Research on Logistics Efficiency of Anhui Province

Han Yanhui

School of Traffic and Transportation, Beijing Jiaotong University, P. R. China

yhhan@bjtu.edu.cn

Keywords: Logistics efficiency; DEA model; Anhui province

Abstract: China's logistics industry has developed rapidly in recent years, and logistics efficiency is the main indicator that reflects the level of logistics development. This article first illustrated the situation of logistics development in Anhui Province and established an index system for evaluation of logistics efficiency, including four input indicators, the number of employees in the logistics industry, the mileage of graded roads, investment in fixed assets in the logistics industry and education expenditure, as well as two output indicators, the freight turnover volume and the added value of the logistics industry; then use the CCR-DEA and BCC-DEA models to evaluate the logistics efficiency of 16 cities of Anhui province. The results show that there is a phenomenon of unbalanced logistics development. Among them, Suzhou, Chizhou, and Anqing have low logistics efficiency, which is the bottleneck that limits the improvement of logistics efficiency in Anhui Province.

1. Introduction

With the growth of China's economic level and the continuous transformation of economic growth pattern, the development level of logistics industry has become an important index to measure the comprehensive development level of a region. Anhui province is located in the middle and lower reaches of the Yangtze river and the Huaihe river. Together with Jiangsu, Shanghai and Zhejiang, forms the Yangtze river delta urban agglomeration.

In 2016, Anhui province issued "logistics industry development planning", put forward building "a circle, four area, multipoint" layout of logistics area, and strive to create "two vertical and three horizontal" logistics channels, relying on a series of logistics infrastructure, unicom logistics node city at all levels, improve the bearing capacity of channel logistics and transport efficiency.

In 2017, issued logistics park layout planning in Anhui province. First Level logistics park layout city is Hefei. Second level logistics park layout cities are Bengbu, Anqing, Ma'anshan, Wuhu, Fuyang. Third level logistics park layout cities are Huaibei, Bozhou, Suzhou, Huainan, Chuzhou, Liu'an, Xuancheng, Tongling, Chizhou, Huangshan.

In 2016, the total social logistics cost of Anhui province was 397.9 billion yuan, accounting for 16.5% of GDP. In 2017 social logistics total cost is 437.55 billion yuan, as a share of GDP is 15.9%, higher than the national average of 14.9%. To study the level of logistics development and logistics efficiency can help decision makers to develop the logistics industry in Anhui province development plan and related policy laws and regulations, also beneficial to the improvement of logistics efficiency.

2. Research Status

Scholars have applied data envelopment analysis to study logistics efficiency.

Anthony (2002) applied DEA method to analyze the operational efficiency of 102 logistics and distribution enterprises [1]

Gao Ying (2011) used network DEA model and the traditional DEA model to measure efficiency of railway transportation, points out that the efficiency of traditional DEA method cannot analyze the invalid reason and the result of a single, more accurate and in-depth network DEA model analysis[2].

  DOI: 10.25236/iwmecs.2019.103

Meng Kui (2014) used the three stages of the six provinces in central energy consumption and carbon emissions constraints to evaluate the efficiency of logistics, it has been proved that this method can eliminate the single DEA method of random factors and environmental factors, more accurate [3].

Xuan Zhang (2016) used three stage DEA model to China new silk road economic belt of the western provincial and surrounding major national logistics comprehensive efficiency, pure technical efficiency and scale efficiency measurement and evaluation [4].

Xinxue mengqi (2017), combined DEA and DEA-based Malmquist index method to calculate the logistics efficiency of 15 border ports in yunnan province [5].

Guo Meng (2017) studied Guangdong province logistics efficiency based on the combination of super efficiency DEA and SFA method, put forward to enhance foreign economic power, perfect the construction of logistics system, internal balanced regional logistics efficiency level [6].

DEA model is now the most commonly used method for evaluating logistics efficiency.

3. DEA Model

This paper mainly uses the CCR and BCC model to calculate the scale efficiency. The CCR-DEA model was proposed by A.Charnes, W.W.Cooper and E.Rhodes. It has n decision units DMU (I =1,2)... , n), which satisfies the homogeneity hypothesis and is comparable. Each DMU has the same t input, and the input vector is:

$$X_i = （X_{1i}, X_{2i}, \dots, X_{ti}）^T > 0 \qquad i = 1,2, \dots, n \tag{1}$$

Each DMU has the same s term output, and the output vector is:

$$Y_i = （Y_{1i}, Y_{2i}, \dots, Y_{ti}）^T > 0 \qquad i = 1,2, \dots, n \tag{2}$$

That is, each DMU has the same type of t inputs and s outputs. Where, X_{ji} represents the input amount of the i DMU to the j DMU, and Y_{ji} represents the output amount of the i to the j DMU.

In order to integrate all decision units uniformly, each input and output need to be assigned a value, so that the weight vectors of input and output are respectively. Then define each of DMUi index of efficiency evaluation. The relative efficiency optimization evaluation model of the $i_0 th$ DMU_{i0} is:

$$\max h_{i0} = \frac{\sum_{r=1}^{s} u_r y_{ri0}}{\sum_{j=1}^{t} v_j x_{ji0}}$$

$$\text{s.t.} \begin{cases} \dfrac{\sum_{r=1}^{s} u_r y_{ri}}{\sum_{j=1}^{t} v_j x_{ji}} \le 1, i = 1,2,\dots n \\ v = (v_1, v_2, \dots v_t)^T \ge 0 \\ u = (u_1, u_2, \dots u_s)^T \ge 0 \end{cases} \tag{3}$$

Equation (3) is the CCR model, and its optimal value is called efficiency value for short. Then the above equation can be transformed into the equivalent linear programming problem and the dual programming model. Then further introduce slack variable s^+ and remaining variable s^-.

$$\begin{cases} \min\theta = v_D \\ \sum_{i=1}^{n} \lambda_i X_i + S^+ = \theta X_0 \\ \sum_{i=1}^{n} \lambda_i X_i - S^- = Y_0 \\ \lambda_i \geq 0, i = 1,2,\ldots,n \\ \theta, \text{unconstrained} \\ S^+ \geq 0, S^- \geq 0 \end{cases} \tag{4}$$

Let the optimal solution of the above problem be $\lambda^*, S^{*+}, S^{*-}, \theta^*$, the following conclusions are drawn.

If $\theta^* = 1$, and $S^{*+} = 0, S^{*-} = 0$, it is DEA efficient decision-making unit DMU_0 efficiency, namely the production technology and scale of the decision-making unit DMU_{i0} effectively at the same time;

If $\theta^* = 1$, and $S^{*+} \neq 0, S^{*-} \neq 0$, then DMU_0 efficiency of decision unit is effective for weak DEA.

If $\theta^* < 1$, then DMU_0 is invalid, and the smaller θ^*, the worse of the effectiveness of DMU.

θ^*evaluated by the model is the comprehensive technical efficiency of DMU.

In actual economic production activities, scale reward is not constant. So Banker, Charnes and Cooper (1984) proposed a BBC-DEA model analysis method based on variable scale reward.

If $\frac{\lambda^*}{\theta^*} < 1$, DMU is increasing; If $\frac{\lambda^*}{\theta^*} = 1$, DMU is constant; If $\frac{\lambda^*}{\theta^*} > 1$, DMU is decreasing.

4. Analysis of Logistics Efficiency in 16 Cities of Anhui Province

4.1. Establishment of logistics efficiency evaluation indicators

At present, when using DEA model to study logistics efficiency in China, there is no relatively consistent system in the selection of indicators, and there are some differences. Due to the data of the logistics industry is also not work completely, can not accurately obtain related data of the logistics industry, so the index of the logistics industry and related data transportation, warehousing and postal service using the relevant data. Based on the development status of Anhui logistics industry, this paper selects input and output indicators according to the basic principles of production factors as follows:

Investment indicators: the number of employees in the logistics industry (10,000 people), the mileage of graded roads (kilometers), the fixed asset investment of the logistics industry (100 million yuan), and the education expenditure (100 million yuan);

Output indicators: freight turnover (100 million tons km), logistics added value (100 million yuan).

4.2. Analysis of logistics efficiency

Using the CCR-DEA and BCC-DEA input-oriented models, the logistics efficiency of Anhui Province from 2012 to 2016 was studied, and the comprehensive technical efficiency, pure technical efficiency and scale efficiency were obtained.

The comprehensive technical efficiency refers to the logistics efficiency in this paper. It is the product of pure technical efficiency and scale efficiency, which reflects the ratio of the actual output to the maximum possible output of the evaluation decision-making units (DMU) under the current conditions of technology and resource input. It is a comprehensive evaluation of resource allocation capabilities and resource utilization efficiency of DMU.

Pure technical efficiency refers to the maximum output capacity of each DMU under the condition of constant input resources. It reflects the technical capability, management level and control ability of the industry.

Scale efficiency refers to the evaluation of whether the logistics industry achieves the optimal operation scale under the current technology and productivity level, and the optimal production condition is that the scale reward remains unchanged.

16 cities in Anhui Province are used as DMUs, and the logistics efficiency of each city in Anhui

Province in the five years from 2012 to 2016 is compared horizontally.

(1) Comprehensive technical efficiency

There are six cities that the comprehensive technical efficiency value is 1 in the five years, and with effective technology, namely Hefei, Huaibei, Bozhou, Fuyang, Luan and Xuancheng, accounting for 37.5% of the total; there are three cities with the value that less than 1, and with ineffective technology, namely, Suzhou, Chizhou and Anqing, accounting for 18.75% of the total. In addition to Chizhou and Anqing, the average annual comprehensive technical efficiency of the remaining 14 cities are more than 0.8, accounting for 87.5% of the total.

Table 1 Comprehensive technical efficiency of 16 cities in Anhui Province

City	2012	2013	2014	2015	2016	Average
Hefei	1.000	1.000	1.000	1.000	1.000	1.000
Huaibei	1.000	1.000	1.000	1.000	1.000	1.000
Bozhou	1.000	1.000	1.000	1.000	1.000	1.000
Suzhou	0.968	0.983	0.851	0.858	0.902	0.912
Bengbu	1.000	0.995	0.757	1.000	1.000	0.950
Fuyang	1.000	1.000	1.000	1.000	1.000	1.000
Huainan	1.000	0.843	0.915	0.984	0.833	0.915
Chuzhou	0.904	1.000	0.982	0.892	1.000	0.956
Lu'an	1.000	1.000	1.000	1.000	1.000	1.000
Ma'anshan	1.000	0.781	0.787	0.809	1.000	0.875
Wuhu	1.000	0.931	1.000	0.958	1.000	0.978
Xuancheng	1.000	1.000	1.000	1.000	1.000	1.000
Tongling	0.971	1.000	1.000	1.000	1.000	0.994
Chizhou	0.980	0.664	0.790	0.729	0.756	0.784
Anqing	0.606	0.609	0.610	0.628	0.836	0.658
Huangshan	1.000	1.000	0.863	1.000	1.000	0.973
Average	0.964	0.925	0.910	0.929	0.958	0.937

(2) Pure technical efficiency

Table 2 Pure technical efficiency of 16 cities in Anhui Province

City	2012	2013	2014	2015	2016	Average
Hefei	1.000	1.000	1.000	1.000	1.000	1.000
Huaibei	1.000	1.000	1.000	1.000	1.000	1.000
Bozhou	1.000	1.000	1.000	1.000	1.000	1.000
Suzhou	1.000	1.000	1.000	0.859	0.907	0.953
Bengbu	1.000	1.000	0.871	1.000	1.000	0.974
Fuyang	1.000	1.000	1.000	1.000	1.000	1.000
Huainan	1.000	1.000	0.920	1.000	0.833	0.951
Chuzhou	0.943	1.000	1.000	1.000	1.000	0.989
Lu'an	1.000	1.000	1.000	1.000	1.000	1.000
Ma'anshan	1.000	0.799	0.787	0.857	1.000	0.889
Wuhu	1.000	0.936	1.000	1.000	1.000	0.987
Xuancheng	1.000	1.000	1.000	1.000	1.000	1.000
Tongling	1.000	1.000	1.000	1.000	1.000	1.000
Chizhou	1.000	1.000	1.000	1.000	1.000	1.000
Anqing	0.609	0.615	0.650	0.709	0.940	0.705
Huangshan	1.000	1.000	1.000	1.000	1.000	1.000
Average	0.972	0.959	0.952	0.964	0.980	0.965

There are nine cities with effective technology, such as Hefei, Bozhou and Huaibei, accounting for 56.25% of the total. It shows that the output of these cities has reached the optimum under the

premise of constant input. Only Anqing is in the state of pure technical efficiency inefficiency, which shows that logistics management in Anqing needs to be strengthened, such as introducing advanced logistics equipment and technology, improving the quality of personnel, so as to achieve effective pure technical efficiency. In addition to Anqing, the average annual pure technical efficiency of the remaining 15 cities are more than 0.8, accounting for 93.75% of the total.

(3) Scale efficiency and return of scale

Table 3 Scale efficiency of 16 cities in Anhui Province

City	2012	2013	2014	2015	2016	Average
Hefei	1.000	1.000	1.000	1.000	1.000	1.000
Huaibei	1.000	1.000	1.000	1.000	1.000	1.000
Bozhou	1.000	1.000	1.000	1.000	1.000	1.000
Suzhou	0.968	0.983	0.851	0.999	0.995	0.959
Bengbu	1.000	0.995	0.869	1.000	1.000	0.973
Fuyang	1.000	1.000	1.000	1.000	1.000	1.000
Huainan	1.000	0.843	0.995	0.984	1.000	0.964
Chuzhou	0.959	1.000	0.982	0.892	1.000	0.967
Lu'an	1.000	1.000	1.000	1.000	1.000	1.000
Ma'anshan	1.000	0.977	0.999	0.944	1.000	0.984
Wuhu	1.000	0.995	1.000	0.958	1.000	0.991
Xuancheng	1.000	1.000	1.000	1.000	1.000	1.000
Tongling	0.971	1.000	1.000	1.000	1.000	0.994
Chizhou	0.980	0.664	0.790	0.729	0.756	0.784
Anqing	0.995	0.990	0.938	0.886	0.890	0.940
Huangshan	1.000	1.000	0.863	1.000	1.000	0.973
Average	0.992	0.965	0.955	0.962	0.978	0.971

From Table 3, it can be seen that the distribution of scale efficiency and comprehensive efficiency of each city in Anhui Province are basically similar. Scale efficiency is 1 in the five-year. There are six cities with scale efficiency, namely Hefei, Huaibei, Bozhou, Fuyang, Luan and Xuancheng, accounting for 37.5% of the total. This shows that these six cities have reached the optimum scale under the current input-output ratio, and the logistics industry is developing well. There are three cities that the value of scale efficiency is less than 1, and in an ineffective state, namely, Suzhou, Chizhou and Anqing, accounting for 18.75% of the total.

Table 4 Return of scale of 16 cities in Anhui Province

City	2012	2013	2014	2015	2016
Hefei	constant	constant	constant	constant	constant
Huaibei	constant	constant	constant	constant	constant
Bozhou	constant	constant	constant	constant	constant
Suzhou	decreasing	decreasing	decreasing	increasing	increasing
Bengbu	constant	increasing	decreasing	constant	constant
Fuyang	constant	constant	constant	constant	constant
Huainan	constant	increasing	increasing	increasing	increasing
Chuzhou	increasing	constant	decreasing	decreasing	constant
Lu'an	constant	constant	constant	constant	constant
Ma'anshan	constant	decreasing	decreasing	decreasing	constant
Wuhu	constant	decreasing	constant	decreasing	constant
Xuancheng	constant	constant	constant	constant	constant
Tongling	increasing	constant	constant	constant	constant
Chizhou	increasing	increasing	increasing	increasing	increasing
Anqing	increasing	decreasing	decreasing	decreasing	increasing
Huangshan	constant	constant	increasing	constant	constant

Returns to Scale of Hefei, Huaibei, Bozhou, Fuyang, Lu'an and Xuancheng have remained unchanged. This shows that under the current input-output ratio, the scale of logistics industry has reached the optimum, the cost of logistics is the lowest, and the development of logistics industry is stable. The other cities have different situations, such as Huainan and Chizhou, most of which are in the state of increasing returns to scale, while Ma'anshan and Wuhu are in the state of decreasing returns to scale. The number of cities with decreasing scale returns has gradually become zero and the logistics industry has been developing well. It is necessary to expand the logistics industry scale of individual cities reasonably to ensure that their scale matches technological production capacity. Increase the utilization rate of resources to achieve the effective state of logistics efficiency.

5. Conclusion

There is imbalance in the development of logistics industry in Anhui province, especially in Anqing, which is quite different from other urban areas, which is not conducive to the healthy development of logistics industry in Anhui province. Therefore, Anhui province needs to pay attention to the development of regions with low logistics level, balance the development of logistics in various prefecture-level cities, and narrow the gap of logistics level. In the 13th five-year logistics planning of Anhui province, Anqing was listed as the second level logistics park construction city. Under such planning, Anqing could also get more development opportunities. At the same time, when paying attention to the input of logistics resources in these areas, the scale of investment should be strictly controlled, and the local logistics demand should be taken as the orientation to avoid serious redundancy of investment.

References

[1] Ross A, Droge C.(2002) An integrated benchmarking approach to distribution center performance using DEA modeling. Journal of Operations Management, 20(1):19-32.

[2] Gao Yin, Li Weidong, You Xiaoyu.(2011) Research on the Efficiency Evaluation of China's Railway Transport Enterprises with Network DEA. China Soft Science, 05:176-182.

[3] Meng Kui.(2014) Logistics Efficiency Evaluation of Six Provinces in Central China Based on Three-Stage DEA Method. Statistics & Decision. 02: 57-60.

[4] Zhang Xuan, Yang Xuerong, Wang Feng. (2016) Evaluation of Logistics Efficiency of New Silk Road Economic Belt Based on Three-stage DEA Empirical Analysis. Study and Practice, 05:21-32.

[5] Xue Mengqi. (2017) Research on Logistics Efficiency of Yunnan Border Port Based on DEA Method.Kunming University of Science and Technology.

[6] Guo Mengya.(2017) study on Logistics Efficiency of Guangdong Province Based on Super-efficiency DEA. Shenzhen University.