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The Contribution of Total Factor Productivity in the Air Transport of Vietnam: The Case of Vietnam Airlines

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Abstract: The aim of this study is to determine the contribution of Total Factor Productivity (TFP) in the air transport of Vietnam over the case of Vietnam Airlines. Based on analyzing data of Vietnam Airlines from 2005 to 2015, this study showed that fixed assets, labor and TFP are factors that affecting the output elements of Vietnam Airlines as Available of Ton-Kilometers Conversion (ATKC), Performance of Ton-Kilometers Conversion (PTKC), revenue and value added. Among these factors, the contribution of fixed assets is higher than labor, especially in generating revenue and value added. In the period from 2006 to 2010, the growth of Vietnam Airlines was due to the increase in fixed assets, labor and TFP, but in the period from 2011 to 2015, this growth was mainly due to the increase of fixed assets. The results of this study suggest Vietnam Airlines and others airline in Vietnam can increase efficiency growth by investing capital in order to increase fixed assets, increase labor, innovate technology, improve management and improve labor skills.

Keywords: Total Factor Productivity, Air Transport, Vietnam Airlines

1. Introduction

Vietnam Airlines is the national airline of Vietnam, founded in 1993 and privatized in 2014, operating under the model of traditional airlines. Vietnam Airlines is the leading role in the air transport capacity of Vietnam. So the operation performance of Vietnam Airlines has great impact on the efficiency of air transport operation in Vietnam.

This article studies the contribution of TFP of Vietnam air transport over the case of Vietnam Airlines. To solve this problem, the article will study the theoretical basis and prior related research to inherit the content and approach and then design study model, collect and analyze Vietnam Airlines's data to estimate and test parameters in the model. Research results will determine the contribution of the Vietnam Airlines's growth factors to recommend the solution to improve the production efficiency of air transport business for Vietnam Airlines.

2. Theoretical Basis and Research Design

2.1. Theoretical Basis

TFP is the result produced by improving capital and labor efficiency (tangible factors), base on the impact of intangible factors such as technological innovations, rationalize production, management process improvement, improve labor skills... [10]. These intangible factors were called as total factor. From this approach, the form of formula of production function is showed as below (1).

$$Y = F(K, L, TFP) \quad (1)$$

Where:
Y: Output or output value
K: Capital (quantity of capital)
L: Labor (number of employees)
TFP: Total Factor Productivity

Cobb-Douglas production function suggested by Knut Wicksell (1851-1926) and tested with statistical evidence by Charles Cobb and Paul Douglas in 1928. In economics, the Cobb-Douglas production function is widely used and

popular in analyzing the growth and productivity. In microeconomics, production function indicates the amount of product produced by the manufacturer. In macroeconomics, production function represents the value of gross domestic product of a country, industry or region. The form of formula of Cobb-Douglas production function is showed as below: (2)

$$Y = A.K^{\alpha}L^{\beta} \quad (2)$$

Where:

A: TFP

α and β: Coefficient contributions of capital and labor

In terms of calculation, TFP shows percent increase of Y after subtracting the contribution of increased capital and labor. From the model of formula (2), the formula for calculating the growth rate of TFP (I_{TFP}) by the Asian Productivity Organization introduced in the form of Formula 3 [10].

$$I_{TFP} = I_Y - (\alpha.I_K + \beta.I_L) \quad (3)$$

Where:

I_{TFP}: Growth rate of total factor productivity

I_Y: Growth rate of output or value output

I_K: Growth rate of capital

I_L: Growth rate of labor

$\alpha + \beta = 1$; $\alpha.I_K$ and $\beta.I_L$ are called contributions of increase I_Y by increased capital and labor.

2.2. Research Overview

Up to now there have been many studies on the effects of TFP to the economic growth in countries [4, 5] or regional [2, 7]. Accordingly to that, variables impact of economic growth are the K, L and TFP. Output variable is the total gross domestic product (GDP) for the country or total gross regional domestic product (GRDP) for regional. The main purpose of this studies were to point out the role of TFP to economic growth.

Concerning air transport industry also have several studies in different contexts. First of all, study of Anton Brits [1] measurement of TPF in South African Airways in 5 years from 2000 to 2005 with the input variables are labor, capital, cost of fuel and materials. Total output production are the rotation volume (passenger-kilometers, freight-kilometers and mail-kilometers, then converted to the ton-km). The research results have identified the change of TFP in South African Airways in order to support the management decisions.

Next, Robert A. Powell II [9] studied the TFP for the airline passenger transportation in the US, including 7 traditional airlines and 5 low-cost carriers (LCC) through data in the period 1995-2010. The input variables are the cost of resources such as labor, capital, fuel, materials. Outputs are revenue being created, revenue passenger miles (RPM), revenue cargo miles (RCM) and revenue mail miles (RMM). After that, the rotation volume of passenger, cargo and mail are converted into aggregate output and measure by ton-mile. Research results are the comparison between the two models airlines and compares the changing about TFP's growth in the period of analysis for the airlines.

Finally, Yagmur OZ., and Can Deniz KO. [11] analyzed the business performance and TPF of airlines in the Star Alliance in 2013 and 2014. Input variables are the number of aircraft, the number of employees, the number of airports to, the destination country. Outputs are measured by the amount of annual passengers, the number of daily flights, passenger-km and revenue. The research results have identified TFP index for 26 airlines and showed there is difference of the airlines due to their use of resources and the effectiveness of different using resources.

The results of empirical research above shows that in air transport, many researchers measured output through the supply volumes and adjusted through the seat/load factor into volume air transport as research Anton Brits [1] or Robert A. Powell II [9]. Air transport volume expressed in value will become revenue as research of Anton Brits [1], Yagmur OZ., and Can Deniz KO. [12]. Economy output of the national or region is measured by GDP or RGDP as studies of Jean-Claude Nachega and Thomson Fontaine [4], Latvijas Banka [5] or Phan Nguyen Khanh Long [7]. While, RGDP is measured by value added such as studies of Dang Hoang Thong and Vo Thanh Danh [2] or J Felope and MC Combie [3].

2.3. Research Design

From the theoretical basis and study related research, this study design input variables are K, L and TFP. Outputs are operation indicators of air transport (supply volume and transportation volume) and value indicators of air transport (revenue and added value) (Table 1).

Table 1. *The input and output variables in the research model.*

Input variables (X_i)	Output variables (Y_j)
K: Quantity of capital; L: Number of employees; A: TFP	Y_1: Supply volume Y_2: Transportation volume Y_3: Revenue Y_4: Value added

Source: Author's proposal

In this research design, capital was not the equity (beside using equity, airlines also use loans) or total assets (because there are many short-term payables), which is used value fixed assets. The value of fixed assets is mainly expressed in the fleet, it usually accounts for up to 80% of total assets [1]. Using fixed asset as input capital factors have been done by many researchers such as Anton Brits [1], Phan Nguyen Khanh Long [7] or Robert A. Powell II [9].

Supply volume of airline includes available of seats (AS) and available of seat-kilometer (ASK) in the passengers transportation or available of ton (AT) and available of ton-kilometer in the cargo transportation. To get uniformity measurement, AS and ASK are converted into AT and ATK. A passenger (80 kg) and their luggage (20 kg) is equivalent to 100 kg [8]. In fact, the International Civil Aviation

Organization (ICAO) used ratio 10 passengers = 1 ton to measure the transport of passengers and goods through airports. The supply volume is selected in this study is ATK converted because it is more general than AT. It shows available of tons converted are supplied on certain distance.

Transport volume by the airline is the number of passengers carried and performance of passenger-kilometers (PPK) in the passengers transportation or tons carried and performance of ton-kilometers in the cargo transportation. Passengers carried and PPK also be converted equivalent into tons carried and PTK. Also as supply volume, transport volume is selected in this study is PTK converted because it is more general than AT. It shows tons converted carried are supplied carried on certain distance.

Revenue generated by the airline include air transportation revenue and non-air transport revenue. In particular, air transport revenue is the monetary value of the volume of air transport. Most generally, it is determined by the PTK converted multiplied the average price for 1 PTK converted.

Value added is an indicator for measuring the output value of enterprises in general and in particular for airline that it contributes to GDP. It is measured by the output value minus input value of the enterprise for a certain period. Macroeconomic theory point out that the added value of the enterprise include: Depreciation, wages, rents, interest, indirect taxes and profits. Based on this theory, in several studies [6, 11] have established formula for calculating the value added by the method of cumulative as formula (4) below.

$$\text{Value added} = \text{Labor costs} + \text{Depreciation} + \text{Interest} + \text{Profit before tax} \quad (4)$$

3. Research Methods

3.1. Method of Estimating the Parameters of the Model

Due to $\alpha + \beta = 1$ or $\beta = 1 - \alpha$, so to facilitate the estimation of parameters, formula (2) is divided both sides by L and then transferred into a logarithmic linearity as formula (5)

$$y_i = A_i.k^{\alpha} \text{ or } \log(y_i) = \log(A_i) + \alpha.\log(k) \quad (5)$$

Where:

$y_1 = Y_1/L$: ATK per one employees (thousands of ton-km/person)

$y_2 = Y_2/L$: PTK per one employees (thousands of ton-km/person)

$y_3 = Y_3/L$: Revenue per one employees (million VND/person)

$y_4 = Y_4/L$: Value added per one employees (million VND/person)

$k = K/L$: Amount of fixed assets per one employees (million VND/person)

The parameters of the model in Formula (5) were estimated by Eview software by method of Ordinary Least Square (OLS). The parameters are accepted when statistical values as t-Statistic ≥ 2 or Prob. ≤ 0.05. The model is accepted when R^2 adjusted $\geq 50\%$ and statistical values as F-statistics ≤ 0.05.

3.2. Data Sources

Data were collected from the activity reports and annual financial statements of Vietnam Airlines for 11 years from 2005 to 2015. It includes fixed assets, number of employees, ASK, ATK, PPK, PTK, revenue, labor costs, depreciation value, interest and profit before tax. The value of fixed assets and number of employees are the data point so that they are determined by the average value of beginning and end of year. In the period from 2006 to 2015 the number of Vietnam Airlines's employees has increased on average is 2.37%/year. The value of fixed assets increased on average 17.39%/year. By 2015, total assets of Vietnam Airlines was 83.538 billion VND and the fixed assets accounted for 60.27% of total assets [13]. After collecting, the data were processed as follows:

- ASK and ATK are calculated to ATK converted (ATKC) with 1 seat = 0.1 tons.
- PPK and PTK are calculated to PTK converted (PTKC) with 1 passenger = 0.1 tons.
- Revenue, labor costs, depreciation value, interest and profit before tax to calculate the annual value added by the formula (4).

From these data, annual value of the fixed asset/employees (k), ATKC/employees (y_1), PTKC/ employees (y_2), revenue/employee (y_3) and value added/employees (y_4) in 2005-2015 is presented in Table 2. Accordingly, all growth rate of output elements (y1, y2, y3, Y4) decrease in the 2011-2015 period compared the 2006-2010 period. While growth rate of input element (k) increased in the 2011-2015 period compared with the 2006-2010 period. This shows Vietnam Airlines's effective of fixed assets tend decreased.

Table 2. *The value of the input and output variables.*

Year	K (million VND/person)	y_1 (1000 ton-km/person)	y_2 (1000 ton-km/person)	y_3 (million VND/person)	y_4 (million VND/person)
2005	1152.00	195.51	149.69	1950.07	384.69
2006	1280.87	225.39	167.71	2155.04	416.92
2007	1585.23	260.01	190.22	2354.09	430.79
2008	1927.57	295.31	211.00	3002.55	555.71
2009	2023.12	299.51	205.25	2708.23	516.65
2010	2008.05	356.01	256.90	3921.41	614.39
2011	2359.53	378.19	257.53	4583.98	714.41
2012	3038.63	373.04	271.03	4888.29	793.23
2013	3439.51	389.74	298.25	5196.88	837.95

Year	K (million VND/person)	y_1 (1000 ton-km/person)	y_2 (1000 ton-km/person)	y_3 (million VND/person)	y_4 (million VND/person)
2014	3798.41	416.61	317.89	5339.09	834.77
2015	4527.88	445.35	339.99	5337.77	998.02
Average growth rate					
2006-2010	11.75%	12.74%	11.41%	14.99%	9.82%
2011-2015	17.66%	4.58%	5.76%	6.36%	10.19%
2006-2015	14.67%	8.58%	8.55%	10.59%	10.00%

Source: Result of data processing of Vietnam Airlines [13]

4. Research Results

4.1. Results Parameter Estimation and Model of Growth

From data in Table 2, the results of parameters estimated and statistical values in models at Formula (5) is presented in Table 3.

Table 3. *The results of parameters estimated and statistical values of the models.*

	Log(y_1)		Log(y_2)		Log(y_3)		Log(y_4)	
	C	**α**	**C**	**α**	**C**	**α**	**C**	**α**
Coefficient	1.4073	0.5650	0.9487	0.5840	1.7515	0.8309	0.9195	0.7127
t-Statistic	2.8877	8.9661	2.5750	12.2603	2.3025	8.4475	2.2952	0.0474
Prob.	0.0180	0.0000	0.0299	0.0000	0.0468	0.0000	13.7571	0.0000
Adjusted R^2	0.8881		0.9372		0.8756		0.9496	
F-statistic	0.0000		0.0000		0.0000		0.0000	

Source: The results estimated from Eview

The parameters estimated have statistical values as t-Statistic ≥ 2 and Prob. ≤ 0.05 so they have been accepted. Coefficients of R^2 adjusted are also quite high (at least 87.56%) and the statistical value as F- statistics are very small (less than 0.05), which suggests that the input variables explain at least 87.56% change of output variable. So the research models are suitable and can apply in practice. The models are determined as follows:

ATKC function model

$$\text{Log}(Y_1) = 1.4073 + 0.5650K + 0.4350L \text{ or } Y_1 = 4.0849K^{0.5650}L^{0.4350}$$

Coefficient contribution of fixed assets and labor in Vietnam Airlines's ATKC are respectively 0.565 and 0.435 (TFP is 4.089). It mean in case other factors not change, fixed assets increased by 1% will increase ATKC to 0.565%, and labor increased by 1% will increase ATKC to 0.435%.

PTKC function model

$$\text{Log}(Y_2) = 0.9487 + 0.5840K + 0.4160L \text{ hay } Y_2 = 2.5822K^{0.5840}L^{0.4160}$$

Coefficient contribution of fixed assets and labor in Vietnam Airlines's ATKC are respectively 0.584 and 0.416 (TFP is 2.5822). It mean in case other factors not change, fixed assets increased by 1% will increase ATKC to 0.584%, and labor increased by 1% will increase ATKC to 0.416%.

Revenue generated function model

$$\text{Log}(Y_3) = 1.7515 + 0.8309K + 0.1691L \text{ or } Y_3 = 5.7634K^{0.8309}L^{0.1691}$$

Coefficient contribution of fixed assets and labor in Vietnam Airlines's revenue are respectively 0.8309 and 0.1691 (TFP is 5.7634). It mean in case other factors not change, fixed assets increased by 1% will increase revenue to 0.8309%, and labor increased by 1% will increase ATKC to 0.1691%.

Value added generated function model

$$\text{Log}(Y_4) = 0.9195 + 0.7127K + 0.2873L \text{ or } Y_4 = 2.5081K^{0.7127}L^{0.2873}$$

Coefficient contribution of fixed assets and labor in Vietnam Airlines's value added are respectively 0.7127 and 0.2873 (TFP is 2.5081). It mean in case other factors not change, fixed assets increased by 1% will increase ATKC to 0.7127%, and labor increased by 1% will increase ATKC to 0.2873%.

From the estimated model shows that the coefficient of contribution of fixed assets are higher than the coefficient of contribution of labor for all the function ATKC, PTKC, revenue and value added. In which, for operation, the difference is not much, but in the creation of value, this difference is very high (almost 5 times for creation of revenue and 2.5 times for with the creation of value added).

4.2. TFP Growth

From the estimation results of parameters in the model, as well as the growth rate of fixed assets and labor, this study has identified the growth rate of output elements (ATKC, PTKC, revenue and value increase) due to increased fixed assets and increased labor. Then determine the TFP growth rate as Formula (3). Results increased TFP for output factors are presented in Tables 4 and 5.

Table 4. *TFP growth rate for air transport operation.*

Year	ATKC (%)				PTKC (%)			
	ATKC growth rate	Increase due to increased fixed assets	Increase due to increased labor	TFP growth	PTKC growth rate	Increase due to increased fixed assets	Increase due to increased labor	TFP growth
2006	17.44	7.49	0.81	9.13	14.14	7.75	0.78	5.61
2007	17.48	14.71	0.80	1.97	15.50	15.20	0.76	-0.47
2008	15.63	13.44	0.78	1.40	12.92	13.89	0.75	-1.72
2009	3.22	3.85	0.77	-1.40	-1.00	3.98	0.74	-5.72
2010	25.97	2.93	2.60	20.43	32.64	3.03	2.49	27.13
2011	14.54	15.08	3.40	-3.94	8.09	15.59	3.25	-10.76
2012	2.19	18.88	1.57	-18.26	9.03	19.52	1.50	-11.98
2013	4.72	7.60	0.10	-2.99	10.30	7.86	0.10	2.34
2014	6.07	5.41	-0.34	0.99	5.76	5.60	-0.32	0.49
2015	6.83	10.80	-0.03	-3.95	6.88	11.17	-0.03	-4.26
2006-2010	*15.71*	*8.31*	*1.15*	*6.25*	*14.35*	*8.59*	*1.10*	*4.66*
2011-2015	*6.79*	*11.38*	*0.92*	*-5.51*	*8.00*	*11.77*	*0.88*	*-4.65*
2006-2015	*11.16*	*9.83*	*1.03*	*0.30*	*11.13*	*10.16*	*0.99*	*-0.02*

Source: Calculated from the results of research

Table 5. *Growth rate of TFP for value creation.*

Year	Revenue (%)				Value added (%)			
	Revenue growth rate	Increase due to increased fixed assets	Increase due to increased labor	TFP growth	Value added growth rate	Increase due to increased fixed assets	Increase due to increased labor	TFP growth
2006	12.58	11.02	0.32	1.24	0.55	9.45	0.54	0.41
2007	11.24	21.63	0.31	-10.70	-3.53	18.55	0.53	-13.86
2008	29.84	19.76	0.30	9.78	39.14	16.95	0.52	13.85
2009	-8.21	5.66	0.30	-14.17	-5.38	4.86	0.51	-10.75
2010	53.45	4.31	1.01	48.13	26.02	3.70	1.72	20.61
2011	26.04	22.18	1.32	2.54	25.37	19.02	2.25	4.10
2012	10.48	27.77	0.61	-17.90	15.03	23.82	1.03	-9.82
2013	6.56	11.18	0.04	-4.66	5.88	9.59	0.07	-3.77
2014	1.94	7.96	-0.13	-5.89	-1.15	6.83	-0.22	-7.76
2015	-0.09	15.89	-0.01	-15.97	19.47	13.63	-0.02	5.87
2006-2010	*18.03*	*12.22*	*0.45*	*5.37*	*9.98*	*10.48*	*0.76*	*1.48*
2011-2015	*8.61*	*16.74*	*0.36*	*-8.49*	*12.52*	*14.36*	*0.61*	*-2.45*
2006-2015	*13.22*	*14.45*	*0.40*	*-1.63*	*11.24*	*12.39*	*0.68*	*-0.46*

Source: Calculated from the results of research

The results determine the factors contributing to the growth of Vietnam Airlines shows that in the period from 2005 to 2010, the growth of Vietnam Airlines is due to the increase in fixed assets, increase labor and increase TFP. Specifically contribution rate of increase of fixed assets, labor and TFP into ATKC respectively are 53%, 7% and 40%; into PTKC respectively are 60%, 8% and 33%; into revenue respectively are 68%, 2% and 30%; into value added respectively are 82%, 6% and 12%. While in the period from 2011 to 2015, the growth of Vietnam Airlines only by an increase in fixed assets and increased labor. TFP in this period did not grow so it did not affect the growth of Vietnam Airlines. Generally for the whole period from 2006 to 2015, growth of Vietnam Airlines was mainly due to the increase of fixed assets and increase labor. Specifically contribution rate of increase of fixed assets, labor and TFP into ATKC respectively are 88%, 9% and 3%; into PTKC respectively are 91%, 9% and 0%; into revenue respectively are 109%, 3% and -12%; into value added respectively are 98%, 5% and -4%.

The period from 2006 to 2010 is the first stage that Vietnam Airlines innovates technological and manufacturing rationalization, so that TFP has an important role in growth. In the period from 2011 to 2015, Vietnam Airlines' fixed assets increased highly by investment thriving owned fleet with new generation aircraft such as the B787 and A350. By the end of 2015, Vietnam Airlines has operated 88 aircraft with nearly 50% owned aircraft, so growth rate of fixed assets in the period from 2011 to 2015 the average up to 20.14% [13], and average growth rate of fixed assets per employees is 16.73%/year. Whereas at this stage the presence and strong competition in the Viet Nam's domestic market from VietJet Air, so market share in the domestic passenger transport by Vietnam Airlines has dropped from 75.5% in 2011 down to 47.10% in 2015. In cargo domestic transport, market share of Vietnam Airlines decreased from 92.14% in 2011 down to 67.82% in 2015 [13]. These problems make the growth rate of fixed assets increased faster than the growth rate of output elements and make TFP growth of Vietnam Airlines reduces in the period from 2011 to 2015.

5. Conclusion and Proposed Solutions

Fixed assets (represent for capital), labor and TFP are factors affecting the output element of Vietnam Airlines as ATKC, PTKC, revenue and value added. The contribution of fixed assets is higher than labor, especially in generating revenue and value added. So in the current conditions of Vietnam Airlines, the increase of fixed assets will be more effective than increasing of labor. The period from 2006 to 2010 is the early stage of the process of technological innovation, Vietnam Airlines's growth thanks to the increase in fixed assets, increased labor and TFP. In the period from 2011 to 2015, Vietnam Airlines focused investments owned new fleet generation and fierce competition in the domestic market, so Vietnam Airlines's growth only due to increased fixed assets and increased labor, in which mainly due to increased assets.

In fact there are many factors affecting the output and efficiency business of the airline. Meanwhile this study just assess the impact of fixed assets, labor and TFP of Vietnam Airlines. However, the results of this study suggest Vietnam Airlines and other airlines in Vietnam can increase efficiency growth by investing capital to increase fixed assets, increase labor, innovate technological, improve management and enhance labor skills of workers. Vietnam Airlines should pay special attention to increasing capital investment of fixed assets because it is more effective to increase labor. Currently, with the ratio of debt/equity is up to 5.66 times, so beside increasing in loan, Vietnam need to raise equity through reducing state shareholding from 86.23% in current to 70% as its oriented.

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Biography

Nguyen Hai Quang (1969, Vietnam) PhD. in Economics (2008) – University of Economics Ho Chi Minh City, Vietnam. Head of training Department, Lecturer and Researcher at Vietnam Aviation Academy. Research Experience: Air transportation management and operation, logistics in the air transport. About 6 books for training, 2 scientific research projects, 12 publications in scientific journals and about 1 paper on conference proceeding.