Research on Logistics Efficiency and Influencing Factors of Anhui Province

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Keywords: Logistics efficiency, DEA model, Tobit regression.

Abstract. This paper 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 using the DEA models to evaluate the logistics efficiency of Anhui province. The results show that the overall logistics efficiency of Anhui Province is relatively high and stable. Then choose five factors: economic development level, utilization rate of logistics infrastructure, logistics demand, informationization level, and opening-up level. Applying the Tobit method to do regression analysis. The results show that the level of economic development has a positive effect on logistics efficiency. Logistics efficiency has a significant positive correlation with the utilization rate of logistics infrastructure and the level of informationization. Logistics efficiency has a significant negative correlation with logistics demand. But the level of opening-up has no significant impact on logistics efficiency.

Introduction

China's logistics industry has developed rapidly in recent years, and logistics efficiency is the main indicator that reflects the level of logistics development. Anhui Province is located in the middle and lower reaches of the Yangtze River and Huaihe River, the hinterland of the Yangtze River Delta, and belongs to the Eastern Economic Zone of China. The comprehensive transportation system of Anhui Province has gradually formed, which has an important location advantage in the Eastern Economic zone. In 2016, the total amount of social logistics in Anhui Province was 5642.4 billion yuan, an increase of 3.67%. The related income of logistics industry was 315.16 billion yuan, an increase of 4.22%. The total social logistics cost of Anhui province was 397.9 billion yuan, accounting for 16.5% of GDP. Anhui logistics industry plays an important role in its economic development. The government issued “logistics industry development planning”, “logistics park layout planning” and “Implementation Plan of Special Action for Cost Reduction and Efficiency Increase in Anhui Logistics Industry (2016-2018)”. Studying the logistics development level and logistics efficiency will be favorable to logistics industry development planning and the formulation of policies and laws. It is conducive to the improvement of logistics efficiency and the development level of logistics industry in Anhui Province.

Literature Reviews

Many scholars studied logistics efficiency based on the method of data envelopment analysis (DEA). Anthony Ross (2002) proposes an integrated benchmarking framework illustrated in the context of a large supply chain system comprised of 102 distribution centers (DCs) by using DEA [1].

Wang Xu-hui (2009) evaluated the logistics efficiency of 24 listed logistics company in China by using super-efficiency DEA. It is considered that the super-efficiency DEA method avoids the defects of traditional DEA [2].

Wang Qinmei (2013) built up a DEA model to analyze the logistics efficiency of Xi’an city, and then uses the Tobit regression model to evaluate the correlation between the logistics efficiency and various factors [3].
Liu Yunfeng (2014) evaluated the logistics efficiency of Beijing and carried out an empirical study in accordance with the characteristics of the logistics industry and based on DEA method [4].

Yu Lijing (2017) calculated the logistics efficiency of 17 cities in Shandong Province from 2010 to 2014 using stochastic frontier analysis. The result displays that the difference of regional logistics efficiency is obvious, the development of logistics is not balanced, showing the pattern of “East High and west low” [5].

Li Cunbin (2018) built an evaluation index system based on the DEA model, then using the software DEAP, studied the index data of 23 example cities, and compared and evaluated the logistics efficiency of them [6].

The study of logistics efficiency by DEA in domestic and foreign scholars provides a reference for this paper.

Analysis Logistics Efficiency of Anhui Province

The DEA model is the most commonly used method to evaluate logistics efficiency. This paper mainly uses the input-oriented CCR-DEA to measure the comprehensive technical efficiency under the condition of return of scale unchanged, and uses the input-oriented BCC-DEA model to measure the pure technical efficiency under the condition of variable return of scale. The pure technical efficiency is then calculated to achieve scale efficiency.

**The comprehensive technical efficiency.** It refers to the logistics efficiency in this paper. It is the product of pure technical efficiency and scale efficiency. It reflects the ratio of actual output to maximum possible output of Decision Making Unit (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.** It 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 and return of scale.** 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.

**Input-output Index.** Combined with the development status of the logistics industry in Anhui Province, the input and output index are selected according to the basic principles of production factors.

- Investment index: 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 index: freight turnover (100 million tons km), logistics added value (100 million yuan).

The annual logistics efficiency will be analyzed as a DMU from 2000 to 2016 in Anhui Province. The data comes from the National Statistical Yearbook and the Anhui Statistical Yearbook.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of employees in the logistics industry (10,000 people)</th>
<th>Mileage of graded roads (kilometers)</th>
<th>Fixed asset investment of the logistics industry (100 million yuan)</th>
<th>Education expenditure (100 million yuan)</th>
<th>Freight turnover (100 million tons km)</th>
<th>Logistics added value (100 million yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>99.7</td>
<td>42579</td>
<td>53.99</td>
<td>84.92</td>
<td>1077.74</td>
<td>215.61</td>
</tr>
<tr>
<td>2001</td>
<td>102.3</td>
<td>59797</td>
<td>66.68</td>
<td>103.90</td>
<td>1093.21</td>
<td>239.5</td>
</tr>
<tr>
<td>2002</td>
<td>107.2</td>
<td>61406</td>
<td>76.91</td>
<td>102.84</td>
<td>1249.87</td>
<td>275.27</td>
</tr>
<tr>
<td>2003</td>
<td>114.9</td>
<td>63374</td>
<td>84.56</td>
<td>116.83</td>
<td>1326.30</td>
<td>326.34</td>
</tr>
<tr>
<td>2004</td>
<td>121.4</td>
<td>65800</td>
<td>105.56</td>
<td>166.86</td>
<td>1450.63</td>
<td>411.6</td>
</tr>
<tr>
<td>2005</td>
<td>133.8</td>
<td>67083</td>
<td>117.43</td>
<td>229.75</td>
<td>1566.48</td>
<td>336.39</td>
</tr>
<tr>
<td>2006</td>
<td>140.3</td>
<td>122584</td>
<td>165.14</td>
<td>300.09</td>
<td>1703.01</td>
<td>363.12</td>
</tr>
<tr>
<td>2007</td>
<td>152.4</td>
<td>128241</td>
<td>212.97</td>
<td>348.58</td>
<td>1988.98</td>
<td>408.33</td>
</tr>
<tr>
<td>2008</td>
<td>166.9</td>
<td>134669</td>
<td>286.26</td>
<td>378.36</td>
<td>5843.49</td>
<td>443.81</td>
</tr>
</tbody>
</table>
Using the CCR-DEA and BCC-DEA Models in MaxDEA Software to Calculate the Logistics Efficiency of Anhui Province.

Table 2. Logistics efficiency of Anhui Province from 2000 to 2016.

<table>
<thead>
<tr>
<th>Year</th>
<th>The comprehensive technical efficiency</th>
<th>Pure technical efficiency</th>
<th>Scale efficiency</th>
<th>Return of scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2001</td>
<td>0.930</td>
<td>1.000</td>
<td>0.930</td>
<td>Increasing</td>
</tr>
<tr>
<td>2002</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2003</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2004</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2005</td>
<td>0.855</td>
<td>0.870</td>
<td>0.982</td>
<td>Increasing</td>
</tr>
<tr>
<td>2006</td>
<td>0.759</td>
<td>0.837</td>
<td>0.906</td>
<td>Increasing</td>
</tr>
<tr>
<td>2007</td>
<td>0.783</td>
<td>0.809</td>
<td>0.967</td>
<td>Increasing</td>
</tr>
<tr>
<td>2008</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2009</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2010</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2011</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2012</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2013</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2014</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>Constant</td>
</tr>
<tr>
<td>2015</td>
<td>0.864</td>
<td>0.951</td>
<td>0.908</td>
<td>Decreasing</td>
</tr>
<tr>
<td>2016</td>
<td>0.858</td>
<td>1.000</td>
<td>0.858</td>
<td>Decreasing</td>
</tr>
</tbody>
</table>

These results show that:

The comprehensive technical efficiency. In the past years, the logistics resources invested in Anhui Province have been effectively utilized for 9 years, and the largest output has been obtained. The logistics efficiency has reached an effective level. In 2001, 2005, 2006, 2007, 2015 and 2016, the comprehensive technical efficiency of logistics is less than 1, which is ineffective in DEA. There was a low efficiency in 2006 and 2007. The efficiency of logistics resource allocation and utilization efficiency in Anhui Province are low, and there is advancement for improvement.

Pure technical efficiency. In the four years of 2005, 2006, 2007 and 2015, the pure technical efficiency of logistics has not reached 1, but it has also reached more than 0.8. For the remaining 13 years, the value of pure technical efficiency of logistics is 1, which has reached the effective state of pure technical efficiency of logistics. The level of logistics technology and management in Anhui Province is relatively high, and the formulation of logistics policy is more reasonable.

Scale efficiency and return of scale. The scale of logistics development in Anhui Province is well controlled, but combined with the scale of returns, it can be seen that the return of scale decreases in 2015 and 2016. It indicates that the excessive investment in Anhui Province in the past two years has resulted in waste of logistics resources, resulting in uneconomical scale. Six of these 17 years have seen inefficiencies in scale efficiency. Increasing returns of scale in 2001 shows that logistics efficiency can be improved by expanding the scale of logistics. In 2016, return of scale declined, and its scale efficiency value was lower than that in 2015. This shows that the scale of logistics in Anhui Province has been over-expanding, and this trend has not been controlled in time. This kind of input redundancy leads to uneconomic scale and hinders the healthy development of the logistics industry. Therefore, while expanding the scale, the logistics industry should pay attention to matching current logistics needs and production technologies to avoid inefficient investment.

The overall logistics efficiency of Anhui Province has stabilized, but there have been large fluctuations in 2005, 2006, 2007, 2015 and 2016. The average comprehensive technical efficiency of
the logistics industry is 0.944, the average pure technical efficiency is 0.969, and the average scale efficiency is 0.974. In these years, the scale efficiency and return of scale is generally constant or increased. It can be seen that the logistics efficiency of Anhui Province is relatively high. As long as the logistics industry needs analysis and logistics development planning, rational resource allocation and scale control, the logistics efficiency can be further improved, and the logistics industry development in Anhui Province can be promoted.

Analysis of Influencing Factors of Anhui Province

Tobit Method. The values of dependent variables in Tobit regression model are truncated and observed in a restricted way. Logistics efficiency values obtained by DEA method are discrete and distributed between 0 and 1. Linear regression analysis with censored data usually adopts maximum likelihood method (MLE) and least squares method (LS). However, there may be biased and inconsistent parameter estimates when estimating by least squares method, so the maximum likelihood estimation of Tobit model is used to regression parameters.

The basic model is as follows:

\[
Y = \begin{cases} 
Y^* = \beta X + \mu ; & Y^* > 0 \\
0 ; & Y^* \leq 0 
\end{cases}
\]  

(1)

Where, \(Y^*\) is the truncated dependent variable vector; \(Y\) is the efficiency value vector; \(X\) is the independent variable vector; \(\beta\) is the correlation coefficient vector; \(\mu\) is a constant value.

Influencing Factors. This paper selects the comprehensive technical efficiency value as the dependent variable, and selects five factors as independent variables, which are economic development level, logistics infrastructure utilization rate, logistics demand, informationization level and opening-up level.

The level of economic development mainly considers the annual GDP growth rate. The utilization rate of logistics infrastructure mainly selects three factors: unit railway freight volume, unit highways freight volume, and unit waterways freight volume. The principal component analysis method is used to extract the index and obtain the utilization rate. Logistics demand mainly considers the total retail sales of consumer goods. The level of informatization mainly considers the number of computer Internet users. The level of opening up mainly considers the proportion of foreign direct investment in GDP.

Model Building. The Tobit regression model is established as follows:

\[
Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \mu
\]  

(2)

Where, \(\beta_0\) is a constant term, \(\beta_1, \beta_2, \beta_3, \beta_4, \beta_5\) are the regression coefficients of each independent variable, \(\mu\) is the error term, \(i\) is the year, \(X_{1i}\) represents the economic development level of the i-th year, \(X_{2i}\) represents the utilization rate of the logistics infrastructure in the i-th year, \(X_{3i}\) indicates the logistics demand in the i-th year, \(X_{4i}\) indicates the informationization level index in the i-th year, \(X_{5i}\) indicates the level of opening in the i-th year.

Result Analysis. The Tobit model is regressed by Eviews 5.0 software. The results are shown in Table 3.

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard deviation</th>
<th>Z</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic development level</td>
<td>0.407122</td>
<td>0.222944</td>
<td>1.826122</td>
</tr>
<tr>
<td>Utilization rate of logistics infrastructure</td>
<td>0.27399</td>
<td>0.045272</td>
<td>6.052089</td>
</tr>
<tr>
<td>Logistics demand</td>
<td>-0.00014</td>
<td>2.54E-05</td>
<td>-5.65162</td>
</tr>
<tr>
<td>Informationization level</td>
<td>0.000263</td>
<td>8.74E-05</td>
<td>3.007784</td>
</tr>
<tr>
<td>Opening-up level</td>
<td>-1.61176</td>
<td>2.277577</td>
<td>-0.70766</td>
</tr>
<tr>
<td>C</td>
<td>1.233672</td>
<td>0.05128</td>
<td>24.05759</td>
</tr>
<tr>
<td>R²</td>
<td></td>
<td></td>
<td>0.855527</td>
</tr>
</tbody>
</table>
R\(^2\) is 0.855527, which indicates that the model fits better. P means the level of significance. P<0.05, which means that the significance test passes, and the lower the p value, the higher the level of significance.

These results show that:

**Economic development level.** The coefficient of economic development level in Anhui Province is 0.407122, and the p value is close to 0.05, indicating that the economic development level of Anhui Province has a positive impact on its logistics efficiency. The logistics industry is a complex new type of industry, covering not only transportation, warehousing, packaging, distribution and processing, but also various industries, including the manufacturing, freight forwarding, distribution, and information industries. Types of logistics resources are not independent, but need to be integrated to improve logistics efficiency.

**Utilization rate of logistics infrastructure.** The correlation coefficient of utilization rate logistics infrastructure is 0.27399, which is positively positively correlated with logistics efficiency. The improvement of the utilization rate of logistics infrastructure can directly promote the improvement of logistics efficiency, and the effect is obvious. The higher the utilization rate of logistics infrastructure, the less waste of logistics related resources in Anhui Province. Anhui Province still needs to continuously improve the utilization rate of various logistics resources, reduce resource idleness and waste, and improve logistics efficiency.

**Logistics demand.** The coefficient of logistics demand is -0.00014, which has a significant negative correlation with logistics efficiency. It shows that with the increase of logistics demand, logistics efficiency does not increase but decreases. This is mainly because the development speed of all aspects of the logistics industry can not keep up with the growth rate of logistics demand and the optimization of logistics demand structure. In recent years, e-commerce logistics, cold chain logistics, automobile logistics and cross-border e-commerce have developed well, and the logistics demand in the field of bulk energy and raw materials has continued to decline. The requirements for logistics informationization, automation, and intelligence are higher. The use of cutting-edge logistics technology is even more important, but the transformation and upgrading speed of the logistics industry cannot keep up with the growth rate of logistics demand.

**Informationization level.** The coefficient of informatization level is 0.000263, which is significantly positively correlated with logistics efficiency. The improvement of the informatization level in Anhui Province can greatly promote the improvement of its logistics efficiency. Reducing information asymmetry in logistics activities is very important to improve logistics efficiency. Anhui Province started to establish Anhui Logistics Information Public Platform in 2008. At present, it is well operated. It not only has basic functions of information inquiry, vehicle and freight matching, commodity inspection and customs declaration, but also strengthens the functions of e-commerce service, linking up with government functional departments and interoperability with other provinces and municipalities.

**Opening-up level.** The coefficient of opening-up level is -1.61176, which indicates that the level of opening-up in Anhui Province is negatively correlated with logistics efficiency, but it has not passed the significant test. With the continuous improvement of the level of opening up and the introduction of foreign capital and excellent foreign logistics enterprises, Anhui's logistics industry has been activated and a competitive pattern has been formed, but it has not been able to promote the improvement of logistics efficiency. Anhui Province also needs to speed up the construction of a new highland inland and promote the transformation and upgrading of the logistics industry.

**Summary**

The development of logistics in Anhui Province should further accelerate the adjustment of economic growth structure, vigorously develop the tertiary industry, and promote the healthy development of logistics industry; introduce advanced information technology, improve the level of logistics information, pay attention to technological innovation; constantly promote multimodal transport projects, accelerate the standardization process of logistics industry and improve the utilization rate of various logistics infrastructure. At the same time, it is committed to improving the logistics
industry policies and regulations, improving the logistics industry supervision and security system, and ensuring the implementation of the plan.

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References


