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Efficiency Estimating in Airline Companies: An Application on Asia-Pacific Companies*

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ABSTRACT

Fuel cost is an important cost factor in civil aviation sector. As fuel prices are determined in global markets, it is not possible for airline companies to intervene in prices. As fuel costs increase, net profit decreases as long as ticket prices remain the same. Firms need to be efficient in their fuel costs in order to compete. This study was performed to evaluate the efficiencies of airline firms taking into consideration the fuel cost and to evaluate financial performance of efficiency airlines. Data Envelopment Analysis was carried out with the purpose of evaluating the efficiencies of 15 airline companies operating in the Asia-Pacific region using data for 2010-2016. Classification Tree from data mining techniques was used to determine the efficiency levels of the companies and the factors being effective on their financial performances by using their financial ratios.

Keywords: *Airline Industry, Fuel Cost, Data Envelopment Analysis, Data Mining, Efficiency*

Jel Classification*: L93, M40, C81*

Havayolu Şirketlerinde Etkinlik Tahmini: Asya Pasifik Şirketlerinde Bir Uygulama

ÖZET

Yakıt maliyeti, havayolu şirketlerinde önemli bir maliyet unsurudur. Yakıt fiyatları küresel piyasalarda belirlenmektedir. Devletlerin vergi politikaları ve enerji yatırımları da yakıt fiyatları üzerinde etkilidir. Yakıt maliyetleri arttıkça bilet fiyatları aynı kaldığı sürece şirketlerin net kârı azalmaktadır. Şirketlerin rekabet edebilmeleri için yakıt maliyetlerinde etkin olmaları gerekmektedir. Bu çalışmanın amacı havayolu şirketlerinin yakıt maliyetinin etkinliklerini ile finansal performansa etki eden faktörleri değerlendirmektir. Uygulamada Asya-Pasifik kıtasında faaliyet gösteren 15 havayolu şirketinin 2010-2016 dönemi verileri kullanılmıştır. Etkinliklerini değerlendirmek amacı ile Veri Zarflama Analizi yapılmıştır. Veri madenciliği tekniklerinden Karar Ağacı yöntemi ile de şirketlerin etkinlik düzeylerine etki eden finansal oranlar belirlenmiştir.

Anahtar Kelimeler: *Sivil Havacılık, Yakıt Maliyeti, Veri Zarflama Analizi, Veri Madenciliği, Etkinlik*

JEL Sınıflandırması: *L93, M40, C81*

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1. INTRODUCTION

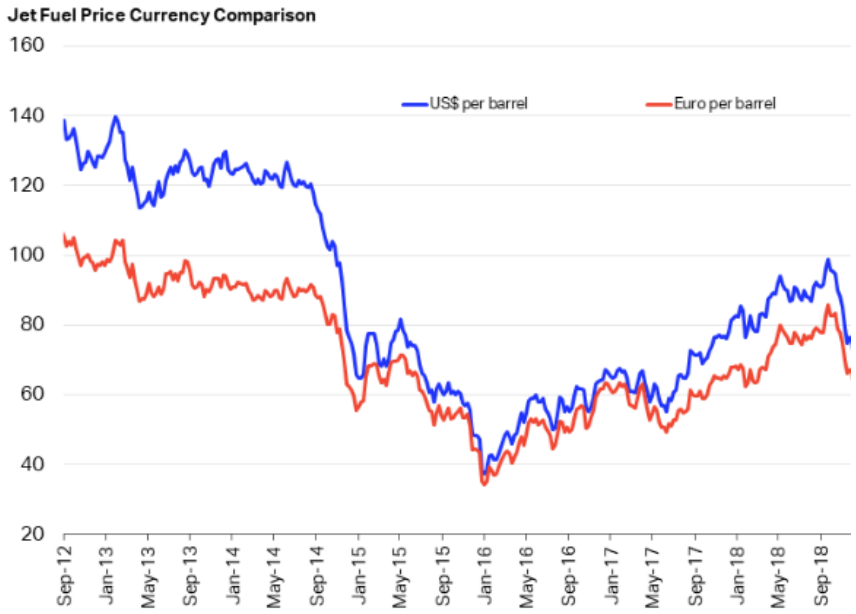
The civil aviation sector has attracted attention since the beginning of the 20th century as a continuously developing and growing. Factors such as the increase in the number of airports and airfields, the increase in the number of industrial companies in airplane manufacturing, the increase in the level of competition, and the increase in the number of passenger transporting companies have contributed to the growth of airline transport. With the development of technology in the airline transport industry, passengers are allowed to travel safely and comfortably by increasing the quality of service offered to passengers. Increased competition with the increase in the number of companies, moving to higher equity with the capacity increase required for competitiveness, requires also the financial statements of these types of structures, which require intensive work force and demand continuity, be carefully managed. It should be of primary interest for companies to pay attention to cost management so that they can efficiently manage their revenues/expenses and balance the asset/liability management.

In order airline companies to make financial decisions for their purposes, they need to plan their revenues, expenses, balance risk and return especially by predicting fuel costs, which are a significant cost factor. Financial planning should be done in order to sell a certain number of seats at reasonable prices by making gift sales in certain periods. For this, airlines do their financial planning by estimating their costs through statistical methods, especially fuel costs, which is a significant cost factor. In addition, macroeconomic variables such as fuel price, unemployment rate, Gross National Product (GNP), earnings obtained by individuals are important factors that companies operating in the civil aviation sector should take into account in the management of revenue-expense. For example, due to legal, economic and political factors, it was seen that the companies in the American civil aviation sector did not develop much until 1978, and showed rapid growth with the onset of application of liberal economic policies (Distexhe and Parelman, 1994: 669). Moreover, as the economic status, structure and local factors of the planned flight country affect the occupancy rate of the airports, it is necessary to take into consideration when financial planning is carried out. Factors such as the geographical conditions of the destinations, their population, the income levels of the customers and the proximity of the airport to the passengers have an influence on the flight planning.

The levels of competition of airline companies depend on the efficiency of cost management. For example, efficiency in fuel costs will reduce the amount of carbon dioxide released into the air as it reduces the amount of fuel consumed. Thus, maximum output with optimum energy will both reduce the environmental pollution and increase the productivity and the efficiency (Azadeh etc., 2007: 3792). The increase in occupancy rate has a significant effect on the reduction of the cost of fuel per passenger. The airplane burns less fuel as removing or mitigating unnecessary fixtures in the airplane will reduce gravity. The cost of fuel for airplanes is falling in new technology engines developed by engineers. It is therefore seen that airline companies have lowered fuel costs by purchasing less fuel-consuming airplanes. Increasing fuel prices may increase the financial pressure (exchange rate pressure) that companies face. In particular, the cost of fuel plays a very important role in company mergers. Some airline companies are partnering with companies selling jet fuel to reduce fuel costs. Others want to increase their net profits by lowering costs through technological

innovation. It has been found that environmental and technological innovations have an impact on the financial performance of airlines. For this reason, it is stated that airlines increase their financial performance with environmental innovative processes (Yan et al., 2016: 80). According to report of United States Government, jet fuel price was tripled in 11 years in 2002-2013 term (United States, 2014: 7). Jet Fuel prices for the period 2010-2016 are given in Figure 1.

Figure 1. Jet Fuel Prices in the World in 2012-2018($)



Reference: (IATA, 2019).

The downward trend of jet fuel price started in 2012 and continued until 2016. While Jet fuel price in 2012 was 140$ per barrel, it was dropped about $40 in 2016. Then the jet fuel price began to rise and became $100 at the beginning of 2019. As the price of fuel increased, so did the costs of companies.

Airlines need to control costs in order to increase their competitive power. The increase in fuel and personnel expenses each year and the fact that ticket prices are increasing less than costs due to competitive policies break the competitive power of companies. For this reason, it is possible to control the consumption of fuel, which is a significant cost factor, by establishing an efficient and productive operational process to obtain more output with less input. Increasing oil prices and the constant increase in exchange rates increase the costs of companies, so companies that make sacrifices for their earnings can maintain their competitiveness. Controlling costs is possible with an effective financial management system. When efficiency in fuel costs cannot be achieved, costs increase. Therefore increasing costs can lead to an increase in the selling price. For this reason, efficiency is important in fuel costs for companies to offer competitive prices. Therefore, financial performance and cost management activities of companies should be tested.

This study was performed to evaluate the efficiencies of airline firms taking into consideration the fuel cost. Efficiency cost effectiveness of airline companies is important in terms of performing more competitive. The study is important in terms of gaining a higher rate of profit by controlling the costs of airline companies. Data Envelopment Analysis (DEA) was carried out with the purpose of evaluating the efficiencies of 15 airline companies operating in the Asia-Pacific region using data for 2010-2016. In the second part of the application, the Classification Tree from data mining techniques was used to determine the efficiency levels of the companies and the factors being effective on their financial performances by using their financial ratios. It is expected to make a significant contribution to the literature.

2. LITERATURE

Looking also at literature on the civil aviation sector, it is seen that while labor costs and advertising expenditures were important in the first years when airline companies became active, over the years the fuel cost and the number of customers (passengers) receiving service have become more important. Foreign exchange prices, liquidity level, interest-related risks, and especially political uncertainty cause both the increase in fuel prices and the decrease in the number of passengers. For this reason, it is seen that airline companies, which have to invest in fixed assets at high amounts, resort to various financial techniques to reduce their fuel costs. For example, some airline companies use derivative instruments to avoid the impact of rising fuel prices. Karaer (2015) has identified the efficiency condition of the airline companies' hedging transactions at the cost of fuel using the data for the 2008-2012 period of 95 airline companies operating across the world's different continents. As a result of the study, it was determined that airline companies benefiting from derivative instruments in order not to be affected by the risks related to fuel costs dominated the situation in terms of finance and management and exhibited a more efficient management. Fuel, personnel, professional service, operational expenses, airplane park, landing expenses, food and beverage expenses, communication, agency commission, advertising and promotion expenses, insurance expenses and tax expenses constitute the major expenses of airline companies (Morrison et al., 2010: 9). In addition, factors such as airplane type, engine, weight, and route are other factors that affect fuel cost. Food and beverage prices outside the fuel price, the increase in employees' salaries, and taxes affect the total cost of the airline company more than any other.

Airline companies are making various analyzes to balance the costs and prices and be able to reach the desired profit. Because working at a high cost brings with it various risks; companies such as West Airlines and Laker Airways, which have failed to manage such costs, seem to go bankrupt (Button and Ison, 2008: 2-3). For this reason, companies need to have efficient and productive management by controlling costs. For example, companies such as AirTran Airways, Allegiant Air, ExpressJet, JetBlue Airways, Go!, Southwest Airlines, USA3000 Airlines, Virgin America, Alaska Airlines, Horizon Air, Island, Air Deccan, Virgin Blue and Tiger Airways operate with low cost strategy (Button and Ison, 2008: 2-3).

Companies operating with low cost management are often preferred by passengers because they offer competitive ticket prices to their customers. The companies that want to reduce their costs have to pay attention the following (Button and Ison, 2008: 2):

- The legal ceiling price should never be applied.

- Planning should be made so that maximum benefit is obtained from production factors.

- Airplane maintenance costs should be kept as low as possible.

- The salaries of employees should not be high.

- Various incentives and discounts should be offered to maximize baggage and other complementary revenues.

- Hard bargain should be driven with airplane producing companies in order to be able to have discounts at airplane prices.

- It is necessary to encourage passengers to buy tickets on the internet as much as possible by facilitating reservations and ticket purchase over the Internet.

Hazledine (2010) states that fuel, personnel and airplane maintenance expenses of airline companies are effective in raising of the average cost. Berrittella et al. (2009) state that the airline sector is a sector that requires intensive workforce, capital and technology. They emphasize that the external competition is as important as the domestic competition in the sector. Zuidberg (2014) states that the labor costs of airline companies operating in Europe are 45.2% higher than those in Latin America. He found that variables such as passenger revenue per kilometer, number of reserved seats, number of flights, and number of passengers carried are frequently used in the cost analyses of airline companies. Dennis (2007) states that staff must work efficiently and productively in order labor costs to be reduced during times when ticket prices are trending down rather than upward trending. It is stated that macroeconomic factors such as exchange rate, GNP and inflation can affect profitability by affecting fuel prices (Suhadak, 2017: 210). Oum and Yu (1998) say that increases in fuel prices due to macroeconomic factors are affecting the growth of the civil aviation sector in negative direction by reducing the profits of companies.

Franke (2004) suggests that Ryanair gained maximum benefit by reducing the number of cabin attendants, that it increased flight times with use of state-of-the-art airplanes, that it reduced landing and taking off costs of airplanes by preferring idle and less used airports in cities, and that it lowered its costs by keeping the number of airplanes with higher seat capacity high. Burrows et al. (2001) state that airline companies require intensive capital investment with high labor costs. Companies with high costs need to set up a good balance of income and expense in order to be successful. Changes in foreign currencies, equipment rental expenses, maintenance costs, airport expenses and fuel costs increase the total cost of the companies. For this reason, it is seen that airline companies are making great efforts and continuously working on productivity of the fuel, which is a significant cost factor (Zou et al., 2014: 306). Flight operations require the management of a complex and costly process. For example, when the flight is not done at the scheduled time, is delayed or canceled, since they pay compensation to the passengers, it leads them to bear extra costs (Berreira et al., 2016: 302). In addition, the high number of landing airplanes and transfer flights increases the capacity utilization rate of the airport (Logothetis and Miyoshi, 2016: 1-2). Choi (2017) found in their studies to test static efficiency and dynamic productivity that the efficiencies of

companies with network carriers were high; the efficiencies of companies operating with low costs were low.

In a study of Cui and Li (2015) examining the efficiency and productivity of airline companies, capital efficiency was found to be an effective factor on energy efficiency. It is also stated that the US-originated Financial Crisis has affected energy efficiency negatively. Zhu (2011) stated in the study where they used DEA for the measurement of efficiency and productivity of airline companies that the fuel costs were high, that the price of airplane tickets may increase with the increase of jet fuel prices and therefore the demand of customers would decrease. Coli et al. (2011) have found that in recent years, in order airline companies to raise their performance, lower increasing fuel and ticket prices, and get the most benefit at minimal cost, they have required to increase their performance.

Michaelides et al. (2009) stated that the productivity of airline companies did not increased much with the increase in technology level in the study where they tested efficiencies of 24 major airline companies around the World. Barros and Peypoch (2009) conducted a DEA using data from the 2000-2005 periods to evaluate the operational productivity of 27 airline companies affiliated to the European Airline Association. The two-step DEA proposed by Simar and Wilson (2007) was applied. In the first analysis, DEA and airline companies were sorted in terms of efficiency, and in the second analysis, "Bootstrapped Truncated Regression" analysis was used to determine efficiency factors. It was stated that the demographic and geographical factors of airline companies were important in evaluating the efficiency.

Barbot et al. (2008) assessed the productivity of airline companies with two different methods using DEA and total factor productivity analysis for efficiency and productivity. It was determined in both analysis methods that low-cost companies are more efficient than full-service companies. It is stated that the labor cost affects the efficiency and that the companies that benefit from the scale economy are more efficient. Scheraga (2004) states that as a result of the twin tower attack in the US on September 11, 2001. There occurred a crisis in the civil aviation sector all over the world and that this crisis adversely affected the financial situations of the companies. Boyd and Pang (2000) found that there was a significant relationship between energy cost and production volume. Tofallis (1997) stated that input and output variables were important in determining efficiency and productivity and that it may give incorrect results if not correctly identified. Gillen and Lall (1997) stated that several studies were conducted to determine the productivity of airline companies, but that no studies were conducted to test the productivity of airports that are important to airline companies. As a result of the analysis, it was stated that the efficiencies of the airports were closely related to the efficiency of the terminal and airplane connection points used. The efficiency of airline companies has an impact on the efficiency of airports. Good et al. (1995) conducted an efficiency analysis using the data of the 8 largest airline companies operating in Europe and America. As a result of the analysis, it was found that European companies were more efficient and saved 4 million US dollars per year according to 1986 data.

3. RESEARCH METHODOLOGY

In this study, DEA was used to test the efficiency of the fuel cost of airlines. Classification Tree method of Data Mining techniques was used to determine the factors that were effective on the efficiency.

DEA is a linear programming method used to evaluate the productivity and efficiency of decision-making units (Li and Lee, 2010: 267; Cooper at al., 2009). When studies in the literature are examined, it is seen that in many important studies to evaluate efficiency and productivity, DEAs are used (Cook and Seiford, 2009: 1). DEA is a non-parametric method. For this reason, when performing linear programming, it is necessary to use the same quality inputs and outputs for analysis (Andersen and Petersen, 1993: 1261; Ji and Lee, 2010: 2). The Fuzzy DEA method, which has been introduced in recent years, is also an important analysis technique in evaluating efficiency and productivity (Charnes et al., 1991: 197). With the introduction of performance evaluation, the use of DEA which helps to determine the efficiencies of decision units has gained importance.

The CCR DEA input-side model, developed by Charnes et al. (1978) with the assumption of fixed income according to the scale, was modeled as the linear programming problem given below so as to find the most appropriate input to produce the most output for each decision unit. This linear programming problem is solved n times for each decision unit and gives the efficiency values for each unit (Állvaez et al., 2016:3).

$$\underset{\theta,\lambda}{Enk} \quad \theta$$

$$\theta x_0 \geq X\lambda$$
$$Y\lambda \geq y_0$$
$$\lambda \geq 0$$

In the established linear programming problem,

X_{nxs}: is the input matrix to which s inputs are given for n decision units and

Y_{nxr}: is the output matrix to which r input values are given for n decision units.

When the established linear programming model is solved for each decision unit, θ the efficiency score will be obtained and the units with an efficiency score of 1 will be considered as efficient, while units with an efficiency score of less than 1 will be considered as inefficient.

According to the input and output values given, DEA successfully reveals whether the decision units are efficient or not, but does not give details of the factors that affect efficiency or inefficiency. The fact that the model does not consider especially the non-numerical factors draws attention as a limitation of the model. On the other hand, data mining techniques use large data sets and ensure to reveal the meaningful and unclear information (Emrouznejad and Anouze, 2010: 231).

Among Data Mining techniques, decision trees are one of the most commonly used methods for discovering information. The Classification and Regression Tree (CART), developed by Breiman et al. (1984), is a frequently used decision tree model. Classification decision trees are a method which tries to determine the belonging of units to a categorical dependent variable class through the values of independent variables (Sohn and Moon, 2004: 281). The Regression Tree is used when the dependent variable is continuous.

CART analysis usually begins with the formation of the starting node taking all variables into account. For all variables, all observation values are evaluated according to the single splitting criterion, and the best resultant variable and observation is assigned as the rule for the starting node. The Gini index or the Entropy index change criterion, which takes into account the homogeneity of the nodes as a splitting criterion, are frequently used methods (Breiman et al., 1998). After the first node is assigned a rule, this node is divided into two sub-nodes. The observations in the split nodes are evaluated according to the stopping criterion and are assigned as the stopping node or the non-stopping node. By using the class-value assignment criterion, it is determined which class of observations are assigned to the stopping nodes.

As in the initial node, new splitting rules are assigned for all the variables of the non-stopping nodes and all their values, and the decision tree algorithm resumes so that all nodes will become stopping nodes. The classification tree that lasts until the last observation is split and the class value is assigned is the most comprehensive tree, as well as it is a complicated and difficult to interpret tree. For this reason, all sub-decision trees obtained by subtracting the node are evaluated according to the criterion including the incorrect classification cost and the level of complexity, and the most optimal resultant tree is used as the classification tree for that problem (Breiman et al., 1984: 66-70).

In this study, it is aimed to identify the causes of inefficiency by first determining the efficiencies of the units with DEA and then analyzing the financial indicators related to the efficient and inefficient units. The two analyses were combined and the DEA-CART model was used. Thus, with data mining, it was possible to extract information that has been left hidden within much data of decision units.

One problem that may be encountered in the DEA-CART analysis is that the limited number of observations used in the DEA is insufficient for data mining. For this reason, the bootstrapping re-sampling method is recommended to increase the number of observation units before a decision tree is formed (Emrouznejad and Anouze, 2010: 237; Alinezhad, 2016: 64).

In the application, it was desired to use a long data set to determine the efficiency and productivity of the fuel costs of airline companies, but the data after 2010 were used due to the crisis experienced in 2008. As the impact of the crisis continued in 2009, data for 2008 and 2009 were not used. 2017 year data was not published when the study was prepared. Therefore, 2010-2016 periods data were used in analysis. There have been used variables in the model like these, Lim and Hong (2014), Cui and Li (2014), Cui and Li (2017), Dennis (2007), Zuidberg (2014), Hazledine (2010), Jain and Natarajan (2015), Zou et al. (2004), Berrittella et al. (2009), Juhadak (2017) and Burrows et al. (2001). Variables of total fuel costs and total fuel expenditure/total expenditure were referenced Zuidberg (2014) and Zhu

(2014). Variables of available seat kilometres and revenue passenger kilometres (thousands) were referenced from Fethi et al. (2011). Staff expenditure/total expenditure was referred from Berrittella et al. (2009). Seat occupancy rate was referenced from Zou et al.(2014).

DEA was performed using the data for 2010-2016 period of the variables and their references given in Table 1.

Table 1. Variables Used in DEA

Variable	Definition	Code
Input 1	Total Fuel Costs (Thousand)	COST
Input 2	Available Seat Kilometres (Thousand)	ASK
Input 3	Staff Expenditure/Total Expenditure	STAFF
Input 4	Total Fuel Expenditure/Total Expenditure	FUEL
Output 1	Revenue Passenger Kilometers (Thousand)	RPK
Output 2	Seat Occupancy Rate (%)	LOAD

From the variables identified in the literature search, the total fuel cost, the number of seats offered per km, the ratio of personnel expenses in total expenditures and the ratio of fuel expenses in total expenditures variables were used as input. Passenger revenue per km and seat occupancy rate variables were used as output variables.

In the second part of the application, the financial performance of companies whose efficiencies were measured by DEA was evaluated. The decision tree method of data mining methods and the financial ratios that are frequently used in the finance literature. Evaluating financial performance and financial structure via ratio analysis were preferred with total debt/total assets, fixed assets/constant capital, fixed assets turnover rate (Akdogan and Tenker, 2007: 653-666). The current ratio is frequently used to measure the liquidity of the company (Karapinar and Zaif, 2019: 252). Dayi and Ulusoy (2018) were used in analysis receivable turnover rate, inventory turnover rate, asset profitability ratio, equity profitability ratio and net profit margin. The ratios in the model were given in Table 2.

Table 2. Variables Used in Data Mining

Variables	Codes
Current Ratio	X1
Total Debt / Total Assets	X2
Fixed Assets / Constant Capital	X3
Fixed Assets Turnover Rate	X4
Receivable Turnover Rate	X5
Inventory Turnover Rate	X6
Asset Turnover Rate	X7
Asset Profitability Ratio	X8
Equity Profitability Ratio	X9
Net Profit Margin	X10

72 airline companies registered with IATA, which carries passengers across the Asia-Pacific region, constitute the universe of the work. The list of companies was given in Annex 1.

The data of only 15 companies were possible to be accessed because some of the companies in the universe just started their operations, some were operating only locally, financial tables and annual reports of some of them were not prepared in English, and some companies had missing data. The ranking according to the number of passengers carried by the companies that make up the sample of the study in 2016 was given in Table 3.

Table 3. Passenger Numbers Carried by Airlines in 2016

Number	Airline Companies	Country	Carried Passengers
1	China Southern Airlines	China	114,618,630
2	China Eastern Airlines	China	101,741,640
3	Air China	China	96,605,870
4	Qantas	Australia	51,426,000
5	All Nippon Airlines	Japan	50,831,000
6	Garuda Indonesia	Indonesia	34,999,847
7	Cathay Pasific	Hong Kong SAR	26,840,000
8	Korean Air	South Korea	26,840,000
9	Air Asia	Malaysia	26,410,000
10	Virgin Blue	Australia	23,700,000
11	Thai Airways	Thailand	22,262,000
12	Singapore Airlines	Singapore	19,029,000
13	Air New Zealand	New Zealand	9,275,000
14	SriLankan	Sri Lanka	4,328,000
15	Air Astana	Kazakstan	3,748,682

When the number of passengers carried by the companies in the application is examined, it is seen that the difference is about 31 times between the least and the most passenger carrying companies in 2016. Therefore, it shows that the airline companies in the sample are small, medium and large scale companies. China Southern Airlines is the largest company in the sample with 114.6 million passengers in 2016. The company's total assets were worth 189.6 billion yuan in 2016, sales revenues were 108.5 billion yuan, and total expenses were 106.02 billion yuan. Air Astana is the smallest company in the sample and operates in Kazakhstan. The company's total assets were US $ 572.5 million in 2016, its sales revenues were US $ 621 million and its total expenses were US $ 583 million.

4. FINDINGS AND DISCUSSION

According to the DEA results, the efficiency scores of the airline companies by years were given in Table 4. According to the results of the analysis, companies with an efficiency score of 1 were considered efficient, while those with an efficiency score lower than 1 were considered inefficient. Air Asia, Air Astana, Air New Zealand, Singapore Airlines, Srilankan Airlines and Virgin Blue were found to be efficient throughout the years. Air China, All

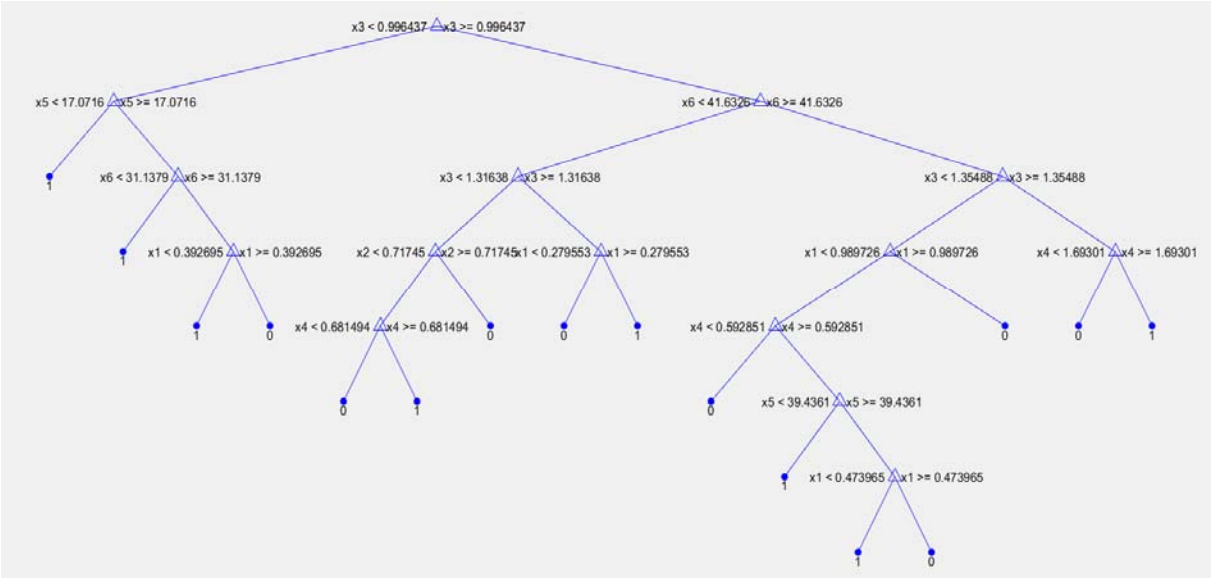
Nippon Airlines and Qantas were not efficient for only a year. Some of the companies in the application seem to be inefficient for some years and efficient in some other years. Thai Airways was the only airline company that did not worked technically efficient in all years. It was determined that 71.43% of the airline companies were efficient when the individual efficiency evaluation of the analysis results were made by the years.

Table 4. DEA Efficiency Scores of Airline Companies

Companies	2010	2011	2012	2013	2014	2015	2016
Air Asia	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Air Astana	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Air China	0.991	1.000	1.000	1.000	1.000	1.000	1.000
Air New Zealand	1.000	1.000	1.000	1.000	1.000	1.000	1.000
All Nippon Airlines	0.986	1.000	1.000	1.000	1.000	1.000	1.000
Cathay Pasific	1.000	0.985	0.994	1.000	1.000	1.000	1.000
China Eastern Airlines	0.961	0.978	0.996	0.978	1.000	1.000	1.000
China Southern Airlines	1.000	1.000	1.000	1.000	0.992	0.989	0.981
Garuda Indonesia	0.917	0.944	0.940	0.928	0.907	1.000	0.902
Korean Air	0.992	0.944	0.967	0.920	0.923	1.000	1.000
Qantas	1.000	1.000	1.000	1.000	1.000	1.000	0.864
Singapore Airlines	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SriLankan	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Thai Airways	0.886	0.863	0.948	0.901	0.828	0.856	0.875
Virgin Blue	1.000	1.000	1.000	1.000	1.000	1.000	1.000

In the second part of the analysis, companies with an efficiency score of 1 were classified as efficient, while those with efficiency score less than one were classified as inefficient companies, so that our classification tree could be created. 30 of 7-year observations of 15 companies were coded as 0, and 75 as 1 representing efficient observations. 7-year efficiency classification data for 15 airline companies and data on financial ratios obtained during the observation years of companies were combined. A 105 observation classification data set was created. Since the data set created for data mining was not sufficient, the numbers of observations were increased with the bootstrap re-sampling method. The number of resampling that the classification error fell to the lowest level and became stationary around that level was determined to be 10. For this reason, the number of observations was increased to 1050 by re-sampling 10 times and the data set and Classification tree were created. The model of the classification tree formed as a result of the analysis was given in Figure 2.

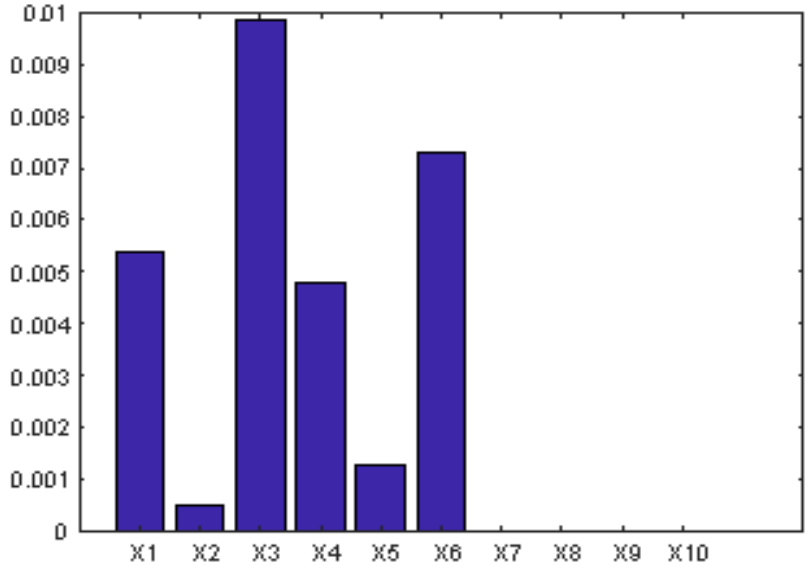
Figure 2. Classification Tree Model



In the first part of the decision tree, it is decided according to the ratio of Fixed Assets/Constant Capital. According to the rate being less and greater than 0.995437, the decision tree is divided into two branches. In the second part of the decision tree, branches are divided according to the ratio of the receivable turnover (X5) and the ratio of inventory turnover (x6). If the receivable turnover rate is below and above 17.0716, the inventory turnover rate is taken into account. If the inventory turnover rate is below or above 41.6326, the assets/constant capital ratio is considered. The decision tree continues this way.

The ranking of significance of the estimators according to the analysis results of the classification tree model is given in Figure 3.

Figure 3. Significance Levels of Variables



It is seen that six of the 10 ratios used in the decision tree classification model are effective in the decision tree model. The most effective ratio in classification is seen to be the fixed assets / constant capital ratio. In the civil aviation sector, high capital expenditures are required to build a sufficient number of fleets by supplying high-cost airplanes. Therefore, fixed assets / constant capital ratio is a very important indicator for airline companies. The inventory turnover rate is found in the second place of the significance ranking. Because airline companies are not manufacturing or trading businesses, they have no high-cost stock investments. But they can keep stocks for fuel and refreshments. The inventory turnover rate is thought to be influential on the financial performance of airline companies, especially with increasing oil prices. In the evaluation of liquidity, generally the current ratio is used. At the significance level of the variables, the current ratio has a significant place as the liquidity ratio. Airline companies need to have enough liquidity to be able to pay their debts on time and to buy fuel at low prices. Fixed asset turnover rate ranks fourth. Whether airline companies use airplanes efficiently is measured by the turnover rate of fixed assets. As a result, the turnover rates of fixed assets of efficient and productive airlines are high. Receivable turnover rate is at the 5th place among the variables' significance ranking. The more quickly and efficiently the receivables are collected, the higher the liquidity level of the business will be. For this reason, it is recommended that forward sales should be collected in a short time as liquidity has a vital significance for businesses.

5. CONCLUSIONS

Airlines operate with high capital investments and high costs. It is unlikely that airlines will achieve the desired profit and profitability if high amount costs such as personnel and fuel expenses are not managed efficiently and productively. For this reason, the efficiency of fuel costs, which is an important factor for airlines, and their financial performance have been examined. In the analysis results, when the efficiency analysis of all companies in the analysis was performed, it was found that 71% of all observation values were effective.

Air Asia, Air Astana, Air New Zealand, Singapore Airlines, Srilankan Airlines and Virgin Blue are efficient airlines and Thai Airways is the only inefficient company all of term. Findings and ratios obtained from efficiency analysis were used in decision tree model and financial performance analysis was done. As a result of the analysis, fixed assets / constant capital ratio was determined as the most important variable in significance ranking among the variables. Since airlines make high amounts of capital expenditures, the rate is important in terms of determining the efficient use of fixed assets. Because the financing of the amount to be paid for assets with high amounts can only be possible by long-term financing resources. Therefore, in the financing policies of airlines, the provision of fixed assets with the constant capital ratio is important.

Although the turnover rate of inventory in the service sector is not seen very important, it has a decisive influence on the financial performance of airline companies. In determining the level of liquidity and the continuity of sufficient liquidity, the current ratio is an important indicator. The higher the rate at which airline companies collect their credit receivables, the higher the levels of liquidity are.

Efficient use of fixed assets is very important for airlines. Because high amount of asset investment in the civil aviation sector and the occupancy rate of seat capacity of airplanes have an important effect on sales revenues. Efficient management of fuel costs of airline companies is possible with performing of successful financial management. It is recommended that studies on the efficiency of personnel expenses, reduction of the share in total expenses and ensuring productivity are carried out in the works to be done in the literature.

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ANNEX 1: List of Airline Companies in Asia Pacific

Companies	Country	Companies	Country
1-Air Asia	Malaysia	37-Jet Lite (India)	India
2-Air Astana	Kazakstan	38-Juneyao Airlines	China
3-Air Caledonie	New Caledonia	39-Kingfisher Airlines	India
4-Air China	China	40-Korean Air	South Korea
5-Air India	India	41-Lao Airlines	Lao People's Dem. Rep.
6-Air Koryo	South Korea	42-Loong Air	China
7-Air Macau	China	43-Lucky Air	China
8-Air New Zealand	New Zealand	44-Malaysia Airlines	Malaysia
9-Air Niugini	Papua New Guinea	45-Malindo Air	Malaysia
10-Air Tahiti	French Polynesia	46-Mandarin Airlines	Chinese Taipei
11-Air Tahiti Nui	French Polynesia	47-MIAT	Mongolia
12-Air Vanuatu	Vanuatu	48-Myanmar Airways Int.	Myanmar
13-Aircalin	New Caledonia	49-Okay Airways	China
14-All Nippon Airlines	Japan	50-Philippine Airlines	Philippines
15-Asiana Airlines	South Korea	51-PIA	Pakistan
16-Bangkok Air	Thailand	52-Qantas	Australia
17-Biman	Bangladesh	53-Royal Brunei	Brunei Darussalam
18-Cambodia Angkor Air	Cambodia	54-SF Airlines	China
19-Capital Airlines	China	55-Shangdong Airlines	China
20-Cathay Dragon	Hong Kong SAR	56-Shanghai Airlines	China
21-Cathay Pasific	Hong Kong SAR	57-Shenzhen Airlines	China
22-China Airlines	Taiwan	58-SIA	Singapore
23-China Eastern Airlines	China	59-Sichuan Airlines	China
24-China Express Airlines	China	60-Silkair	Singapore
25-China Southern Airlines	China	61-Singapore Airlines	Singapore
26-Eastar Jet	Korea	62-SriLankan	Sri Lanka
27-Eva Airlines	Chinese Taipei	63-Suparna Airlines	China
28-Fiji Airways	Fiji	64-Thai Airways	Thailand
29-Garuda Indonesia	Indonesia	65-Thai Lion Air	Thailand
30-Guangxi Beibu Gulf Airlines	China	66-Tianjin Airlines	China
31-Hainan Airlines	China	67-Tiger Airlines	Singapore
32-Hong Kong Airlines	Hong Kong SAR	68-T'way Air	Korea
33-Hong Kong Express	Hong Kong SAR	69-Vietjet	Vietnam
34-Japan Airlines	Japan	70-Vietnam Airlines	Vietnam
35-Jeju Air	Korea	71-Virgin Blue	Australia
36-Jet Airways	India	72-Xiamen Airlines	China