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Does fleet standardization matter on profitability and financial policy response of airlines during COVID-19 pandemics in the U.S?☆

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ABSTRACT

This study tries to find the contribution of the fleet standardization index of airline companies through the financial values of airlines in the COVID-19 pandemic crisis. One of the driving forces of this research is the stagnation in the aviation industry, along with the cessation of all international flights to prevent worse pandemic conditions. The main contribution of the study is clarifying the effect of fleet variety and its financial inferences about fleet standardization and crisis management relationship under inoperative service considerations. Data Envelopment Analysis (DEA) is used as a complementary method for standardization index calculations. According to the results, while the positive contribution of the fleet standardization index to operational revenues was observed, there was no sign of the effects of fleet standardization on the accounting performance of companies. Besides, fleet standardization enabled us to measure the response of Low-Cost Carrier (LCC) and Full-Service Carrier (FSC) airlines in crises. In this study, nine airline companies were selected from both trend representatives, and the results were presented for the U.S. It is found that fleet standardization is related to the adopted flight network type and profitability of each company directly. Results obtained revealed the relationship between fleet standardization and financial relations under inoperative conditions positively. In addition, inferences were made about the effects of the operational policies adopted by the companies.

1. Introduction

Aviation activities have been the subject of many economic pieces of research since the day they emerged. Not only aviation activities, but also all other logistics activities are important in this regard, but they have a wide place in life. However, the aviation field has become the focus of attention recently, especially since the beginning of 2000, when airline transportation started to become widespread. From this point of view many researchers, have shed light on the airline industry and made great contributions to companies operating in this field. One of the leading studies in the field of aviation about yield management was conducted by Smith et al. in 1992. The main purpose of their study is to determine the inventory levels effectively and to ensure effective income management. Moreover, there are studies where not only economic factors but also basic cost items are at the forefront. An example is the comprehensive flight network structure study conducted by Bowen (2012). The study investigates hub and spoke and direct network effects. Likewise, Luo (2014) investigated and presented the price effects and the merger effect.

Another important area that airline researchers focus on is fleet management. Fleet management is a field of study which aims to efficiently use the vehicle fleet that is brought together to carry out a logistics business. Fleet management research are often used not only for effectiveness but also for economic effects. In particular, the travel restrictions caused by the recent pandemic of COVID-19 (a contagious virus that is transmitted by droplets and requires social distance in the environment, Huang et al., 2020) have been very effective in this case. On March 13, 2020, the World Health Organization (WHO) declared Europe as the center of the COVID-19 pandemic due to over-reported cases and deaths (World Health Organization, 2020). Due to the high infectious potential of the virus, many states banned international flights and restricted urban transport. The daily flight time and amount

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decreased with the cessation of flights, which forced all airlines' fleets to take down. Also, aviation activities around the world decreased significantly due to the restriction of international travel. It is possible to see this effect even only in the European continent in the report published by IATA (IATA, 2020). Another study published on 14 April 2020 foreseen a revenue drop of $314 billion (55 percent) and a traffic drop of around 48 percent in passenger count for 2020 (Harper, 2020). Keeping fleet vehicles constantly useable and robust is also another factor that increases internal efficiency and organizational profitability. The efficient use of these assets, which have a significant cost to companies, both prevents extra costs and increases continuity. However, in this case, the use of aircraft in the fleet must be stopped (See Table 1).

Cessation of aviation activities in the main European countries caused great losses as seen in Table 1. Maximum pax loss in June reached a minimum of 88 million, while the total number of people at risk of losing their jobs reached around three million. On the other hand, a decrease in the number of personnel employed by airline carriers within the USA is significant and is shown in Figs. 1 and 2 (BTS, 2020).

As shown in Fig. 1, the total number of employees increased until February, when COVID-19 cases began to spread, while dropping dramatically following the flight bans. While this situation caused some personnel to lose their jobs, the workload of the ground handling personnel increased. Thus, ground handling costs increased and aircraft fleet management became difficult. The introduction of mandatory restrictions and travel bans also reduced the number of passengers that can be transported. As can be seen in Fig. 2, the reduction in a number of passengers carried within the U.S. summarizes the aviation industry during the COVID-19 crisis (See Fig. 2).

It is thought that the landing of fleets caused to arise higher fixed costs and maintenance costs of the fleet. Again, flight bans and high costs led many airlines to financial trouble. However, at this point, the following questions, which were not new but came back to the agenda, became popular (KPMG, 2020).

- How much is fleet standardization necessary?
- What are fleet standardization and its economic implications?
- How do factors of fleet standardization and route concentration affect in times of crisis?

Under non-operative circumstances, there is not important how many aircraft you have or how varies your fleet is. At this point, there is a question regarding the grounded aircraft fleet about how erratic their fixed and variable maintenance costs. The study explored how fleet standardization and service type can affect changing economic conditions in times of crisis. Airline companies subject to this paper were selected from the US, where many trends coexist, and used an open database provided by MIT called as Airline Data Project. In other words, data accessibility and consistency were our main consideration, and the database used was evaluated as beneficial for us and can provide precious information for researchers who is interested in this area. This paper is divided as follows. Section 2 presents the discussion of the literature on fleet standardization in the airline industry. Section 3 presents the methodology and design of the research, including a discussion. Section 4 presents the results and discussions. Section 5 presents the conclusion and limitations of the study.

Table 1
Impact of COVID-19 on European aviation (June 2020).

COUNTRY	UK	SPAIN	GERMANY	ITALY	FRANCE
April Pax Estimates	−140 mn	−114 mn	−103 mn	−83 mn	−80 mn
June Pax Estimates	−154 mn	−124.5 mn	−113.4 mn	−92 mn	−88.7 mn
April Jobs At Risk	−661.200	−901.300	−483.600	−310.400	−392.500
June Jobs At Risk	−732.5	−983.1	−534	−345.3	−434.700
April Gdp	-$50.3bn	-$59.4bn	-$34bn	-$21.1bn	-$35.2bn
June Gdp	-$55.7bn	-$64.7bn	-$37.6bn	-$23.5bn	-$38.9bn

*mn: million, bn: billion.

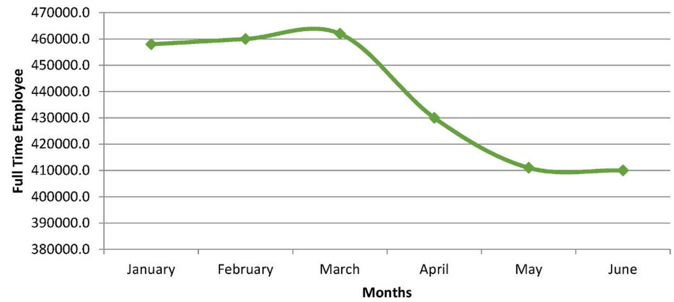

Fig. 1. Passenger airline employment in the U.S carriers for 2020 (BTS, 2020).

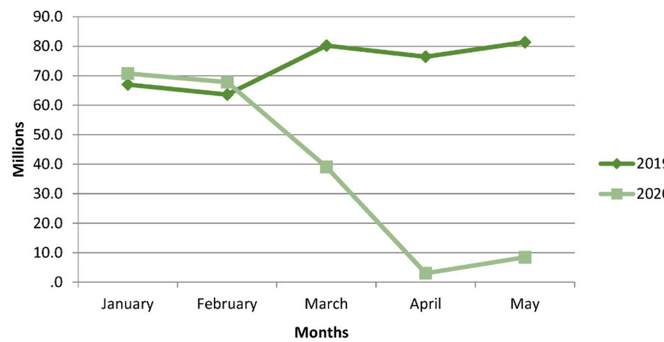

Fig. 2. Domestic passenger enplanements on the U.S. Airlines (BTS, 2020).

2. Literature review

Fleet standardization plays a major role in determining performance and quality standards in modern air transport. Standardization principles are generally shaped depending on the companies' strategic horizons. Decisions on fleet differentiation or standardization can be taken and implemented according to strategic horizons. The formation of the fleet from a similar family or finding a fleet similarity is directly related to the route structure and business culture adopted by the company. Thus, suitable aircraft for the routes to be flown can be selected and a fleet can be created. In this area, the following table summarizes the main papers dealing with this problem (See Table 2).

There is a primary factor in creating the fleet called the service structure. This structure is explained as the choice of aircraft type according to planned flight distance and cost incurrence. if the market is more suitable for long flights, fleet preferences are made according to long flights. On the other hand, fleet preferences are generally similar for domestic routes. If the firm is structurally closer to one of the FSC or LCC trends, the preferred fleets determine the company's position in the market. Thus, being able to be at certain levels for fleet standardization is important for the company's market position in the modern air transport industry (Narcizo et al., 2020). Considering all these studies and findings, calculations were made under the conditions of company structure (LCC or FSC), maintenance costs or operational efficiency adopted in all of the studies carried out. However, the effect of fleet standardization is lacking in the literature when traffic continuity cannot be ensured under operational disruption as in the COVID-19 period. This study wants to fill this gap in the literature.

Table 2
Development of studies on fleet standardization and planning.

Author	Main Findings
Borges Pan and Espírito Santo (2004)	Suggest an index for assessment of fleet similarity
Seristö and Vepsalainen (1997)	Found a negative correlation between standardization and maintenance cost
Zou et al. (2015)	Suggest that standardization may decrease unit flight cost
West and Bradley (2008)	Suggest that a more diversified fleet is more useful if you are operating in different markets
Kilpi (2007)	Found a positive correlation between standardization and profit margin
Brüggen and Klose (2010)	Released a positive association of standardization on operational efficiency
Merkert and Hensher (2011)	Suggest an LCC business model has no significant evidence of profitability
Barros and Peypoch (2009)	Presented that LCC companies have high efficiency and standardization
Zuidberg (2014)	Found that fleet standardization and operational performance are related positively
Zou et al (2015)	Suggest to use of standardization index would be efficient under some operational metrics

2.1. Standardization and commonality of fleets

Commonality and Standardization are two terms that have different concepts from each other. Fleet Standardization addresses fleet homogeneity established from similar aircraft manufacturers, on the other hand, the term commonality ignores aircraft manufacturers and discusses the similarity of aircraft power units (Brüggen and Klose, 2010). A largely standardized aircraft fleet tends to consist of a single aircraft model. Conversely, as the standardization decreases, the aircraft model included in the fleet diversifies. It is not necessary to have the same model aircraft in a fleet with a high commonality index because it is common to use the same model aircraft with different power units. A Boeing 737 model has both CFM56 and P&W JT8D type power unit options. This situation differentiates the fleet commonality index. De Borges Pan and Espirito Santo (2004) propose two standardization indexes to define the similarity of aircraft in the fleet. These indexes are named as follows;

1. The Cell Standardization Index (IPC)
2. The Powerplant Standardization Index (IPM)

To calculate the actual fleet commonality, many different factors may be needed, and the need-dependent operational and flight equipment input can be found. Also, different approaches can be adapted to calculate fleet standardization such as Zou et al. (2015) examined the model, family, and manufacturers of aircraft with the Herfindahl-Hirschman index. The main purpose of this analysis is to measure operational costs taking into account the similarities of the aircraft equipment and flight crew.

Maintenance and training costs are low in a standardized fleet, and capacity utilization tends to be high (Berrittella et al., 2009 Kilpi, 2007). There is a negative correlation between fleet standardization and flight and maintenance costs (Seristö and Vepsäläinen, 1997). Hence, it is possible to increase financial efficiency by decreasing flight costs. On the other hand, Zuidberg (2014) found a negative correlation between operational costs and fleet standardization, but the results were statistically insufficient. Thereby, the author suggested that fleet standardization may have a slight impact on operational costs.

West and Bradley (2008) observed the relationship between market concentration and fleet structure. They suggested a more diversified fleet structure, that is more appropriate if the airline considers serving different markets. Hence, contrary to the hypothesis established by the authors, the results of the study showed that the increase in the fleet standardization index increased the profitability. They conclude the positive tendency between fleet standardization and airline profit margin as with Kilpi (2007). Merkert and Hensher (2011) also found some evidence of fleet standardization and operational efficiency in parallel with Brüggen and Klose (2010).

On the other hand, some studies are approached strategically on fleet management. Flouris and Walker (2005) inspected the impact of the 9/11 crisis on the U.S airline sector by reviewing their financial data. In that study, their main focus was monitoring financial data gathered from the stock market and the impact of the crisis on the airline market in a manner of monetary value. Again Hätty and Hollmeier (2003) made effort to define and review the strategy of an airline company during the time of the 2001/2002 crisis. Related to fleet expansion and crisis management Debnath et al. (2020) worked on a paper which aimed to define the possible impacts of the crisis aroused in India on the aviation sector.

As a summary of the literature provided, many of the studies done relative to airline and fleet management on economic aspects of crisis is concluded with a policy recommendation or empirical analysis. Hence, those studies do not enrich the fleet management literature at a glance. Therefore, the need for integration of studies on fleet management and standardization has emerged with the COVID-19 pandemic situation. Because it is perceived as a crisis for the airline sector in every country during forced confinement. Forced confinement circumstances that enable people to travel neither domestic nor international is made a cut-off effect for air transportation. Throughout the restriction, air traffic has decreased up to %94 of its normal pace for passenger transportation worldwide (Suau-Sanchez et al., 2020).

However, further research into the subject is needed certainly, especially the topics that either motivate AFS and crisis management in economic and managerial perspectives with an integrated approach. This motivation should make a point on the limits of AFS and decision points to maintain or change AFS (Narcizo et al., 2020). As the airline industry consists of a dynamic environment, it is highly sensitive to many changes. This high degree of sensitivity makes this industry difficult to manage and operate. Especially financial crises or other environmental and political events that could lead to financial crises easily affect the aviation industry. COVID-19 which is one of the pandemics in history has caused an unprecedented crisis for the world's airlines (Albers and Rundshagen, 2020). All states around the world have taken measures in the aviation industry, as in many other industries, to cope with this pandemic situation. As a result of those precautions, the travel and hospitality industry in general, and airlines in particular, are in dire straits: more than 60 percent of the world's commercial aircraft have been grounded (Hollinger, 2020). According to the forecast conducted by IATA, revenues from the airline industry are expected to decrease by half in 2020 (IATA, 2020).

Moreover, many governments also announced support packages and aid, as the aviation industry is seen as a major source of income for many countries (Rushe, 2020). Hence, most researchers are assuming that airlines will not have returned to the status of state-owned companies or even divisions of national transport administrations in the post-COVID-19 era (Albers and Rundshagen, 2020). From this point of view, finding sources of costs and taking measures in airline industries play a key role in ensuring continuity during the crisis period. However, the profitability factors in the airline sector have changed and differentiated in the World over time (Scotti and Volta, 2017). By the way, fleet standardization has emerged as a factor that has increased its popularity recently. In this study, the airline companies considered are explained with the fleet standardization index, which has been compared in terms of operational and financial terms.

The first aim of this paper is to benchmark the selected airline carriers in the COVID-19 period in operational terms and to explain the relationship with the fleet standardization index. Also, another aim of this study can see the effects of the actions within the scope of the measures taken during the crisis period have been adopted. For example, some airlines have tried to find solutions by reducing the number of employees and limiting the number of flights (Albers & Rundshagen, 2020). Most of the responses to the current crisis have developed under retrenchment, preserving, or exit conditions. Also, innovative approaches were tried to implement. Innovative approaches have generally been created to preserve existing employment and create an active workforce in other operations. This situation is thought to play a role in balancing the unemployment rate in the airline industry. In addition, financial performance analysis was conducted via financial ratio analysis to see the relationship between operational measures and financial measures. The methodology developed by Mason and Morrison (2008) was adopted for our problem.

3. Methodology

It is known that fleet planning depends on many parameters, and even a well-planned fleet cannot meet all the interests of the company (Clark, 2017). Among the fleet planning strategies, the most important and vital tool is the airline fleet standardization (AFS) setup, commonly known as the Low-Cost Carrier (LCC) characteristic. In this regard, while IPC specifies a model for standardization depending on the body structure of the aircraft, IPM is an index that measures the standardization by considering the power unit similarity of the aircraft. The total standardization index is formed by adding these two determined index scores in Eqs. (1)–(2) below;

$$IPCC = \frac{Total\ number\ of\ airplanes\ from\ one\ manufacturer}{Number\ of\ families\ from\ that\ manufacturer\ x\ Total\ Fleet} \quad (1)$$

$$IPC = \frac{\sum IPCC}{Number\ of\ Manufacturers} \quad (2)$$

The methodology developed by Mason and Morrison (2008) is also applied to U.S. carriers by Lohmann and Koo (2013), to African carriers by Heinz and O'Connell (2013), and to EU low-cost carriers by Lenartowicz et al. (2013) as it was. Later on the current model, O'Connell et al. (2020) brought a different perspective and a more consistent benchmarking tool has been proposed. Their proposed methodology aims to compare the best and worst performances of each unit participating in benchmarking on a factor basis and can be explained in Eqs. (3)–(4) in Appendix;

where BR_{min} refers to benchmarking ratio which is used for situations where the current factor performs best when the available factor is the smallest, while the BR_{max} is a ratio used for situations where it performs best when the available factor is greatest. For example, the best score in total cost is given to the minimum, while the highest score for the total number of passengers carried gets the maximum score. By the way, widely used financial ratio analysis was used to evaluate the financial performance of selected airlines. Financial ratios can be grouped into four categories such as liquidity ratio, activity ratio, financing ratio, and profitability ratio. The liquidity ratio ensures a measure that the company's ability to satisfy short-term obligations as seen in Eq. (5). Activity Ratio is a measure that provides information about the management efficiency of firms' assets as seen in Eq. (6). The financing Ratio defines the measure of possible risk occurrence to pay their long-term debts as seen in Eq. (7). Profitability Ratio assists in the evaluation of different aspects of a firm's profitable activities as seen in Eqs (8)–(10) in the appendix.

Data required for the study were compiled from SEC 10-Q reports periodically announced by each airline company on sec.gov. Samples from both groups were selected to reflect the LCC and FSC trends when selecting the airline companies. This situation also allows us to see the crisis outcomes of the transportation policies adopted by airline companies. Data were collected and analyzed in two different ways as operational and financial data. Fleet data were used to calculate the standardization index, operational data were used for active benchmarking, and financial data were used for ratio analysis. Cell Standardization Index was used in the calculation of fleet standardization index. Studies conducted to measure airway efficiency and effectiveness in the current literature were reviewed while researching the data to be used. An idea about performance metrics was obtained here based on the study by Yu (2016). Data used in the benchmarking study are as follows; the number of full-time equivalent employees (FTE's), cost per available seat mile (CASM), revenue per available seat mile (RASM), and the load factor (LF). Attention has been paid to the fact that some of the selected data represent inputs while some of them represent outputs. Thus, it is expected that not only the inputs but also the produced values are included in the benchmarking process. The dataset covers the first half of both the years 2019 and 2020.

The simplest way to measure productivity in a business is to find the ratio of output to input. The DEA technique has undergone many changes, both theoretically and methodologically, starting from 1978 until today. The most common basic DEA model is known as CCR and was developed by Charnes, Cooper, and Rhodes (Cooper et al., 2007). This technique, which was used with the assumption of constant returns to scale (CRS), was later adopted by Banker, Charnes, and Cooper (BCC) with the methodological adjustments made in the technique in 1984, with the assumption of variable returns to scale (VRS) that enables the measurement of scale and efficiency separately. The steps below are generally followed in the application of DEA models sequentially.

1. Selection of DMUs
2. Selection of inputs and outputs
3. Measurement of the relative effectiveness
4. Determination of reference sets
5. Setting targets for inactive DMUs
6. Interpretation of results

In order to make a detailed analysis of inefficient units and take corrective actions to improve their performance, this paper considers both the CRS assumption and the VRS assumption in estimating the efficiency indices as discussed below. Let us first assume that there are constant returns to scale, we can then formulate the following model:

$$\text{Min} \quad l_0 - \varepsilon[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+] \quad (11)$$

$$\text{Subject to:} \quad \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^- \ \text{where} \ \ i = 1, \ldots m \quad (12)$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \ \text{where} \ r = 1 \ldots s \quad (13)$$

$$\lambda_f \geq 0, f = 1 \ldots N, \ S_i^-, \ S_r^+ \geq 0 \ \forall \ i \text{ and r} \quad (14)$$

Where $x_{if} y_{rf}$ and are levels of the i^{th} input and r^{th} output, respectively for DMU f. N is the number of DMUs. ε is a very small positive number (non-Archimedean) used as a lower bound to inputs and outputs. λ_f denotes the contribution of DMU f in deriving the efficiency of the rated DMUf_o (a point at the envelopment surface). S_i^- and S_r^+ are slack variables proxying extra savings in input i and extra gains in output r. l_o is the radial efficiency factor that shows the possible reduction of inputs for DMU f_o. If l_o^* (optimal solution) is equal to one and the slack values are both equal to zero, then DMU f_o is said to be efficient. When $S_i^- S_r^+$ or take positive values at the optimal solution, one can conclude that the corresponding input or output of DMUf_o can improve further once input levels have been contracted to the proportion l_o^*.

If a convexity constraint is incorporated in model (1), the following VRS version of the DEA model can be written as follows:

$$\text{Min} \quad l_o - \varepsilon[\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+] \quad (15)$$

$$\text{Subject to: } \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^- \text{ where } i = 1 \ldots m \tag{16}$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \text{ where } \quad r = 1 \ldots s \tag{17}$$

$$\sum_{f=1}^{N} \lambda_f = 1 \tag{18}$$

$$\lambda_f \geq 0, f = 1 \ldots N, S_i^-, S_r^+ \geq 0 \; \forall \; i \text{ and } r \tag{19}$$

This model differs from the model (1) in that it includes the so-called convexity constraint, $\sum_{f=1}^{N} \lambda_f = 1$ which prevents any interpolation point constructed from the observed DMUs from being scaled up or down to form a referent point which is not permissible under the VRS. In this model, the set of λ values minimil$_o l_o^*$ zes and identifies a point within the VRS model whose input levels reflect the lowest proportionl_o^*. At l_o^*, the input levels of DMU f_o can be uniformly contracted without detriment to its output levels. Therefore, DMU f_o has efficiency equal to l_o^*. The solution to model (2) is summarized in the following fashion: DMU f_o is Pareto-efficient if $l_o^* = 1$ and $S_r^{+*} = 0, r = 1 \ldots s, S_i^{-*} = 0, i = 1 \ldots m$. Technical efficiencies assessed under VRS are referred to as pure technical input efficiency as they are net of any scale effects.

If the convexity constraint in the model (2) is dropped, one obtains model (1), which can generate technical input efficiency under the CRS assumption. This implies that the pure technical input efficiency of a DMU is always greater or equal to its technical input efficiency. Under both CRS and VRS assumptions, the resulting scale efficiency can be measured since in most cases, the scale of operation of the firm may not be optimal. The firm involved may be too small in its scale of operation, which might fall within the increasing returns to scale part of the production function. While conducting data envelopment analysis, used input measures are; Available Full-Time Employees, Fuel Cost per kilometer, Available Seat Kilometers, Total Expenditures, Cost Available Seat Miles, and Load Factor of those airlines. As a consequence of this input data, Revenue Available Seat Miles and Passenger Revenue per Available Seat Mile (PRASM). In addition, Yield is not useful for comparisons across markets and/or airlines, as it varies dramatically by stage length and does not incorporate load factor (unlike PRASM).

4. Findings

The findings of the study were examined under three headings such as operational comparison and fleet standardization relationship, financial ratio analysis results, and interpretations by airline service type (FSC and LCC). Changes were observed in all factors studied. However, it perceived that the most important changes were on *FTE*, *RASM*, *CASM*, and *LF*.

4.1. Findings on fleet standardization index (IPC)

The fleet standardization index was calculated using the method mentioned in Section 2.1. The fleet considered for the calculated index is the fleet data announced at the end of the year 2019. According to the index, if the data approaches 0, this indicates the diversity of the fleet. In other words, if it approaches index 1, the fleet has become so stable and standard. The calculated index results are shown in Fig. 3. According to the findings, the airline with the highest fleet standardization is Allegiant and Southwest, while the airline with the lowest fleet standardization index is United and Delta.

The striking issue here is the finding that the fleet standardization of airline companies operating with the LCC trend is higher as parallel with Barros and Peypoch (2009). The reason may lie behind this is that FSC airlines continue their activities with the principle of differentiation and

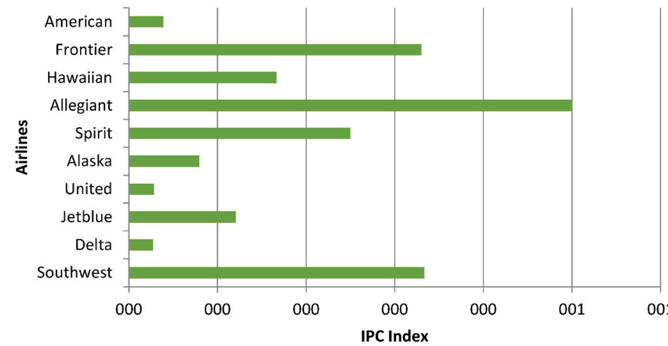

Fig. 3. Fleet standardization index of selected airlines.

try to offer a more flexible structure in terms of operation (Rozenberg et al., 2014). Also, the principle of quality service (Business Class, First Class) has led to the diversification of the aircraft fleet to be ahead and respond to the demands in the most appropriate way. This statement is supported by the work done by West and Bradley (2008).

However, government legislation such as stopping international flights and forced confinement due to COVID-19 has eliminated the need for quality service and created the need for direct service. These obligations imposed by the states have completely changed the economic structure of airline companies and made their situation much more difficult. In this manner, the main contribution of this study is to take roots from the information gathered by Zou et al. (2015). Because Zou et al. (2015) stated that, the standardization index would be efficient under some operational metrics. However, no information exists about a sectoral environment that operational disruption likewise COVID-19 pandemics. Our study stated that airlines that have high standardization index would suffer more in this type of inoperative circumstances in terms of operations. Findings gathered about IPC are supported by the change of FTEs of airline companies during the challenging pandemic years.

4.2. Findings on full-time employees (FTEs)

The amount of full-time employees roughly refers to the total number of active personnel working within that airline company. It is directly related to the size of the firm. If an airline company is large enough, the number of personnel is expected to increase as the routes it flies and the number of airlines it serves will increase. In this case, if a firm decreases or increases the number of active personnel, it is possible to make some comments from an operational point of view. If the stable situation of LCC airline companies in the number of employees is examined, it is possible to draw a few inferences. According to Hunter (2006), LCC airline companies pay poor wages between %5-%40 compared with FSC companies. In this case, it can be said that the loss of income during the pandemic period is less for personnel working in LCC airlines because they receive much less salaries than FSC airline employees.

This situation has pushed companies to protect their employees. Moreover, the number of personnel working in LCC airlines is much less than in FSC airlines. Therefore, if the size of the fleet operated is also taken into account, the loss of personnel and income will increase according to the size of the airline. In Fig. 4, it can be observed that three airline companies (American, Delta, and United), which are representatives of the FSC trend, have made obvious changes in the number of employees working before and after COVID-19. According to Kilpi (2007), considering that there is a positive relationship between standardization and profit margin under operational conditions, disruption of operations or interruption as in the pandemic period has created greater financial losses in airlines with low standardization index. It is thought that the main reason for this loss is because the biggest income

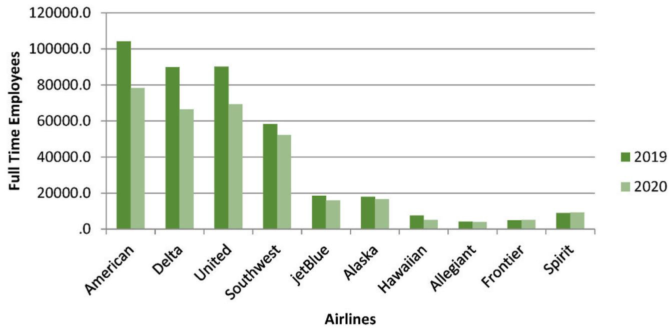

Fig. 4. Change in FTE from 2019 to 2020 (BTS, 2020).

sources of airline companies with low standardization index are directly provided by money flow and their expenses are as large as their incomes. However, in case of operation interruption, the decrease in income does not cover the expenses since the expenses are various and high. For this reason, the amount of idle labor force is seen as the main reason for high expenses under the inoperative situation. As consequences of financial trouble caused by diversified fleet expenses layoffs arise.

4.3. Findings on RASM, CASM, and LF

The RASM and CASM parameters indicate an airline's revenue per mile flown and its costs per mile. The Load Factor (LF) expresses the occupancy rate of the aircraft during the year the statistics are kept. The importance of RASM and CASM values in operational statistics is that they can be used to measure the functionality of the aircraft. For example, if the aircraft in the fleet have actively flown and carried passengers, RASM values tend to increase, conversely, CASM tends to decrease (Wei and Hansen, 2003). The operational stagnation created by the COVID-19 pandemic has affected many airlines in different ways.

Looking at Fig. 5, it is clear that a good performance was not observed in the total seat mile performance due to flight disruption. Except for 3 companies, all airline companies made a loss in terms of seat miles. However, Jetblue, Hawaiian, and Delta airlines were able to outperform their total seat-mile costs. However, since these performance criteria are given as percentages, it can be said that the percentages of loss are less than the percentages of revenues. Among these companies, except for Delta airlines rest of the companies are the representatives of the LCC trend. Unlike the analysis, Delta airlines showed better performance than other FSC airline companies. FSC airlines, in particular, have grounded most of their aircraft fleet due to the international flight ban. The block hours that occurred have financially challenged all airlines. As seen in Table 3, each airline has lost revenue

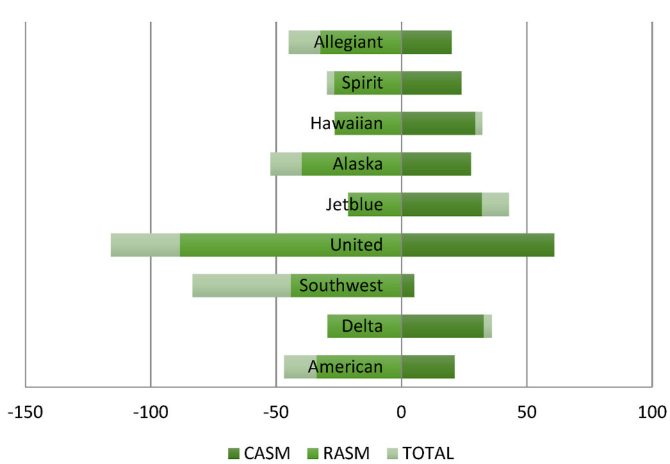

Fig. 5. Total seat mile performance of airline companies.

Table 3
Changes in RASM and CASM from 2019/Q2 to 2020/Q2.

AIRLINE	CASM	RASM
AMERICAN	21.09%	−33.96%
DELTA	32.73%	−29.49%
SOUTHWEST	4.98%	−44.16%
UNITED	60.94%	−88.42%
JETBLUE	32.06%	−21.31%
ALASKA	27.67%	−39.94%
HAWAIIAN	29.42%	−26.67%
SPIRIT	23.91%	−26.85%
ALLEGIANT	20.00%	−32.47%

and increased costs. The biggest increase in CASM belongs to United airlines with a rate of 60.94%. Similarly, United has the highest loss on RASM with %88.42. The lowest cost increase belongs to Southwest with a rate of 4.98% (See Table 3).

Considering that the losses in low-cost airlines are less, it can be said that this is due to the LCC philosophy. Abda et al. (2012) reported that low-cost carriers started to shift to the second, third, and fourth airports in airports in their flight network. As low-cost carriers operate mostly with flights to airports that do not have large densities, they have not been the biggest focus of travel restrictions under COVID-19. Of course, this does not mean that they are not affected by the total restriction. A dramatic decrease is seen in the values of full-service carrier companies when the changes in the load factor values are examined as seen in Fig. 6.

Dramatic declines are also observed for airlines with the lowest fleet standardization index. It is possible to see that the load factor percentages decrease at similar rates in airlines with a high IPC index. For example, the losses in the load factor of Hawaiian, Alaska, Spirit, and Allegiant airlines have occurred in similar trends. Because the airplanes they keep in their fleet meet certain standards and have an almost uniform structure. Although the number of passengers varies according to the routes flown, aircraft capacities do not differ greatly.

4.4. Findings on financial ratio analysis

A financial ratio analysis is a good way to examine companies' cash balances and sustainability. It makes it possible to measure the impact of events and observe the course of the situation, especially when important events occur. In this study, four main financial ratio analyses, Liquidity Ratio, Activity Ratio, Financing Ratio, and Profitability Ratio, are emphasized. Effects of the COVID-19 pandemic can be observed when the accounting performances of companies are examined through these rates. The data needed for the rates are obtained from each firm's SEC fillings form 10-Q. A picture can be drawn to understand the general situation with activity and liquidity ratios. Table 4 summarizes the financial ratio changes of airline companies for both 2019 and 2020

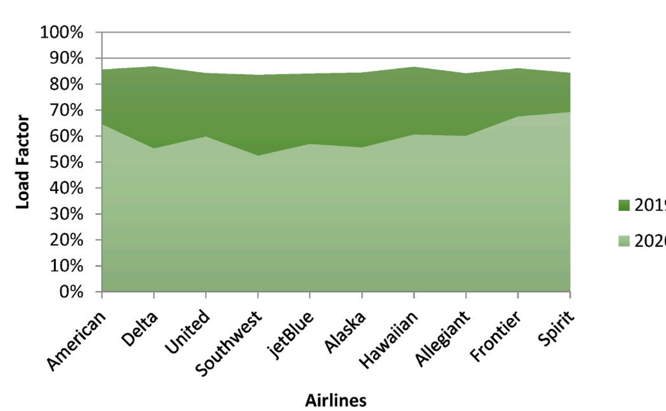

Fig. 6. Load factor change from 2019 to 2020.

Table 4
Financial ratio change of Airline companies from 2019/Q2 to 2020/Q2.

	Current Ratio	Total Asset Turnover	Debt Ratio	Net Profit Margin	ROA	ROE
American	41.50%	−139.23%	−5.79%	89.74%	75.45%	−512.81%
Delta	56.51%	−164.35%	−3.22%	84.80%	59.82%	80.33%
Southwest	60.64%	−193.57%	−145.51%	−28.51%	−277.28%	−23.69%
United	10.44%	−131.70%	0.00%	81.72%	57.64%	70.02%
Jetblue	29.24%	−332.20%	0.00%	68.76%	−35.03%	2.13%
Alaska	19.18%	−360.48%	0.00%	86.05%	35.75%	46.83%
Hawaiian	12.36%	−1049.28%	0.00%	98.15%	78.69%	83.21%
Spirit	5.04%	−126.63%	0.00%	51.90%	−9.00%	−2.42%
Allegiant	15.81%	−91.93%	8.83%	43.81%	−7.85%	17.30%

from January to June. The liquidity ratios of all airlines have significantly increased in 2020 compared to 2019. The criterion examined here as the liquidity ratio is the current ratio. The current ratio reveals the ability of companies to fulfill their short-term obligations. While there were obvious increases in all airlines, Spirit showed little improvement. This situation may be a harbinger of some dangerous situations. On the other hand, the total asset turnover rate, which we examine as the activity ratio, is used to measure the financial management efficiency of companies. A decrease in many income items naturally created very difficult situations for the management of companies. It is possible to see large decreases in Activity ratios in Table 3. However, the biggest drop was reported by Hawaiian Airlines.

Another important finding can be seen from financing ratios. The financing ratio, which we examine as the debt ratio, refers to possible risks that may occur in long-term debt payments of companies. It refers to the share of assets acquired through debt within total active assets at the rate that occurs here. There are negative debt ratios that can be tracked in Table 4. Companies that experience a negative debt to equity ratio may be seen as risky to analysts, lenders, and investors because this debt is a sign of financial instability. Southwest which is the leader of the LCC trend (Ren, 2020), is an airline that announced the lowest debt ratio during the COVID-19 pandemic period. On the other hand, Allegiant was the only company that announced a positive debt ratio during this period. Another remarkable finding is Southwest and Allegiant, which received the two highest values in the IPC index, did not disclose very similar financial data. This indicates that other issues such as route structure, fare policy, and customer segmentation should also be examined (Table 4).

Finally, the profitability ratio, one of the most important indicators, was examined. Ratios examined as profitability ratios are net profit margin, Return on Assets (ROA), and Return on Equity (ROE) respectively. Net profit margin measures the number of profits available to shareholders after all payments (taxes, interests, etc.) are eliminated on the income statement. Southwest is the only airline that declares a negative change in net profit margin among the airlines selected for this study. Companies with the highest net profit margin are included in the FSC class except for Hawaiian Airlines. A negative net profit margin change means that the money you make from selling your products or services is not enough to cover the cost of making or selling those products or services. At this point, it can be interpreted that airlines with a high fleet standardization index (IPC) are financially unprotected against crises, but it cannot be generalized from the view of management efficiency and profitability. The return on Assets (ROA) ratio measures a firm's ability to use its assets to generate profits. If ROA is high, it means that firm uses its profit-making tools well and achieves high returns. The Return on Equity (ROE) measures the return on the owner's equity. The higher the ratio means how the healthier firm is. It can be seen from Table 4 that Southwest has a large ROA loss compared to other airlines. We can interpret this as the LCC representative and best of all, that Southwest's operational revenues generate substantial financial returns. Another major ROA loss airline is Jetblue, also an LCC representative (See Fig. 7).

However, when we look at FSC representative airlines, we see a gain,

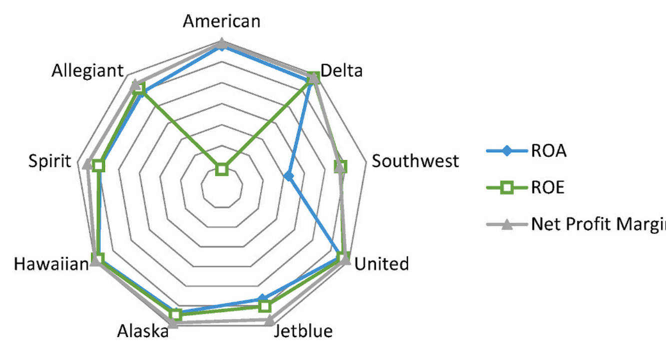

Fig. 7. Financial ratio comparison of airlines.

in the ROA index. This situation, in contrast to the LCC trend, shows that companies' revenues are not based solely on operational revenues and lower costs. Likewise, when the ROE values are examined, American Airlines experienced the biggest loss. However, it is clear that despite having achieved the largest ROA increase, a large drop in ROE value reveals that the company is using its revenues to cover incurred costs so that it cannot share profits with its partners. These effects come from the instinct of companies to maintain their current position by paying less cost in profit sharing. In this context, American Airlines and Southwest airlines have some distinctive features according to the financial ratio analysis. American Airlines has one of the lowest fleet standardization indexes and southwest has one of the highest ratios among others. Bu Southwest airlines have the lowest ROA feature that expresses their income can not generate profit in this situation. This ratio clarifies the situation of the high fleet standardization index airlines extremely dependent on operational activity.

4.5. Findings on data envelopment analysis

Data envelopment analysis is also a very flexible method in terms of determining inputs and outputs. In the analysis phase, we can use a single output as well as benefit from more than one output variable. Ultimately, an efficient analysis method that allows multiple input and output variables. Data envelopment analysis is not the only method used for effectiveness evaluation; however, it is the most popular in the statistical literature due to its ease of use and flexibility (Table 5).

As a result of data envelopment analysis, an efficiency score for each decision-making unit is calculated. If the value of the efficiency score of the decision-making unit is 1, that unit is active; If it is less than 1, we consider it inactive for input-oriented models. Even if this value is 0.999, the relevant unit is not considered active. The activity score of the observation that wants to be an active unit must also be 1. Thus, in the inverse model, if its score is 1, it is the worst efficient. If the score gets higher than 1 means becomes more efficient. CCR input-output and BCC input-output models have been studied to show that there is consistency between technical efficiency measurement and models at the local level. While the CCR model calculates the total technical efficiency as a whole, the BCC model provides the opportunity to calculate by separating the

Table 5
DEA efficiency scores of Airline companies pre/post covid seasons.

	2019/Q2				2020/Q2			
	Input	Input	Output	Output	Input	Input	Output	Output
	CRS/CCR	VRS/BCC	CRS/CCR	VRS/BCC	CRS/CCR	VRS/BCC	CRS/CCR	VRS/BCC
American	0.7684	0.9518	1.3014	1.2535	0.8341	0.9442	1.1988	1.1748
Delta	0.8326	1.0000	1.2011	1.0000	0.7971	0.8468	1.2545	1.1811
Southwest	0.7618	1.0000	1.3126	1.0000	0.8389	1.0000	1.1921	1.0000
United	0.7434	0.9522	1.3452	1.2788	1.0000	1.0000	1.0000	1.0000
Jetblue	0.7290	1.0000	1.3717	1.0000	0.8013	0.9834	1.2480	1.1737
Alaska	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Hawaiian	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Spirit	0.9019	1.0000	1.1088	1.0000	0.8730	1.0000	1.1455	1.0000

technical efficiency and scale efficiency. It can be concluded that all airline companies on pre covid season are efficient due to output-oriented CRS/CCR and VRS/BCC scores. It is possible to say that situation in this environment is capable to create profit for all companies as outputs. Hence, input measures of precovid season are not efficient enough to say those airlines were active. If we focus on results, two LCC representative airline companies are efficient according to input-oriented CRS/CCR scores which try to identify overall efficiency considering all measures determined. These airline companies are the ones that have the highest fleet standardization index among all airlines considered. When we look at VRS/BCC input-oriented efficiency scores of precovid season, just two companies are detected as inefficient which is the member of the lowest fleet standardization index.

According to Fig. 8, It is possible to interpret that two LCC representative airline companies that have a high fleet standardization index performed well in terms of input activity. It is easy to understand this issue as low-cost input values and high fleet utilization helped to achieve input efficiency. On the other hand, the output efficiency of LCC companies is not performing well because under inoperative conditions LCC airlines suffer to create value and profit. It is possible to see similar results in post covid season for input-oriented analysis. Differ from pre covid season, in 2020 most companies are taking some precautions to stabilize their efficiency and financial flows by decreasing their employees and the number of flights scheduled. However, these precautions affect their output measures and levels of cash flow also the efficiency measures overall. Although some fluctuations are observed in the efficiency and financial indicators of all airlines, there is no disruptive effect detected in terms of the financial response of airlines. In addition to this, there is not an enormous effect of fleet standardization recorded on the financial profitability of airline companies under crises for both LCC and FSC representatives.

5. Conclusion

Despite the sudden interruption of flights with the spread of the COVID-19 pandemic and the financial crisis encountered, organizations started to implement measures to maintain their continuity. Statistics on the sector and information on the changing number of flights are given in the relevant section. The precautions taken in the aviation sector in the face of the crisis can be summarized in following Table 6 (Maneenop and Kotcharin, 2020). In the early stages of the crisis, many airlines preferred to park their planes primarily at their home bases or nearby airports. However, more and more aircraft were withdrawn from active duty due to flight bans and falling demand. Thus, a race has started for airlines all over the world to choose places where they can safely park their planes and do the maintenance required by the authorities without interrupting them. In April, May, and June, when the most parking is experienced, decision-making and operational realization process with many options and conditions have been entered in this process, which poses both financial and logistical difficulties for airlines. In addition to parking on airport aprons, wing-to-wing parking has been made on taxiways and runways at airports with more than one runway.

Breakdowns were observed in the fleet activities of airlines on similar dates. The reason for this is the waves of the pandemic in the world at different times. Quarantine practices, which started especially in the autumn months, are softened after the decrease in the number of cases, and quarantine practices are hardened during the holidays. With the warming of the weather, the number of cases decreases, and traffic of airlines increases again as of June–July. Depending on the findings, the results obtained in this study can be itemized as follows:

- The closure policies of the country where the airline is located affect the usage of a fleet of airlines.

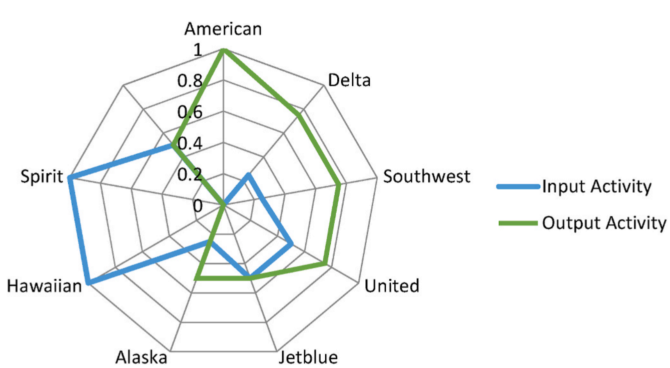

Fig. 8. Input-Output overall efficiency scores of airlines.

Table 6
Precautions taken in relevant areas.

Area	Precautions
Finance	Searching for Capital
	Loan Agreements
	Low-Interest Rates
	Tax Exemption
	Government Subsidies
	Debt Rollover
Manpower	Deductions in Wages
	Unpaid Leave
	Request for Employee Support From the Government
	Dismissal
Airport Fees	Airport Usage Fee Discounts
	Parking Fee Exemption
	Deferment/Exemption in ANSP Expenses
	Reduction in Services
	Postponement in Ground Handling Company Debts
Management	Business Model/Planning Change
	Tariff Changes
	Path Changes
	Flight Point Changes
	Restructuring
	Regional Agreements with Other Airlines
	Exclusion of Old Aircraft From Flight
	Parking Excess Demand Aircraft

- Airlines are affected by fleet structure decisions of the group they are in partnership with.
- Airline fleet use is affected by the airline's flight network and aircraft types in fleet structure.
- Although airlines have flexible flight permits in their own countries, the fact that the destination they will fly to is restricted for different reasons affects the use of the airline fleet.

Although we can statistically estimate that fleet standardization affects the company's revenue per mile, looking at the whole picture, it is possible to get the idea that LCC airlines are generally prepared for unexpected events with structured solutions but this situation indicates much more an unstructured problem. The possible reason for this situation is the cabin crew and pilot requirements of airlines which are having high fleet standardization are low and easy to schedule the crew because all pilots are flown with the same type of aircraft and it is possible to arrange them without considering special pilot education. This situation brings profitability by eliminating the complexity of pilot orientation and difficulty of flight assignment for pilots and flight legs. Considering that factors that affect profitability in aviation are not just aircraft, this creates an even more complex environment. It is possible to say that;

- Fleet standardization of FSC and LCC airlines could affect Revenue Available Seat Mile (RASM) value,
- LCC airlines might have a higher fleet standardization index,
- Ensuring the financial sustainability of companies in crises might not be directly related to fleet standardization.

As a result, airlines with a high fleet standardization index in their financial structure during the COVID-19 period were able to maintain their financial positions. However, the potential for profitability was not seen. However, FSC airlines with a lower fleet standardization index have those that declare profitability as well as maintain their financial assets. For example, Delta and United shared profits with their stakeholders by increasing their ROE ratio by 80.33% and 70.02%, respectively. In addition, the large loss in ROA and ROE ratios from LCC airlines with high fleet standardization also expresses the dependence of their financial returns on operational activity. For instance, Southwest −277.28% ROA loss and Jetblue 35.03% ROA loss are examples of the financial dependency of LCC companies. Of course, all airlines need to be active operationally, but they also need a lever to balance them in crises. This only means that there are alternatives and relatively less operational dependency.

6. Limitations and future works

While constructing this paper, there were some limitations existing on both justifications of study and interpretation of results. When stated results are examined, it comes to the fore that airlines should work in harmony with the policies of their country of origin. Although the support of governments to airlines during the pandemic process strengthens airlines' ties with politics, this situation is thought to be temporary. It seems possible for airlines to be able to compete with low-cost carriers in terms of efficiency, innovation, and service quality in a liberal order. It is thought that the return of the market to the pre-deregulation period will reduce competition (Budd et al., 2020). Since the emergence of new variants and the prolongation of the pandemic conditions will prevent traffic from returning to its former state, it should be considered that the ownership and partnership status of airlines will change, and governments may be involved in partnerships. Since there is no source for this situation, the subject has not been mentioned and since the subject has just started to come to the agenda, it has been seen among the works that need to be studied in the future. Another limitation is the route structure and OD-pair relationships of the airlines examined in the study. Because one of the situations that affect the income the most is the route structure (Fu et al., 2019). Financially, FSC airlines with a low fleet standardization index have been seen to have suffered major losses during the COVID-19 crisis, but they are in a more economically stable position than LCC airlines. The main factors of this situation need to be investigated and this is one of the limitations of this study. The following inferences can be made about the requirement for fleet standardization for future works;

- Fleet standardization can be determined according to the adopted flight network structure.
- It can be thought that the expenses of a standardized fleet will be stable, but since it limits the aircraft capacity per route, it sets an upper limit on the possible revenue amount.
- Not only fleet standardization provides companies with great profitability, but also active income actions that will improve the financial structures of companies and maintain their existence in crises should be taken.

Despite all these limitations, the scope of the study should be expanded to achieve a more dynamic structure and more consistent results. More developed studies with state or privately supported projects and partnerships will contribute to the world economy. In addition, the contribution of the competitive environment to the current fleet structure and the economic situation should be investigated.

Declaration of competing interest

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

APPENDIX

$$BR_{max} = \frac{Airline\ Performance - Worst\ in\ Class}{Best\ in\ Class - Worst\ in\ Class} \tag{3}$$

$$BR_{min} = \frac{Worst\ in\ Class - Airline\ Performance}{Worst\ in\ Class - Best\ in\ Class} \tag{4}$$

$$Liquidity\ Ratio;\ Current\ Ratio = \frac{Current\ Assets}{Current\ Liabilities} \tag{5}$$

$$Activity\ Ratio;\ Total\ Asset\ Turnover = \frac{Sales}{Total\ Assets} \tag{6}$$

$$Financing\ Ratio;\ Debt\ Ratio = \frac{Total\ Liabilities}{Total\ Assets} \tag{7}$$

$$Profitability\ Ratio; Net\ Profit\ Margin = \frac{Net\ Income}{Sales} \tag{8}$$

$$Profitability\ Ratio; ROA = \frac{Net\ Income}{Total\ Assets} \tag{9}$$

$$Profitability\ Ratio; ROe = \frac{Net\ Income}{Stakeholders\ Equity} \tag{10}$$

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