ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

Research on Influencing Factors of Low-Carbon Total Factor Productivity of Aviation Logistics Enterprises

Hualei Ju [1], Zihong Chen [2,*]

[1] *College of Economics, Northwest University of Political Science and Law, Xi'an 710122, China*
[2] *The School of Economics Resource Management, Beijing Normal University, Beijing 100875, China*
[*] *Corresponding author e-mail:chenzihong01@outlook.com*

ABSTRACT. *This paper incorporates carbon emissions as an undesired output into the total factor productivity analysis framework. Based on the super-efficiency DEA and Malmquist-luenberger index, this paper measures the low-carbon total factor productivity of China's listed aviation logistics companies from 2012 to 2018, and constructs a two-way fixed effect model to analyze the influencing factors of low-carbon total factor productivity. The empirical test results show that the quality of labor factors and profitability have a positive effect on the low-carbon total factor productivity of China's listed aviation logistics companies, while listing time and operating capacity are negatively correlated with the low-carbon total factor productivity.*

KEYWORDS: *aviation logistics; low-carbon total factor productivity; influencing factors*

1. Introduction

Environmental pollution and greenhouse gas emissions have become a global social problem, and it has become a consensus for all countries in the world to jointly tackle climate change [1]. In December 2018, at the UN Climate Change Conference in Katowice, Poland, representatives of various countries improved the detailed rules of the Paris Agreement, adopted many comprehensive, balanced and effective results, and fully implemented the provisions of the Paris Agreement. China, as one of the world's largest carbon dioxide emission countries, its ability to better achieve the "Nationally Determined Contribution" (NDC) goal promised in the "Paris Agreement" has attracted widespread attention from the international community. For this reason, the Chinese government has set a binding target of an 8% reduction in carbon dioxide emissions per unit of GDP during the 13th Five-Year Plan period, compared with the 12th Five-Year Plan period, and has added "ecological civilization" and "green development" to the national development strategy [2]. However, existing research results show that under the continuation of the current emission reduction efforts, by 2030, China can basically achieve the minimum NDC target of reducing carbon dioxide emissions per unit of GDP by 60% in its nationally determined contribution compared with 2005, but still need to make efforts to reduce emissions to reach the ceiling target of reducing carbon dioxide emissions by 65%. Therefore, the consideration of carbon emission factor in productivity research is in line with current realistic requirements.

As an important part of the social high-speed operating system, aviation logistics has made great contributions to China's social and economic development [1]. However, with the rapid development of the aviation logistics industry, the number of aircraft, transportation volume, and fuel consumption continue to increase, causing the aviation logistics industry become one of the important sources of global greenhouse gases [3]. In 2017, the global aviation logistics industry's carbon emissions reached 85.9 million tons of carbon dioxide equivalent, and the growth rate is staggering. By 2050, about 22% of the total global greenhouse gas will come from the air transportation industry. China, which is in the transition period from industrial civilization to ecological civilization and has the world's second-largest air transportation system, scientifically and rationally measures the total factor productivity of aviation logistics enterprises from the perspective of carbon emissions, and explores its influencing factors, which is of great practical significance for the rational adjustment of industrial structure and the promotion of low-carbon development of aviation logistics industry.

At present, there are abundant researches on the influencing factors of total factor productivity from the perspective of carbon emissions, but they all concentrated in the fields of agriculture, industry, and power industry. For example, Bai (2014) used the Tobit model to analyze the environmental TFP influencing factors of the OECD and BRIC power industry, and found that technological progress and fuel structure were the main driving forces. Wu Xianrong (2014) also adopted the Tobit model and found that the education level of the labor force and industrial structure have a significant impact on agricultural carbon emissions TFP. Chen Honglei

ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

(2013) found that Guangdong's industrial carbon emission TFP is mainly affected by factors such as industry openness degree and labor quality. But relatively few studies focus on factors affecting carbon emissions TFP of aviation logistics. In order to enrich the research on TFP of the aviation logistics industry from a low-carbon perspective, this article intends to promote the existing results from the following aspects: (1) Introduce carbon emissions as undesired output, and use the super-efficiency DEA-Malmquist-luenberger model to measure the low-carbon TFP of aviation logistics enterprises from 2013 to 2018; (2)Two-way fixed effect model is further utilized to explore the influencing factors of aviation logistics low carbon TFP and analyze their influencing logic.

2. Methodology

2.1 Malmquist-Luenberger production index method of super efficiency DEA-DDF

In this paper, Malmquist-Luenberger production index method based on super efficiency DEA-DDF is used to calculate the low carbon total factor productivity of aviation logistics enterprises. The calculation ideas are as follows : (1) to construct the effective frontier of economy through super-efficiency DEA model and environmental technology; (2) The DDF function is used to calculate the "distance" between each production decision unit and the effective frontier; (3) The Malmquist-Luenberger index values were calculated based on the DDF of the two phases.

2.2 Two-way fixed effect model

In this paper, Two-way fixed effect model is adopted to test the influencing factors of low carbon TFP of aviation logistics by using panel data. Considering both individual fixed effect and time fixed effect, the missing variables that do not change with time can be controlled and the effects that do not change with time can be captured.

3. Empirical test

3.1 Sample selection and data sources

According to the sector classification of the China Securities Regulatory Commission in 2012, the A-share listed companies in the air transport industry are selected as the research object. And in order to ensure the continuity of research and avoid the impact of extreme values, listed companies of incomplete financial data or ST or *ST were excluded. Finally, seven listed aviation logistics companies including Shenzhen Airport, CITIC Amanoatae, Shanghai Airport, China Southern Airlines, China Eastern Airlines, HNA Holdings and Air China are the remaining research objects. The research period is from 2012 to 2018, and the data sources are CSMAR database, annual reports of listed companies, and "Annual Data of Major Cities" of the National Bureau of Statistics of China.

3.2 Construction of indicator system

Table 1 shows the indicators needed to calculate the low-carbon TFP of aviation logistics enterprises. According to Solow's theory of production factors, capital and labor, as the most basic production factors of an enterprise, are the key factors that determine the potential production capacity. Based on existing research, this paper selects the average number of employees as the labor input index, and the operating cost and total assets as the capital input index. In terms of expected output indicators, operating income and net profit are selected as the expected output, and in terms of undesired output indicators, annual jet fuel cost (fuel fee) is selected.

Table 1 Input-output variables for calculation of GML index of listed aviation logistics companies

Category	Input variables	Category	Output variables
capital input indicators	Operating costs	Desirable Output	Operating income
	Total assets		Net profit

ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

Labor input indicator	Average number of employees	Undesirable Output	Jet fuel costs

3.3 Measurement of Low-carbon total factor productivity (GML)

Using panel data from 2012 to 2018, adopting the super-efficiency DEA model and the Malmquist-Luenberger model, the low-carbon total factor productivity index GML of listed logistics companies was calculated. Table 2 shows the GML index from the low-carbon perspective of listed aviation logistics companies from 2013 to 2018. It can be seen that the low-carbon TFP values of Shenzhen Airport and Shanghai Airport during the observation period are both greater than or equal to 1, and the remaining companies have varying degrees of fluctuations around 1. The maximum value is 1.245 of China Southern Airlines in 2015, and the minimum value is 0.656of HNA Holdings in 2017.

Table2 2013-2018 GML index of listed aviation logistics companies

Listed companies	Year					
	2013	2014	2015	2016	2017	2018
ShenzhenAirport	1.000	1.000	1.000	1.000	1.000	1.000
CITIC Amanoatae	0.947	0.941	1.082	0.953	0.948	1.005
Shanghai Airport	1.099	1.028	1.098	1.020	1.216	1.071
China Southern Airlines	0.910	0.981	1.245	0.988	0.969	0.947
China Eastern Airlines	0.906	0.905	1.131	1.025	0.957	1.065
HNA Holdings	0.925	1.200	0.938	1.223	0.656	1.050
Air China	0.899	1.046	1.140	1.062	0.955	1.015

3.4 Analysis of influencing factors

Furthermore, this article considers both time effect and individual effect to construct a two-way fixed effects model (Two-wayFE):

In the formula,$GML$is the dependent variable, which represents the TFP of the aviation logistics industryfrom the low-carbon perspective ; α_{it} is a constant term; β_j represents the regression coefficient of each variable;x_j， $j = 1,2,\cdots,4$, represents the 4explanatory variables; $\mu_i$represents the individual effect'sstandard deviation (individual error); $\lambda_t$represents the time effect's standard deviation (time error); e_{it}represents the standard deviation ofstochastic disturbance terms (random error); $i = 1,2,\cdots,7$represents 7 listed aviation logistics companies; t indicates the year. According to the data availability and characteristics of the aviation logistics industry, five factors, including time to market(x_1)、 quality of labor factors(x_2)、operating capacity(x_3) andprofitability(x_4)， are selected on the basis of existing research as explanatory variables. The description of the variables is shown in Table 3.

Table 3Variable declaration

Variable name	Indicator code	Variable declaration
Low-Carbon Total Factor Productivity	GML	See above
Time to market	x_1	Number of full years of listing of listed aviation logistics companies
Quality of labor factors	x_2	Average years of education of employees
Operating capacity	x_3	Operating income/Average total assets
Profitability	x_4	Net profit/Average total assets

1) Time to market(x_1): There are two explanations for the impact of time to market on low-carbon TFP. On the one hand, Yi Languang (2019) believes that the longer an enterprise is listed, the higher its production efficiency and stability will be due to its long-term acceptance of standardized market supervision, and the higher production efficiency will be achieved with long-term production experience, employee work experience and consumption relationship accumulation.On the other hand, companies that have been on the market for a long time may not be able to propose effective countermeasures to the complex new situation due to factors such as large scale, rigid systems, and limited thinking, which will lead to a decline in low-carbon TFP [8].

ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

2) Quality of labor factors(x_2): Loko and Diouf (2009) pointed out that the quality of labor factors will directly affect production efficiency. High-quality workers are more likely to have the ability to be aware of the negative externality of pollution, and then pay attention to and control environmental pollution, which affects low-carbon TFP. In this paper, the quality of labor factors is measured by the average years of education of employees.

3) Operating capacity(x_3): This variable represents the efficiency of the allocation and utilization of human resources and means of production under the constraints of the external market environment. The higher the operating efficiency, the more effective the company can use its assets and create income. Based on the viewpoints of Xia Yidan (2014) and Zhang Yibo (2017), this paper uses total asset turnover to measure the operating capability of aviation logistics companies.

4) Profitability(x_4): Shen Junxi (2017) states that the improvement of profitability will provide necessary financial support for enterprises to optimize management level, expand enterprise scaleand improve emission reduction technology, which will affect enterprises' low-carbon TFP. On the contrary, low profitability will limit the high-quality development of enterprises, restrict the advancement of emission reduction projects such as technological improvement and model updating, and reduce the level of low-carbon TFP. In this paper, return on assets(ROA) is chosen to represent the profitability of aviation logistics companies.

Table 4 Statistical description of influencing factors

Variables	Mean	Standard deviation	Median	Maximum	Minimum
Quality of labor factors	14.5909	0.5895	14.6635	15.7142	13.0166
Time to market	15.3571	3.4490	16	21	7
Operating capacity	0.3980	0.1459	0.3217	0.6784	0.2287
Profitability	0.039857	0.034113	0.028737	0.143277	-0.0178

Table 4 shows descriptive statistical indicators such as mean and standard deviation of main variables

4. Analysis of Empirical Results

In this paper, STATA 16 software is used to carry out the regression of two-way fixed effect model of low carbon TFP of aviation logistics.The regression results are shown in Table 5:

Table 5 Regression results of two-way fixed effects model

Variables	Regression coefficients
Time to market(x_1)	-0.041**
	(-4.10)
Quality of labor factors(x_2)	0.020
	(0.12)
Operating capacity(x_3)	-0.547**
	(-3.04)
Profitability(x_4)	1.233**
	(3.69)
constant term	1.400
	(0.61)
company FE	Control
year FE	Control
Observations	42
R-squared	0.399

Note: in brackets are Robust standard errors ,***,**,* respectively representing p<0.01,p<0.05,p<0.1

Time to market has a significant negative correlation with environmental TFP. The empirical results show that the accumulation of experience and long-term capital market norms in the aviation logistics industry have not achieved positive benefits onTFP,on the contrary, low carbon TFP has been reduced due to problems such as long listing time, large scale and rigid system. This conclusion is the same as that of Ji Shengbao (2011). The possible reasons are as follows: for companies that have been listed for a long time, on the one hand, due to the large scale of the company, the capital cost and time period required for emission reduction measures such as flight route optimization and ground handling facilities "oil-to-electricity" are high;On the other hand, the corporate management system is relatively large, so the awareness of emission reduction and the in-depth and effective implementation of emission reduction management and control plans may lag behind. Therefore,

ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

compared to aviation logistics companies with a shorter listing time, a long listing time has a negative impact on low-carbon TFP.

The quality of labor factors is not significantly positively correlated with environmental TFP. From 2013 to 2018, the average years of education of listed aviation logistics companies rose from 14.38 to 14.84, an increase of 3%. The empirical results manifest that with the improvement of the average years of education of employees, environmental performance is also improving.On the one hand, high cultural quality can enhance the mastery of modern production and management technology, so as to make theefficient realization of air transportation emission reduction optimization systems such as APU fuel-saving equipment and QAR systems, and ultimately affect the change of low-carbon TFP. On the other hand, high cultural quality helps to establish and penetrate a stronger awareness of emission reduction and environmental protection,and plays a positive role in promoting low carbon TFP. The reason for the above-mentioned insignificant effect may be due to the characteristics of the employee structure in the aviation logistics industry, so the improvement of the quality of labor factors has an insignificant impact on low-carbon TFP.

Operating capacity is signally negatively correlated with environmental TFP. From 2013 to 2017, the average total asset turnover(TATO) of listed airline companies declined year by year, but recovered after 2017, reaching 40.9% in 2018. Positive analysis demonstrates that the increase in TATO does not show a high asset utilization rate, but instead reduces thelow-carbon TFP. This is contrary to the conclusion of Du Chuanzhong (2009). The possible reason is that for the aviation logistics industry, a higher TATO means that companies pay more attention to the speed of asset investments to making profits, and thus relatively underestimate energy conservation, emission reduction and environmental pollution. Thereby reducing low-carbon TFP.

Profitability is notably positively related to environmental TFP. From 2013 to 2015, the return on assets(ROA) of listed aviation logistics companies rose from 3.71% to 4.24%. After 2015, the ROA continued to fluctuate, reaching the highest point of 4.66% in 2017 and falling back to 3.78% in 2018. The empirical findings indicate that with the change in profitability, the low-carbon TFP changes in the same direction. For this phenomenon, the possible reason lies in that the emission reduction measures of aviation logistics industry mainly include the introduction of environment-friendly new aircraft models and the installation of winglets, which require large funds. So the higher rate of ROAproves that companies have a certain degree of financial strength, which can effectively promote and implement emission reduction measures and improve low-carbon TFP.

5. Conclusion

In this paper, carbon emission is regarded as an undesired output, and the influencing factors of low carbon TFPare analyzed by using super-efficiency DeA-Malmquist Luenberger model and Two-way fixed effects model. The main conclusions can be drawn as follows: Time to market has an inhibitory effect on low-carbon TFP ; the improvement of the quality of labor factors will promote the growth of low-carbon TFP , but its impact is not obvious; operating capacity has a negative impact on low-carbon TFP, and rapid asset turnover may underestimate the restriction of emission reduction, causing environmental pollution; the increase in profitability has a significant incentive effect on the growth of low-carbon TFP.

References

[1] ZHOU Y X, HONG X J. Measurement and Dynamic Driving Mechanism of Chinese Transportation Total Factor Carbon Emission Efficiency[J].Journal of Business Economics,2018(05):62-74.
[2] ZHANG Q. An Analysis on Transportation Carbon Emission Efficiency of “the Silk Road Economic Belt” in China: Based on Luenberger Productivity Index Method[J]. Journal of Hunan University(Social Sciences), 2018,32(05):78-84.
[3] LIU Y, ZHU Y. New Development in Global Governance of Climate Change:Carbon Offsetting and Reduction Scheme for International Aviation[J]. Journal of Beijing Institute of Technology(Social Sciences Edition), 2019,21(03):39-49.
[4] XIE B C, SHANG L F, YANG S B, et al. Dynamic environmental efficiency evaluation of electric power industries: Evidence from OECD (Organization for Economic Cooperation and Development) and BRIC (Brazil, Russia, India and China) countries[J]. Energy, 2014, 74(sep.):147-157.
[5] WU X R, ZHANG J B, TIAN Y, et al.Provincial Agricultural Carbon Emissions in China:Calculation, Performance Change and Influencing Factors[J].Resources Science, 2014,36(01):129-138.
[6] CHEN H L, TAN W F, WU J X. The Empirical Study on Total Factor Productivity by Considering Carbon Emission and its influence factors:In Case of Guangdong's Industries[J].Industrial Economics Research, 2013(05):45-53.

ISSN 2616-7433 Vol. 2, Issue 6: 12-17, DOI: 10.25236/FSST.2020.020603

[7] YI L G, HU M M. Efficiency Evaluation of Hunan Listed Companies and Influencing Factors[J].Economic Geography, 2019,39(06):154-162.

[8] JI S B, XI Y L. Efficiency Evaluations and Influencing Factors of China Food＆Beverage Listed Companies:DEA-Tobit model based on SORM-BCC＆Malmquist[J].Shanghai Journal of Economics, 2011(09):71-84.

[9] LOKO B , DIOUF M A . Revisiting the Determinants of Productivity Growth - Whats new?[J]. Imf Working Papers, 2009, 09(225).

[10] XIA Y D, HU Z Y, DAI Y. Factor Analysis of China's Listed Culture/Media Corporations Total Factor Productivity Calculation and Influence Based on the Global Malmquist Index[J].The Theory and Practice of Finance and Economics, 2014,35(04):48-52.

[11] ZHANG Y B, HE J M. An Empirical Study of the Comparison and Affecting Factors of TFP of Listed Hotel Groups: Based on Chinese and Foreign Large-scale Internationalized Listed Hotels[J]. Tourism Science, 2017, 31(02):69-81.

[12] SHEN J X, YANG R X. Total Factor Productivity of Strategic Emerging Industries in Yangtze River Delta and Its Influencing Factors[J]. Finance and Trade Research,2017,28(11):24-33.

[13] DU C Z, LV K, LIU Y H. Empirical Study on Production Efficiency of Listed Companies in Chinese brewing Industry :a two-stage Analysis Based on DEA Model[J].Inquiry into Economic Issues,2009(11):87-93.