Evaluation of Transportation Efficiency in Guangdong Province Based on Data Envelopment Analysis

Yingxia Ye
He Yuan Polytechnic, He Yuan, Guangdong, China
email: yeyingxia0762@163.com

Key words: DEA, Transportation, Transport efficiency.

Abstract: Build the BCC model of evaluation of Guangdong province transportation operation efficiency based on the Data Envelopment Analysis(DEA)method. Select operational mileages of all kinds of transport mode as input indicators, passenger and freight turnover as output index. DEAP2.1 software used transport industry data of Guangdong province for quantitative analysis and evaluation, the evaluation results show that before 2012, the transportation efficiency of Guangdong province in the DEA is invalid, and return to scale is in an increasing stage. Guangdong should increase the scale of transportation investment. Since 2012, Guangdong province's transport efficiency has been effective in DEA,, and various modes of transportation have maintained overall dynamic coordination.

1 INTRODUCTION

Transportation is one of the important infrastructure and pillar industries in the national economic structure. Guangdong province is located in the south of the mainland of China. Guangdong province is bordered by south of China sea, and adjacent to Hong Kong and Macao, whichis an important outlet of our country and the south gate, with important traffic location and strategic position. Since the reforming and opening up, the rapid development of Guangdong's transportation industry has provided a strong guarantee for the social and economic development and promoted the development of integrated transportation, modern logistics and foreign trade. In 2016, the mileage of new expressways in Guangdong province was 655 kilometers and the mileage of railway operation was 134 kilometers. The main bridge project of Hong Kong-Zhuhai-Macao Bridge is connected to the whole line, and the new construction of the main road of Jiangxi, Shenzhen and other major highways. After the 13th five-year plan, Guangdong province will become an increasingly important strategic hub for the belt and road and the maritime silk road, which will play a major role in promoting the maritime logistics channel, the maritime silk road air corridor, the opening of the silk road economic belt and the two-way railway freight corridor. Guangdong railway, aviation and other transportation means made great progress and outstanding achievements, but there are also some problems, so the reasonable transportation efficiency evaluation to the economy of the whole transportation industry development is of great practical significance. In this paper, Data Envelopment Analysis (DEA) method is used to analyze and evaluate the transportation efficiency of Guangdong province from 2005 to 2015, and calculate the relative effectiveness value of various modes of transportation, analyze its development and change characteristics and trends, thus providing basis for regional strategy decision.

2 EVALUATION OF TRANSPORTATION EFFICIENCY IN GUANGDONG PROVINCE

DEA is a multi-input and multi-output method based on relative efficiency proposed by the famous operational research scientist A.charnes and W.W. Cooper in 1978. It is a non-parametric method to evaluate whether the Decision making unit (DMU) with multiple input and output is relatively effective. It considers each evaluation unit as a DMU, and all DMU constitute an evaluation group.

Ye, Y.
Evaluation of Transportation Efficiency in Guangdong Province Based on Data Envelopment Analysis.
In *3rd International Conference on Electromechanical Control Technology and Transportation (ICECTT 2018)*, pages 379-382
ISBN: 978-989-758-312-4

2.1 The BCC model of DEA evaluation

There are many methods of DEA model, and there are two main types: fixed returns to scale DEA model -- CCR model and variable returns to scale DEA model -- BCC model. The CCR model is the basic DEA model, which assumes that the input of decision unit (DMU) can increase the output. That's an ideal assumption. In reality, changes in scale lead to different outputs. Therefore, a variable scale compensation DEA model, namely the BCC model, is produced. It measures the pure technical efficiency, comprehensive efficiency and scale efficiency of the decision unit. In this paper, the BCC model is used to evaluate the transportation efficiency of Guangdong province.

2.2 Input and output index selection

For transportation, the input indicators can include the number of employees, the length of the line, the number of stations, and the number of vehicles. The output indicator can include passenger and freight volume, and turnover, etc. Taking into account data availability, the following index is used as input X and output Y index (input indicator: railway line mileage X_1; Highway mileage X_2; Mileage of highway lines X_3; Water route mileage X_4; Air miles X_5; Turnover of goods Y_1; Turnover of passenger Y_2. The original data were obtained by referring to the statistical yearbook of Guangdong province from 2005 to 2015, as shown in table 1.

Table 1 The data of the input and output index of transportation in Guangdong province from 2005 to 2015.

Year	Mileage of the line					Turnover of goods	Turnover of passenge
	Railway	Highway	Expressway	Inland waterway	Civil air route		
2005	1924	115337	3140	13596	1080706	3917.43	**2043.23**
2006	1862	178387	3340	13596	1113479	4162.77	2245.37
2007	1871	182005	3518	13596	1413918	4489.69	2626.71
2008	1859	183155	3823	13596	1365418	4591.22	2551.92
2009	2176	184960	4035	13596	1699629	4942.83	**2853.30**
2010	2297	190144	4839	13596	1807385	5933.88	**3342.23**
2011	2555	190724	5049	13596	1671100	7113.29	**3851.84**
2012	2577	194943	5524	13780	1851000	9780.56	**4372.06**
2013	3203	202915	5703	12096	2140600	12212.56	**3538.10**
2014	3818	212094	6266	12150	2285800	15020.92	**3967.28**
2015	5141	216023	7021	12150	2372900	15130.59	**4335.79**

Note: the mileage unit is km, and the freight units are 100 million tons of kilometers, and the passenger turnover units are 100 million people of kilometers

In this case, because the civil aviation routes in the statistical yearbook of 2011-2015 are 10,000kilometers, this article can only be converted directly to kilometers.

According to the 11 decision units in table 1, BCC model and DEAP2.1 analysis software were applied to analyze the traffic efficiency of Guangdong province. The evaluation results are shown in table 2 and table 3 respectively.

As we can see from table 2, the transportation system of Guangdong province from 2005 to 2015 has three years (2012, 2014, 2015) comprehensive efficiency, technical efficiency and scale efficiency are all effective in DEA. In the year when the DEA was invalid, overall efficiency kept rising, and the comprehensive efficiency reached the effective state after 2012. In addition to 2009 and 2012, the technical efficiency of transportation in Guangdong province is 1, indicating that the optimization of input and output has been achieved. At the same time, the five years when DEA is invalid (2005, 2006, 2007, 2008, 2013), increasing return to scale is increasing that is to say increase inputs can drive the comprehensive efficiency of transportation. Therefore, Guangdong province should increase the transportation scale input, strengthen the management of all links, and improve the transportation efficiency.

Table 2 Comprehensive efficiency, technical efficiency and scale efficiency of transportation.

DMU	Year	Comprehensive efficiency	Technical efficiency	The scale efficiency	Increase and decrease of size
DMU1	2005	0.822	1.000	0.822	Increasing
DMU2	2006	0.854	1.000	0.854	Increasing
DMU3	2007	0.943	1.000	0.943	Increasing
DMU4	2008	0.843	1.000	0.843	Increasing
DMU5	2009	0.893	0.984	0.908	Increasing
DMU6	2010	0.873	0.992	0.880	Increasing
DMU7	2011	0.976	1.000	0.976	Increasing
DMU8	2012	1.000	1.000	1.000	Constant
DMU9	2013	0.974	1.000	0.974	Increasing
DMU10	2014	1.000	1.000	1.000	Constant
DMU11	2015	1.000	1.000	1.000	Constant

As can be seen from table 3, there are years of investment redundancy and insufficient output in 2009 and 2010. In 2010, redundancy and output stood out. In 2010, the length of the railway was 319.776km of redundant expressways, 140880km of air traffic and 132.6 billion tons of freight traffic. Therefore, in 2009, Guangdong province should appropriately reduce the operating mileage of railway and the operating mileage of civil aviation routes. In 2010, it should be appropriate to reduce the mileage of expressway and the operating mileage of civil aviation routes.

Table 3 Calculation results of traffic operation efficiency in Guangdong province.

DMU	Year	investment redundancy					insufficient output	
		Railway	Highway	Expressway	Inland waterway	Civil air route	Turnover of goods	Turnover of passenge
DMU1	2005							
DMU2	2006							
DMU3	2007							
DMU4	2008							
DMU5	2009	13.306				137059	1067	
DMU6	2010			319.776		140880	1326	
DMU7	2011							
DMU8	2012							
DMU9	2013							
DMU10	2014							
DMU11	2015							

3 CONCLUSION

Based on the model of variable return to scale DEA model -- BCC model, this paper constructs an evaluation of the operation efficiency of traffic transportation in Guangdong province, and selects the operating mileage of various modes of transportation as the input index, and the passenger and freight turnover as the output index, based on the statistics of Guangdong province from 2005 to 2015, and evaluates the relative effectiveness of its operation. Judging from the evaluation results, Guangdong province has experienced a huge increase in traffic mileage in recent years, and the passenger and freight mileage has been significantly improved. Although there are slight fluctuations in the overall efficiency of transportation and transportation, the overall trend of overall growth has been maintained, and the effective value 1 is finally reached. Except for individual years, the pure technical efficiency is basically valid value 1. The

total compensation of scale is increasing, which indicates that the transportation performance of Guangdong province is generally good, and all modes of transportation are in dynamic coordination.

REFERENCES

cui yan, wu limei, qu jianhua, Assessment on Hennan transportation efficiency based on DEA[J], henan science, 2013,31 (2) : 201-204.

wang dongdong, li liqin, xiao liang, evaluation and analysis of transportation efficiency in shaanxi province based on DEA [J], practice and cognition of mathematics, 2014,44 (10) :33-38.

Li Guishan, evaluation of highway transportation in Jilin province based on fuzzy comprehensive evaluation [D], Jilin university, 2007.

Liu Jian, Ye Yingxia, application of DEA method in green supply chain performance [J], industrial technology economy, 2008, 27 (1): 63-65.

Charnes A, Cooper W W, Rhodes E. Messruing the efficiency of decision making units［J］. European Journal of Operational Analysis, 1996, 7: 99-101.