logistics hubs, Anhui province has a new development opportunity, and it is urgent and important to improve the development level of logistics industry to build a better logistics hub in Anhui province. At the same time, the progress of science and technology and the development of e-commerce in Anhui Province has prompted the development of logistics industry in Anhui Province to change to modern logistics. Logistics efficiency has also become an important issue to be considered in developing modern logistics and improving the development level of logistics industry. How to minimize logistics cost and maximize logistics efficiency has become the key to the rapid development of modern logistics [1]. Based on this, the empirical study and analysis of logistics efficiency in 16 prefecture-level cities in Anhui Province and further analysis of its specific influencing factors are of great significance to improve logistics efficiency in Anhui Province.

At present, scholars mainly analyze the efficiency of logistics industry from the perspective of research methods and geographical areas. Jia Wenxin [2] et al. established a data envelopment analysis method model to compare the data of 16 cities in Anhui Province and analyzed the development of logistics efficiency in different cities; Zhang Yunfeng [3] et al. used a heterogeneous stochastic frontier model based on C-D production function to evaluate the

efficiency of logistics industry in 30 provinces and cities in China; Wu Zuoliang [4] et al. studied the factors influencing logistics efficiency and the path of action in Anhui Province based on QCA model ; Qin Wen [5] established the input-output index system of logistics industry in Guangdong-Hong Kong-Macao Greater Bay Area, influencing factor variables, and empirically studied the efficiency of logistics industry in 9+2 city clusters in Guangdong-Hong Kong-Macao Greater Bay Area from 2012-2018 using a three-stage DEA model, and analyzed it in two dimensions of time and space. For logistics efficiency-related studies, scholars also adopt the idea of combining multiple modeling methods to evaluate and analyze, and further explore its influencing factors. He Jingshi [6] and others used Malmquist index, super-efficient SBM model and Tobit model to investigate the logistics efficiency and influencing factors of the three major urban agglomerations in China's Bay Area based on carbon emission constraints, and concluded that economic level, etc. negatively influenced green logistics efficiency, and logistics transportation intensity, etc. positively influenced green logistics efficiency; Wei Guochen [7] and others used super-efficient DEA model to analyze the efficiency of the logistics industry in the Yangtze River Economic Belt. Wei Guochen [7] used the super-efficiency DEA model to analyze the efficiency of logistics industry in Yangtze River Economic Zone, and used Tobit regression model to explore the correlation between its influencing factors; Jia Daren [8] used DEA-BCC model, Malmquist index method and Tobit regression model to measure the logistics efficiency and explore its influencing factors based on northern Anhui region; Liu Li [9] used DEA model to evaluate the logistics efficiency of 11 cities in eastern region from 2008 to 2017. -2017 in 11 provinces (cities) in the eastern region, and further analyzed the influencing factors using Tobit model.

Based on this, based on the real situation of Anhui Province, we select the appropriate evaluation indexes and use the DEA-Malmquist index method to analyze the logistics efficiency of 16 cities in Anhui Province from 2013 to 2020 in a dynamic and static empirical analysis, from the perspective of logistics scale efficiency, input redundancy, total factor productivity (M index), time series The factors influencing logistics efficiency in Anhui Province were analyzed from the perspective of logistics scale efficiency, input redundancy, total factor productivity (M index), time series, etc. Based on the findings of the empirical analysis, we propose suggestions for the improvement of logistics efficiency in Anhui Province, considering the relevant national and provincial policies.

2 Data sources and evaluation index system construction

2.1 Data sources

There is no clear data of logistics industry in China, and considering that the value added of transportation, storage, and postal industry accounts for 80% of the value added of logistics industry in China, the data of transportation, storage and postal industry is generally chosen to start the analysis. Based on the availability of data and the need of empirical research, the data of 17 prefecture-level cities in Anhui Province from 2013 to 2019 were chosen as the input and output indicators of logistics industry. The data are extracted from the Anhui Statistical Yearbook published by Anhui Bureau of Statistics. According to the concept of "logistics" and the choice of most related studies, the logistics industry is defined as including transportation, transport, storage, and postal industry.

2.2 Input indicator selection

In the selection of input indicators, existing studies mainly choose the number of people employed in the logistics industry, the amount of investment in fixed assets in the logistics industry, carbon emissions and business mileage in the logistics industry as input indicators from three aspects: human resources, financial resources, and environment. Therefore, in this study, based on the existing research, based on the principles of scientific, objectivity and representativeness of the index data, and considering the characteristics of the regional logistics industry in Anhui Province, four indicators are selected as input indicators: the number of people employed in the logistics industry, the amount of new fixed asset investment in the logistics industry, the total amount of wages in the logistics industry and the mileage of business in the logistics industry.

2.3 Output indicators selection

In this study, the gross value of logistics industry, annual cargo turnover and freight volume are selected as the output indicators to measure the efficiency of regional logistics industry in Anhui Province, considering the relevant literature and the actual situation of regional logistics development in Anhui Province. Among them, the gross value of logistics industry directly reflects the status of the whole logistics industry in Anhui Province; the annual cargo turnover and freight volume are an intuitive representation of logistics efficiency, and the specific evaluation index system is shown in Table 1.

Table 1 Logistics efficiency evaluation index system of 16 cities in Anhui Province

primary indicator	Code	secondary indicator
input indicator	X1	Number of employees in logistics industry/person
	X2	Logistics industry new fixed asset investment / million yuan
	X3	Total wages in logistics industry / million yuan
	X4	Logistics business mileage/km
Output Indicators	Y1	Gross value of logistics industry / billion yuan
	Y2	Annual cargo turnover / million tons of kilometers
	Y3	Cargo volume / million tons

3 Empirical analysis

3.1 Static analysis of DEA model

Measuring the efficiency of logistics industry in 16 prefectures in Anhui Province is the basis for understanding the development of logistics industry in 16 prefectures in Anhui Province. In this study, the panel data of logistics industry of 16 prefectures in Anhui Province from 2013 to 2020 were selected according to the evaluation index system of logistics efficiency constructed by DEAP2.0 software, and the variable scale payoff input-oriented BCC model of DEA model was applied to measure the development level of logistics industry in each city.

From the overall average value, the average value of overall logistics efficiency in Anhui Province from 2013 to 2020 is 0.925, the average value of pure technical efficiency is 0.972, and the average value of scale efficiency is 0.952, which shows that the overall logistics efficiency in Anhui Province is high and in a stable state of development. In terms of scale effectiveness, the overall efficiency value of the nine regions of Hefei, Huaibei, Bozhou, Suizhou, Fuyang, Chuzhou, Liuan, Xuancheng and Tongling is 1.000, which indicates that the logistics efficiency of these nine prefecture-level cities has reached the DEA effective level during 2013-2020, and the inputs of logistics industry have been used reasonably and effectively. The overall logistics efficiency values of Bengbu, Huainan, Maanshan, Wuhu, Chihuahua, Anqing and Huangshan are less than 1, 0.856, 0.756, 0.835, 0.937, 0.705, 0.769 and 0.950, respectively, indicating that the inputs of logistics in these four cities have not been fully and reasonably utilized, resulting in the low level of logistics efficiency. The non-effective levels of DEA in Bengbu, Maanshan, Wuhu and Anqing indicate that there are problems in the rational allocation and utilization of resources in logistics in these four cities. The overall logistics efficiency values of Huainan, Chizhou and Huangshan are at the DEA non-effective level, reflecting that the logistics industry of these three cities is still in the development period, and it is necessary to increase the resource input and strengthen the infrastructure construction in this period, to better achieve the best balance between input and output. From the perspective of input indexes, with other inputs and all outputs unchanged, Bengbu and Wuhu cities are over-invested in the number of employees in logistics industry, and over-invested in the amount of new fixed asset investment in logistics industry in Bengbu, Maanshan and Anqing, while the three cities are still over-invested in total wages in logistics industry, resulting in redundancy. Among all cities, three of the four input indicators in Bengbu are redundant, and the excessive input resources are not actually used to improve the efficiency of logistics in Bengbu. From the perspective of output indicators, with other outputs and all inputs unchanged, only Anqing has redundancy in the output of gross logistics industry, and Maanshan, Wuhu, and Anqing have redundancy in annual cargo turnover, while Bengbu and Wuhu also have redundancy in freight volume. The redundancy of output in these four cities indicates that there are too many inputs related to this output indicator, and the planned volume of logistics in this city is not predicted correctly, so that the excess output value cannot be absorbed and used, resulting in the waste of resources.

3.2 Dynamic analysis of Malmquist index

Based on the input-oriented perspective, the Malmquist index method was used to calculate and integrate the logistics efficiency input and output data of 16 prefecture-level cities in Anhui Province from 2013 to 2020, and the corresponding results were obtained by using DEAP2.1 software. The calculated results were integrated and mainly included five evaluation indexes, namely, logistics technical efficiency change index, technical progress index, pure technical efficiency index, scale efficiency index and total factor productivity index (M index) of Anhui province. From the analysis, the average value of logistics efficiency in Anhui Province during 2013-2020 is 1.004, and the total factor productivity increases by 0.4 percentage points per year, i.e., M index > 1, which indicates that the development of logistics industry in Anhui Province shows a good upward development trend as time goes forward. Technological progress index, i.e., "frontier moving effect", increases by 1% per year, with the average value of 1.010>1, which indicates that the overall logistics industry in Anhui Province is improving in technology. The total factor productivity index, i.e., M index, shows that Anqing has the highest logistics

efficiency and Tongling has the lowest logistics efficiency.

By decomposing the technical efficiency into pure technical efficiency and scale efficiency, the pure technical efficiency index decreases by 0.1 percentage point on average, and the scale efficiency index decreases by 0.4 percentage point, which makes the technical efficiency change index decrease by 0.5 percentage point on average, and the scale efficiency index has a greater influence on the technical efficiency, and the change trend of scale efficiency index is basically the same as the change trend of technical efficiency index. This also reflects that the change of technical efficiency of logistics industry in 16 cities in Anhui Province mainly depends on the expansion of logistics industry scale. The average value of pure technical efficiency is 0.999, and the average value of scale efficiency is 0.996. Since the level of logistics organization and management is basically the same and the value of scale efficiency is around 1, the development of overall logistics efficiency in Anhui Province is basically not backward. However, from the average value of each prefecture-level city, the pure technical efficiency and scale efficiency of logistics in Anhui Province are low, which indicates that Anhui Province should pay attention to the rational allocation of logistics resources. Among all prefecture-level cities, only three prefecture-level cities, Hefei, Huaibei and Anqing, have five evaluation indexes, namely, technical efficiency change index, technical progress index, pure technical efficiency index, scale efficiency index and total factor productivity index (M index), all of which are greater than 1. The development of logistics industry is on an upward trend, which indicates that logistics resources in these three cities are reasonably utilized, and logistics efficiency is at a high level. Among all cities, only Suzhou and Tongling are in a declining state, which means that the logistics efficiency is low, and the development level of logistics is lagging behind. Among all the cities, only Maanshan City has a scale efficiency index less than 1, but all other indexes are greater than 1. This indicates that Maanshan City has a good level of logistics efficiency, but the development is unbalanced, and the effective allocation and rational use of logistics resources are not realized in the process of logistics industry development. The total factor productivity of logistics industry in Anhui Province from 2013 to 2020, the value is gradually increasing and break through 1 to achieve annual growth, and the value of the last four years are also stable above 1. The maximum value is 1.346 in 2018-2019, and the minimum value is 0.689 in 2014-2015. It is much lower, combined with the actual situation, it should be that the development of logistics industry suffered from the serious impact of the new crown pneumonia epidemic, which led to the development of logistics facing a great impact, but the overall view of logistics efficiency in Anhui Province 2019-2020 is still high, still in the process of development.

Overall, the technical efficiency change index is relatively low in Anhui Province from 2013 to 2020, and the value of the technical efficiency change index does not exceed 1 in most years, which means that the logistics industry has not achieved technological development and is in the process of regression. Further decomposition of the technical efficiency index shows that the pure technical efficiency index is less than 1 in most years and has not been developed, while the scale efficiency index is around 1 every year, which indicates that there are great problems in the rationalization of resource utilization, technology level, operation management and system construction in 16 cities in Anhui Province, and the solution of these problems is very important for the high-quality development of logistics industry in Anhui Province.

4 Conclusions and Recommendations

Using DEA-Malmquist index model to measure and analyze the logistics efficiency of 16 prefecture-level cities in Anhui Province from 2013-2020, the following conclusions are mainly obtained: (1) The logistics development in Anhui Province from 2013-2020 is gradually developing for the better and steadily maintaining the development trend, but the logistics efficiency from 2019-2020 suffers from the epidemic, which hinders the improvement of logistics efficiency in Anhui Province. (2) The mean value of pure technical efficiency of logistics in Anhui Province is 0.999, and the mean value of scale efficiency is 0.996, which indicates that the inefficiency of logistics in Anhui Province is caused by the failure of pure technical efficiency and scale efficiency together, and the inhibiting effect of scale efficiency is more obvious. (3) The total factor productivity index, i.e., M index, shows that logistics efficiency is the highest in Anqing and the lowest in Tongling, and there is an unbalanced development of logistics among cities in Anhui Province. (4) Among all cities in Anhui Province, Bengbu, Maanshan, Wuhu and Anqing have redundancy of inputs and outputs in logistics development, which causes waste of resources and is not conducive to improving the logistics efficiency of Anhui Province.

According to the results of the above empirical analysis, the following suggestions are made to improve the logistics efficiency of Anhui Province: (1) Anhui Province should focus on improving the scientific and technological innovation ability and increasing the technological investment. By introducing high-tech talents, increasing investment in science and technology innovation, and encouraging the transformation of high-tech achievements, the logistics efficiency can be further improved, the rational utilization rate of resources can be enhanced, and the waste of resources in logistics industry can be reduced. (2) Anhui Province should play a good location advantage, strengthen the close contact with Shanghai, Jiangsu, Zhejiang, and other neighboring strong economic areas, and learn the advanced logistics development experience. Through the region inside and outside the logistics enterprise talent echelon construction, logistics technology innovation and logistics model innovation and other aspects to strengthen the utilization of logistics resources. (3) Anhui provincial government should increase the support to improve the construction of logistics infrastructure and enhance the scale efficiency. For the regional differences of logistics efficiency among cities in Anhui Province, the local governments should increase financial support and introduce relevant policies to realize information interchange and technology interposition among logistics enterprises in different regions, to optimize resource allocation and realize common progress.

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