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Impact of COVID-19 on Airlines' Financial Performance and Innovation Strategy

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Abstract:
The COVID-19 pandemic profoundly affected the airline industry, prompting an exploration of non-financial factors that influence global airline financial performance. This study employs regression analysis on a panel dataset sourced from airlines' annual reports and financial statements from 2015 to 2020. The dataset is divided into pre-COVID-19 (2015-2018) and COVID-19 (2019-2020) periods, encompassing 72 samples from International Air Transport Association member airlines, categorized as full-service carriers (FSC) and low-cost carriers (LCC). Notably, pre-COVID-19 performance is statistically linked to non-financial factors such as passenger numbers (PAX) and passenger load factor (PLF). During COVID-19, financial performance was impacted by factors including PAX, available seat kilometers (ASK), revenue passenger kilometers (RPK), PLF, and aircraft count (ACT). This research advances our understanding of the interplay between airline-specific factors and financial performance during exogenous shocks such as COVID-19, potentially serving as a model for similar studies in extreme circumstances. Airline business innovation strategies are also discussed for the post-pandemic era. We analyze the impact of COVID-19 on airlines' financial performance and propose service innovation measures with the aim of promoting sustainable industry growth. The methodology included an embedded case study, statistical modeling, and hypothesis testing. This study reveals a positive correlation between passenger demand and total asset turnover because passengers play a vital role in the commercial airline sector. However, measures imposed by the World Health Organization (2020) during the pandemic, such as mandatory mask-wearing and seat distancing on flights, severely impact airline revenue. This study indicates that the passenger load factor positively influences total asset turnover, suggesting that airlines may have effectively adapted to optimize asset deployment in the COVID-19 era. The analysis of the given case on the impact of COVID-19 could serve as a foundation for further innovation initiatives for sustainable market growth of air transportation. By adding the financial performance data to the discussion on airline service innovation, we identified a strong relationship between airline management and innovation strategy during the pandemic.

Keywords: COVID-19 pandemic, airline industry, financial performance, non-financial factors, service innovation.

新冠肺炎对航空公司财务绩效和创新战略的影响

摘要：
新冠肺炎大流行深刻影响了航空业，促使人们探索影响全球航空公司财务业绩的非财务因素。本研究对来自航空公司 2015 年至 2020 年年度报告和财务报表的面板数据集进行回归分析。该数据集分为新冠肺炎之前（2015-2018）和新冠肺炎（2019-2020）时期，包括 来自国际航空运输协会成员航空公司的 72 个样本，分为全服务航空公司(森林管理委员会)和低成本航空公司（低成本航司）。值得注意的是，新冠肺炎之前的表现在统计上与乘客数量(帕克斯)和乘客负载系数(PLF)等非财务因素相关。在新冠肺炎期间，财务业绩受到帕克斯、可用座位公里数(问)、收入旅客公里数(RPK)、PLF 和飞机数量(行为)等因素的影响。这项研究加深了我们对新冠肺炎等外源冲击期间航空公司特定因素与财务绩效之间相互作用的理解，有可能成为极端情况下类似研究的模型。会议还讨论了后疫情时代的航空公司业务创新战略。我们分析了新冠肺炎对航空公司财务业绩的影响，并提出服务创新措施，以促进行业可持续增长。该方法包括嵌入式案例研究、统计建模和假设检验。这项研究揭示了乘客需求与总资产周转率之间的正相关关系，因为乘客在商业航空领域发挥着至关重要的作用。然而，世界卫生组织（2020）在大流行期间采取的措施，例如强制佩戴口罩和航班上座位距离等，严重影响了航空公司的收入。这项研究表明，客座率对总资产周转率产生积极影响，这表明航空公司可能已经有效适应了新冠肺炎时代的资产部署优化。对特定案例对新冠肺炎影响的分析可以作为航空运输可持续市场增长的进一步创新举措的基础。通过将财务绩效数据添加到有关航空公司服务创新的讨论中，我们发现了大流行期间航空公司管理与创新战略之间的密切关系。

关键词：新冠肺炎大流行、航空业、财务绩效、非财务因素、服务创新。

1. Introduction

Aviation provides fast worldwide transportation for the global business and tourism industries. Air transportation significantly boosts the global economy because it provides access to the global market in many countries. Undeniably, air transportation offers the most convenient and time-saving means for travelers and cargo activities. Additionally, aviation activities increase the global gross domestic product (GDP) relating to export and import goods, connecting people worldwide and offering job employment. The difficulties that the aviation industry might face differ regarding consumer behavior and economic circumstances at that time. The pandemic caused by the coronavirus COVID-19 is one of the biggest threats to the aviation industry. The business stopped observing the pandemic in the civil aviation industry for a while. Nearly every airline could not carry passengers or cargo during this period. This situation appears not only on domestic routes but also on international routes. Hence, the Air Transport Action Group (ATAG) (2020) points out that the number of jobs supported by aviation decreased to 46 million jobs (compared with normal circumstances), and that of worldwide direct aviation jobs reduced by 4.8 million. Even though airports gain revenue from aeronautical activities, including landing and parking charges, departure passenger service charges, aircraft service charges, and rent from building properties, the impacts of COVID-19 are still significant, owing to a decrease in revenues.

In addition, the World Health Organization (WHO) (2020) suggested wearing masks and maintaining social distance to avoid and reduce the risk of infection among people. This condition restricts all airlines from leaving a distance between the seats, resulting in half of the revenue being lost. COVID-19 creates domino effects on the aviation industry, that is, the number of aircraft, the drop in passenger demand, and the decrease in net income and total revenue. According to the Airports Council International World (ACI) (2021), the number of passengers worldwide in 2020 was 6,121 million, and the percentage of change compared to 2019 is 64.6% of global passenger traffic. In addition, the Asia-Pacific region has a loss of 2,148 million passengers, representing a decrease of 61.3% from all regions. The International Civil Aviation Organization (ICAO) (2021) reported that during the COVID-19 outbreak, the number of worldwide passengers decreased by 60% in 2020, 49% in 2021, and 27% to 32% in 2022 compared with the year 2019. Moreover, the Airports Council International World (ACI) (2021) said that airlines' revenue dropped by around $380 billion compared to 2019. Due to the pandemic, travel restrictions grounded global aircraft by 64% in April 2020.

Several studies have focused on factors impacting the airline industry. Bendinelli et al. (2016), Kalemba and Campa-Planas (2019), Fardnia et al. (2021), Chang et al. (2018) examine the relationship between accident records or safety and financial performance. Kiracı (2019) and Goh and Rasli (2014) explore the impact of the global financial crisis on the airline industry. Additionally, some studies have investigated the impacts of COVID-19 on corporate performance, for example, stock return (Maneenop & Kotcharin, 2020; Richardson et al., 2014), ROE and ROA (Achim et al., 2022; Anh & Gan, 2021), and return on ROI (Barros & Couto, 2013). However, studies on the impacts of non-financial factors, the number of passengers, available seat kilometers, revenue passenger kilometers, passenger load factor, and number of aircraft, on

financial performance are needed.

2. Background and Literature Review

This study focuses on the financial performance of airlines, where the dependent variables are the return on assets (ROA), return on equity (ROE), current ratio (CR), total asset turnover (TATR), debt ratio (DR), and non-financial factors are independent variables: the number of passengers (PAX), available seat kilometers (ASK), revenue passenger kilometers (RPK), passengers load factor (PLF), and the number of aircraft (ACT).

A financial ratio is the most practical way to measure a company's performance and evaluate the business. Fielding et al. (1978), Fielding and Anderson (1983) created a conceptual model for public transportation to improve transit performance through financial aspects and several factors such as service inputs, servicer outputs, and service consumption. Feng and Wang (2000) redeveloped a conceptual framework from Fielding and Anderson (1983); the aviation industry's operational performance evaluation includes three indicators: production efficiency, marketing efficiency, and execution efficiency. The results show that the transportation indicator and financial ratios must be measured together with an airline's performance.

Customer satisfaction leading to customer purchase behavior, resulting in an increase in the number of customers and employees, was found to have a positive impact on accounting performance by Ittner and Larcker (1998). This indicates that both customer and employee growth directly influence financial performance. In addition, Lee and Warner (2005) observed the impact of severe acute respiratory syndrome (SARS) on the human resource and labor markets in the service sector in Taiwan. While SARS increased the unemployment rate, the aviation and tourism industries demonstrated a swift recovery.

The impact of the September 11th terrorist attacks on airline stocks, including Continental Airlines, Delta Airlines, British Airways, EasyJet, Air France, and KLM, as well as employment, was observed by Drakos (2002). Furthermore, Flouris and Walker (2005) employed financial ratio analysis to assess the performance of airline stocks in the aftermath of the 9/11 attacks. In a similar context, Barros and Couto (2013) conducted a study on European airlines affected by the 9/11 terrorist attacks that occurred on September 11, 2001. Their analysis of airline productivity, which encompassed input variables (employees, operating cost, and available seat kilometers) and output variables (revenue per passenger-km and revenue cargo tones carried), revealed a consistent decline in airline productivity from 2001 to 2011, indicating a lack of growth in airline productivity following the 9/11 terrorist attacks.

In a study by Gramani (2012) on the operational and financial performance of Brazilian and American airlines from 1997 to 2006, improved operational performance has a positive influence on the financial performance of airlines. Additionally, Stepanyan (2014) conducted a case study focusing on the largest US carriers during the economic crisis from 2007 to 2012. This investigation revealed that a reduction in the demand for air transportation, air traffic, and passengers had short-term adverse effects on the current ratio. Furthermore, when such events persisted over an extended period, they exerted a significant impact on the return on assets (ROA) and return on equity (ROE). During the economic crisis, the total stockholders' equity of the airlines turned negative, resulting in the inability to measure return on equity (ROE) for the affected firms.

During the period from 2011 to 2013, a study on major airlines was conducted to analyze financial ratios and airline-specific factors following the financial crisis. This investigation delved into how the financial crisis affected return on equity (ROE) and debt-to-equity ratios. Notably, available seat kilometers (ASK) and revenue passenger kilometers (RPK) exhibited significant increases in the three years after the crisis. However, their impact on return on assets (ROA) was found to be inconsistent. Furthermore, the study's findings indicated that profitability ratios were adversely affected by the passenger load factor (PLF). Dizkirici et al. (2016) studied the relationship between traditional and profitability ratios of airlines and found that financial ratios, which are the current and debt ratios, have a significant adverse effect on profitability ratios.

Examining the financial performance of airlines has yielded a wealth of insights using various metrics and dimensions. Teker et al. (2016) employed harmonic indices to evaluate four aspects of performance: profitability, operational efficiency, liquidity, and overall effectiveness. Their analysis incorporated data from financial statements, balance sheets, employee counts, and the number of aircraft in service. Notably, their empirical findings demonstrated that a company's financial performance significantly influences both short-term and long-term decision-making. While Teker and colleagues identified a positive correlation between the number of employees and aircraft and return on assets (ROA), Kalemba and Campa-Planas (2019) offered a contrasting view, indicating a significant negative impact of the number of aircraft on ROA. These findings underscore the complex relationship between variables in determining financial performance, with passenger numbers emerging as a consistent positive factor affecting profitability ratios.

Zuidberg's (2019) research, which focused on the Scandinavian airline industry from 2005 to 2015, delved into financial ratios and the number of departures (flights). The study revealed that a decline in available seat kilometers (ASK) and revenue passenger kilometers (RPK) had adverse implications for leverage ratios (debt ratios) and liquidity ratios (current ratios).

Shifting the focus to the Korean airline industry, Lee (2019) explored the influence of the PLF on

profitability ratios, establishing a positive relationship. The impact of external factors became evident in Devi et al.'s (2020) study in Indonesia, where the COVID-19 pandemic caused a decline in profitability, liquidity ratios, and activity ratios, signaling a substantial effect on return on assets (ROA). A parallel study by Rababah et al. (2020) extended this insight to companies in China, highlighting the pandemic's influence on financial performance and emphasizing return on assets (ROA) and return on equity (ROE) as critical measures.

During the COVID-19 pandemic, Budd et al. (2020) highlighted the plummeting number of passengers in European airlines, prompting cost-cutting measures, including staff reductions, flight reductions, and decreased flight frequency, as companies sought to ensure their survival. However, rising jet fuel prices introduced cash flow challenges, potentially resulting in higher debt ratios and, in extreme cases, bankruptcy.

Finally, the aftermath of mega-mergers from 2008 to 2013 within the US airline industry was evaluated by Huang et al. (2021). Their findings suggested that the number of employees negatively impacted airline operating efficiency, implying that staff reductions could adversely affect airline operations. These diverse insights underline the multifaceted nature of the factors influencing airline performance and profitability.

$$ROA_{it} = \beta_0 + \beta_1(PAX_{it}) + \beta_2(ASK_{it}) + \beta_3(RPK_{it}) + \beta_4(PLF_{it}) + \beta_5(ACT_{it}) + \beta_6(SIZE_{it}) + \varepsilon \quad (1)$$

$$ROE_{it} = \beta_0 + \beta_1(PAX_{it}) + \beta_2(ASK_{it}) + \beta_3(RPK_{it}) + \beta_4(PLF_{it}) + \beta_5(ACT_{it}) + \beta_6(SIZE_{it}) + \varepsilon \quad (2)$$

$$CR_{it} = \beta_0 + \beta_1(PAX_{it}) + \beta_2(ASK_{it}) + \beta_3(RPK_{it}) + \beta_4(PLF_{it}) + \beta_5(ACT_{it}) + \beta_6(SIZE_{it}) + \varepsilon \quad (3)$$

$$TATR_{it} = \beta_0 + \beta_1(PAX_{it}) + \beta_2(ASK_{it}) + \beta_3(RPK_{it}) + \beta_4(PLF_{it}) + \beta_5(ACT_{it}) + \beta_6(SIZE_{it}) + \varepsilon \quad (4)$$

$$DR_{it} = \beta_0 + \beta_1(PAX_{it}) + \beta_2(ASK_{it}) + \beta_3(RPK_{it}) + \beta_4(PLF_{it}) + \beta_5(ACT_{it}) + \beta_6(SIZE_{it}) + \varepsilon \quad (5)$$

Notes: β_0 - the intercept of the equation, β_i - coefficients of variables, i - the 62 airlines analyzed in the study, t - time as the 7 years between 2014 and 2020, 〖ROA〗_it - return on assets of airlines i in the year t, 〖ROE〗_it - return on equity of airlines i in the year t, 〖CR〗_it - current ratio of airlines i in the year t, 〖TATR〗_it - total asset turnover of airlines i in the year t, 〖DR〗_it - debt ratio of airlines i in the year t, 〖ASK〗_it - available seat kilometers of airlines i in the year t, 〖RPK〗_it - revenue passenger kilometers of airlines i in the year t, 〖PLF〗_it - passenger load factor of airlines i in the year t, 〖PAX〗_it - number of passengers of airlines i in the year t, 〖ACT〗_it - number of passengers of airlines i in the year t, 〖FL〗_it - number of flights of airlines i in the year t, ε - the error term.

3. Methodology

3.1. Population and Sample

This quantitative research uses descriptive statistics, correlation, and regression analysis. This research collects data from the annual report and financial statement for the fiscal year of each airline for six years (2015-2020) divided into two periods: pre-COVID-19 from 2015 to 2018 and COVID-19 from 2019 to 2020. The population membership of the International Air Transport Association (IATA) was 72 airlines worldwide, focusing on commercial airlines divided into two types of business: full-service carriers (FSC) and low-cost carriers (LCC). All the airlines operate domestic and international flights (Table 1).

Table 1. List of the airlines (International Air Transport Association, 2021)

No.	Airlines	Airlines Code	Country	Business Type
1	Qatar Airways	QR	Qatar	FSC
2	Singapore Airlines	SQ	Singapore	FSC
3	Emirates Airlines	EK	Emirates Airlines	FSC
4	Japan Airlines	JL	Japan	FSC
5	Cathay Pacific Airways	CX	Hong Kong	FSC
6	EVA Air	BR	Taiwan	FSC
7	Qantas Airways	QF	Australia	FSC
8	Air France	AF	France	FSC
9	British Airways	BA	United Kingdom	FSC
10	China Southern Airlines	CZ	China	FSC
11	Lufthansa	LH	Germany	FSC
12	Aeroflot	SU	Russia	FSC
13	Garuda Indonesia	GA	Indonesia	FSC
14	KLM Royal Dutch Airlines	KL	Netherland	FSC
15	Turkish Airline	TK	Turkey	FSC
16	Bangkok Airways	PG	Thailand	LCC
17	Air New Zealand	NZ	New Zealand	FSC
18	Korean Air	KE	South Korea	FSC
19	Thai Airways	TG	Thailand	FSC
20	Virgin Atlantic	VS	United Kingdom	LCC
21	Asiana Airlines	OZ	South Korea	FSC
22	AirAsia	AK	Malaysia	LCC
23	Delta Air Lines	DL	United States	FSC
24	Finnair	AY	Finland	FSC
25	JetBlue Airways	B6	United States	LCC
26	Air Canada	AC	Canada	FSC
27	Iberia	IB	Spain	LCC
28	Aegean Airlines	A3	Greece	FSC
29	Croatia Airlines	OU	Croatia	FSC

Continuation of Table 1

30	China Airlines	CI	Taiwan	FSC
31	Southwest Airlines	WN	United States	FSC
32	All Nippon Airways	NH	Japan	FSC
33	Air Astana	KC	Kazakhstan	FSC
34	LATAM	LA	Chile	FSC
35	Aer Lingus	EI	Ireland	FSC
36	Azul Airlines	AD	Brazil	LCC
37	Vueling Airlines	VY	Spain	LCC
38	IndiGo	6E	India	LCC
39	EasyJet	EC	United Kingdom	LCC
40	Cebu Pacific	5J	Philippines	LCC
41	Ryanair	FR	Ireland	LCC
42	GOL	G3	Brazil	LCC
43	United Airlines	UA	United States	FSC
44	Alaska Airlines	AS	United States	FSC
45	SAS Scandinavian	SK	Sweden	FSC
46	TUI Airways	X3	United Kingdom	LCC
47	Hawaiian Airlines	HA	United States	FSC
48	Norwegian	DY	Norway	LCC
49	American Airlines	AA	United States	FSC
50	China Eastern Airlines	MU	China	FSC
51	Kenya Airways	KQ	Kenya	FSC
52	Hainan Airlines	HU	China	FSC
53	Copa Airlines	CM	Panama	FSC
54	Jet2.com	LS	United Kingdom	LCC
55	SpiceJet	SG	India	LCC
56	Pakistan International Airlines	PK	Pakistan	FSC
57	Air China	CA	China	FSC
58	Wizz Air	W6	Hungary	LCC
59	Icelandair	FI	Iceland	FSC
60	Royal Jordanian Airlines	RJ	Jordan	FSC
61	Aviance	AV	Colombia	FSC
62	Citilink	QG	Indonesia	LCC
63	Jazeera Airways	J9	Kuwait	FSC
64	Jeju air	7C	South Korea	LCC
65	VietJet Air	VJ	Vietnam	LCC
66	Pegasus Airlines	PC	Turkey	LCC
67	Air Mauritius	MK	Mauritius	FSC
68	Ethiopian Airlines	ET	Ethiopia	FSC
69	EgyptAir	MS	Egypt	FSC
70	SriLankan Airlines	UL	Sri Lankan	FSC
71	Aeromexico	AM	Mexico	FSC
72	Volaris	Y4	Mexico	LCC

3.2. Variables

This study investigates the impact of non-financial factors on the financial performance of airlines both before and during the COVID-19 pandemic. The study employs various financial indicators as dependent variables, including return on assets (ROA), return on equity (ROE), current ratio (CR), total asset turnover (TATR), and debt ratio (DR). Independent variables include the number of passengers (PAX), available seat kilometers (ASK), revenue passenger kilometers (RPK), passenger load factor (PLF), and number of aircraft (ACT). In addition, the study incorporates a control variable: the size of the airlines as indicated by the number of employees (SIZE).

To assess profitability, return on assets (ROA) is used as a key metric to gage how effectively firms employ their assets. This ratio is determined by dividing net profit (or loss) by total assets, with prior studies by Feng and Wang (2000), Stepanyan (2014), Yaghi (2015), Teker et al. (2016), Dizkirici et al. (2016), Kalemba and Campa-Planas (2019) contributing to the formula's validation.

Return on equity (ROE) is another essential ratio that assesses a firm's ability to generate profit. ROE represents the ratio of net profit (or loss) to total equity. It is a significant indicator for investors seeking insights into a firm's capacity to deliver returns, as supported by the works of Feng and Wang (2000), Stepanyan (2014), and Yaghi (2015). The current ratio, a measure of a firm's liquidity, is computed as the ratio of current assets to current liabilities, with validation from Dizkirici et al. (2016) and Zuidberg (2019). Total asset turnover, which evaluates a firm's efficiency in using its assets, is determined by the ratio of total revenue to total assets. This measure is supported by Dizkirici et al. (2016) and Zuidberg (2019). For leverage ratios, the study utilizes the debt ratio, which is derived from the ratio of total liabilities to total assets, as an indicator of a firm's financial leverage, with validation from Dizkirici et al. (2016) and Zuidberg (2019).

The non-financial indicators, representing airline-specific factors, incorporate indicators such as PAX, as established by Ittner and Larcker (1998), Feng and Wang (2000), and Stepanyan (2014). Available seat kilometers (ASK) are calculated by multiplying the number of seats on an aircraft by the distance traveled

in kilometers, with reference to studies by Barros and Couto (2013) and Yaghi (2015). Revenue passenger kilometers (RPK) are calculated by multiplying the number of paying passengers by the number of kilometers flown by those seats, as recognized by Feng and Wang (2000) and Yaghi (2015). The passenger load factor (PLF) is determined by dividing revenue passenger kilometers (RPK) by available seat kilometers (ASK), drawing from studies by Yaghi (2015) and Lee (2019). The number of aircraft (ACT) represents the total number of aircraft operated by each airline, with support from Feng and Wang (2000), Teker et al. (2016), and Kalemba and Campa-Planas (2019).

4. Empirical Results and Discussion

The descriptive statistics relating to financial performance and non-financial performance variables are reported in Table 2, following each airline's financial data and specific aviation data from 2015 to 2020.

Table 2. Descriptive statistics of the variables for 2015–2020

Variable	Obs.	Mean	Std. Dev.	Min	Max
ROA	432	-0.05	0.86	-17.34	1.48
ROE	432	-0.09	8.86	-173.02	32.61
CR	432	0.92	1.13	0.06	12.56
TATR	432	0.83	0.87	-0.45	11.92
DR	432	0.79	0.55	-2.35	9.02
PAX	432	3,980,000	62,300,000	47,000	969,000,000
ASK	432	86,165	94,628	871	458,804
RPK	432	69,559	78,291	432	388,256
PLF	432	0.79	0.09	0.35	0.96
ACT	432	213	263	7	1,551
SIZE	432	22,363	24,650	430	133,700

Notes: ROA represents the return on assets, ROE represents the return on equity, CR represents current ratio, TATR represents total asset turnover, DR represents debt ratio, PAX represents the number of passengers, ASK represents available seat kilometers, RPK represents revenue passenger kilometers, PLF represents passenger load factor, ACT represents the number of aircraft, SIZE represents the size of the airline.

Table 2 summarizes all variables of 72 airlines worldwide between 2015 and 2020 for 432 observations. The table shows that the standard deviation values of the dependent variable for a return on assets (ROA) are 86%. This means that the profit of the airline company concerning the total assets is efficient. The return on equity (ROE) is 886%, which means that the airline company generates profits efficiently and converts equity financing into profit. The current ratio (CR) of 1.13x means that the airlines can pay back short-term debt, and the company has good financial health. The total asset turnover (TATR) is 0.87x, which means that the airline company uses assets with poor efficiency, and the debt ratio (DR) is 55%, which means that the airline company has more assets than debts. Another, the min and max values of the independent variables for the number of passengers (PAX) are 47,000 and 969,000,000, respectively. In addition, passenger demand majorly affects the airline's business. The available seat kilometers (ASK) are 871 and 458,804, respectively. It is a measure of an airline's capacity to generate revenue, taken from multiplying the available seats on any given aircraft by the number of kilometers flown on a given flight. The revenue passenger kilometers (RPK) are 432 and 388,256, respectively. It calculates the number of kilometers traveled by paying customers by multiplying the number of paying passengers by the distance traveled. The passenger load factor (PLF) is 35% and 96%, respectively. It measures an airline's capacity defined as the ratio between RPK and ASK.

Moreover, increasing PAX, ASK, RPK, and PLF is more significant for the airline business because the airlines can sell many tickets, and the number of aircraft (ACT) is 7 and 1,551, respectively. Finally, the min and max of the control variable are the sizes of airlines (SIZE) 430 and 133,700, respectively. The increase in the number of employees means that the business is growing up.

To analyze the data, this study employs multiple regression to investigate the relationship between non-financial variables or airline-specific factors. Each variable is added separately to determine its impact on each financial variable. The final results, which include all variables, are presented in Tables 4-6.

From Table 3, the correlation coefficient result shows that CR has a negative relationship with PAX from -0.1025, and the most positive relationship with PLF can be seen from 0.0243. TATR has a positive relationship with PLF, as can be seen from 0.1638. DR has the most destructive relationship with PLF, which can be seen from -0.1432.

Table 3. Correlation of the variables for 2015–2020

	ROA	ROE	CR	TATR	DR	PAX	ASK	RPK	PLF	ACT	SIZE	PS	AS	RS	LS	CS
ROA	1.0000															
ROE	0.0024	1.0000														
CR	0.0616*	0.0086	1.0000													
TATR	0.0752*	0.0167	0.1403**	1.0000												
DR	-0.0108	-0.0210	-0.0482*	-0.2556**	1.0000											
PAX	0.0481*	-0.0177	-0.1025**	-0.0396*	-0.0482*	1.0000										
ASK	0.0625*	-0.0216	-0.1297**	-0.0741*	-0.0395*	0.6057**	1.0000									
RPK	0.0649*	-0.0220	-0.1263**	-0.0631*	-0.0496*	0.6003**	0.9838**	1.0000								
PLF	0.1020**	-0.0188	0.0243	0.1638**	-0.1432**	0.1590**	0.2121**	0.2504**	1.0000							
ACT	0.0442*	-0.0306	-0.1192*	-0.0936**	0.0059	-0.6394**	0.8229**	0.8091**	0.0645*	1.0000						
SIZE	0.0277	-0.0444*	-0.1422**	-0.1093**	0.0131	0.6288**	0.8393**	0.8184**	0.0785*	0.8026**	1.0000					
PS	0.0253	-0.0220	-0.0906**	-0.0486*	-0.0034	0.9370**	0.5526**	0.5420**	0.0434*	0.6161**	0.6617**	1.0000				
AS	0.0370*	-0.0326*	-0.1168**	-0.0584*	0.0060	0.6100**	0.8882**	0.8764**	0.0970**	0.8503**	0.8840**	0.6793**	1.0000			
RS	0.0379*	-0.0329*	-0.1169**	-0.0530*	0.0021	0.6030**	0.8833**	0.8823**	0.1165**	0.8413**	0.8746**	0.6710**	0.9975**	1.0000		
LS	0.0366*	-0.0445*	-0.1452**	-0.0930**	-0.0050	0.6229**	0.8450**	0.8325**	0.1752**	0.7834**	0.9902**	0.6501**	0.8823**	0.8823**	1.0000	
CS	0.0269	-0.0383*	-0.0984**	-0.0583*	0.0266	0.5965**	0.7468**	0.7332**	0.0277	0.9144**	0.8114**	0.6851**	0.9214**	0.9214**	0.7976**	1.0000

Notes: * and ** represent p<0.05, p<0.01; PS represents PAX*SIZE, AS represents ASK*SIZE, RS represents RPK*SIZE, LS represents PLF*SIZE, and CS represents ACT*SIZE.

Table 4. Non-financial factors affecting financial performance from 2015 to 2020

Variables	ROA	ROE	CR	TATR	DR
PAX	8.14e-10	-3.79e-09	-2.66e-09	3.98e-09	-3.23e-09
	(3.33e-09)	(3.43e-08)	(4.29e-09)	(3.26e-09)	(2.09e-09)
ASK	-0.00000139	-0.0000248	0.000000561	0.00000227	0.00000315
	(0.00000643)	(0.0000662)	(0.00000830)	(0.00000630)	(0.00000404)
RPK	0.00000221	0.0000293	-0.000000918	-0.00000361	-0.00000504
	(0.00000704)	(0.0000725)	(0.00000909)	(0.00000691)	(0.00000442)
PLF	0.637	-4.603	2.074*	2.203***	0.0364
	(0.794)	(8.176)	(1.025)	(0.778)	(0.498)
ACT	0.000160	0.00346	-0.000403	-0.00121	0.000471
	(0.000859)	(0.00885)	(0.00111)	(0.000843)	(0.000540)
SIZE	-0.0000114	-0.000174	0.0000489	0.0000251	0.0000267
	(0.0000272)	(0.000280)	(0.0000351)	(0.0000267)	(0.0000171)
PAX*SIZE	-6.44e-15	6.47e-14	2.27e-14	-4.06e-14	2.94e-14
	(3.59e-14)	(3.70e-13)	(4.63e-14)	(3.52e-14)	(2.25e-14)
ASK*SIZE	8.82e-11	1.27e-09	-7.58e-11	-1.26e-10	-1.32e-10
	(2.21e-10)	(2.28e-09)	(2.86e-10)	(2.17e-10)	(1.39e-10)
RPK*SIZE	-1.04e-10	-1.36e-09	9.86e-11	1.74e-10	1.74e-10
	(2.53e-10)	(2.60e-09)	(3.26e-10)	(2.48e-10)	(1.59e-10)
PLF*SIZE	0.0000113	0.000165	-0.0000691	-0.0000389	-0.0000312
	(0.0000330)	(0.000340)	(0.0000426)	(0.0000323)	(0.0000207)
ACT*SIZE	-1.17e-09	-6.26e-08	3.51e-09	1.13e-08	-5.31e-09
	(125e-08)	(0.000000128)	(1.61e-08)	(1.22e-08)	(7.83e-09)
Constant	-0.599	3.839	-0.471	-0.719	0.799*
	(0.618)	(6.364)	(0.797)	(0.606)	(0.388)
N	432	432	432	432	432
R-sq	0.014	0.005	0.035	0.061	0.038
Adj. R-sq	-0.012	-0.021	0.010	0.036	0.013

Notes: *, **, and *** represent p<0.05, p<0.01, p<0.001; ROA represents the return on assets, ROE represents the return on equity, CR represents current ratio, TATR represents total asset turnover, DR represents debt ratio, PAX represents the number of passengers, ASK represents available seat kilometers, RPK represents revenue passenger kilometers, PLF represents passenger load factor, ACT represents the number of aircraft, and SIZE represents the size of the airline.

Table 5. Non-financial factors affecting the financial performance before COVID-19

Variables	ROA	ROE	CR	TATR	DR
PAX	-1.75e-09	-1.15e-08	-6.63e-09	3.10e-10	-1.51e-09
	(5.72e-09)	(1.52e-08)	(7.21e-09)	(4.00e-09)	(1.92e-09)
ASK	-0.0000138	0.00000694	-0.0000116	0.00000459	0.000000131
	(0.0000155)	(0.0000413)	(0.0000196)	(0.0000109)	(0.00000522)
RPK	0.0000194	-0.0000272	0.0000146	-0.00000955	0.000000662
	(0.0000200)	(0.0000533)	(0.0000252)	(0.0000140)	(0.00000674)
PLF	0.424	3.926	1.589	2.415*	-0.255
	(1.656)	(4.401)	(2.087)	(1.159)	(0.557)
ACT	0.000355	0.00644	-0.000126	-0.000104	-0.000240
	(0.00152)	(0.00404)	(0.00191)	(0.00106)	(0.000511)
SIZE	-0.000103	0.0000662	-0.0000182	0.0000556	-0.0000150
	(0.0000724)	(0.000193)	(0.0000913)	(0.0000507)	(0.0000244)
PAX*SIZE	6.87e-14	6.73e-14	8.32e-14	-1.51e-14	2.24e-14
	(1.01e-13)	(2.68e-13)	(1.27e-13)	(7.06e-14)	(3.39e-14)
ASK*SIZE	6.36e-10	-4.55e-10	3.31e-10	-2.96e-10	2.07e-12
	(5.58e-10)	(1.48e-09)	(7.03e-10)	(3.91e-10)	(1.88e-10)
RPK*SIZE	-7.95e-10	8.82e-10	-4.01e-10	4.41e-10	-7.94e-12
	(7.02e-10)	(1.87e-09)	(8.84e-10)	(4.91e-10)	(2.36e-10)
PLF*SIZE	0.000114	-0.0000918	0.00000668	-0.0000777	0.0000157
	(0.0000843)	(0.000224)	(0.000106)	(0.0000590)	(0.0000284)
ACT*SIZE	-3.46e-09	-9.67e-08	1.26e-11	-5.22e-09	2.75e-09
	(2.17e-08)	(5.76e-08)	(2.73e-08)	(1.52e-08)	(7.28e-09)
Constant	-0.392	-2.328	0.123	-0.741	0.994*
	(1.318)	(3.503)	(1.660)	(0.922)	(0.443)
N	288	288	288	288	288
R-sq	0.026	0.021	0.042	0.069	0.021
Adj. R-sq	-0.013	-0.018	0.004	0.032	-0.018

Notes: *, **, and *** represent p<0.05, p<0.01, p<0.001; ROA represents the return on assets, ROE represents the return on equity, CR represents current ratio, TATR represents total asset turnover, DR represents debt ratio, PAX represents the number of passengers, ASK represents available seat kilometers, RPK represents revenue passenger kilometers, PLF represents passenger load factor, ACT represents the number of aircraft, and SIZE represents the size of the airline.

Table 6. Non-financial factors affecting the financial performance during COVID-19

Variables	ROA	ROE	CR	TATR	DR
PAX	1.31e-09	-4.68e-09	8.21e-10	9.10e-09	-5.67e-09
	(8.56e-10)	(9.52e-08)	(2.54e-09)	(6.52e-09)	(5.05e-09)

Continuation of Table 6

ASK	0.00000217	-0.0000116	0.00000393	0.00000404	0.00000469
	(0.00000143)	(0.000158)	(0.00000423)	(0.0000109)	(0.00000841)
RPK	-0.000000855	0.0000368	-0.00000395	-0.00000399	-0.00000700
	(0.00000139)	(0.000154)	(0.00000412)	(0.0000106)	(0.00000818)
PLF	0.236	-11.59	1.028*	1.287	0.268
	(0.170)	(18.94)	(0.506)	(1.298)	(1.005)
ACT	-0.000477*	0.00365	-0.000266	-0.00180	0.000721
	(0.000197)	(0.0219)	(0.000584)	(0.00150)	(0.00116)
SIZE	0.00000241	-0.000182	0.0000558***	0.00000810	0.0000282
	(0.00000545)	(0.000606)	(0.0000162)	(0.0000415)	(0.0000321)
PAX*SIZE	-1.22e-14	1.02e-13	-1.04e-14	-9.29e-14	5.33e-14
	(8.89e-15)	(9.89e-13)	(2.64e-14)	(6.78e-14)	(5.25e-14)
ASK*SIZE	-6.58e-11	1.52e-09	-1.82e-10	-1.42e-10	-1.57e-10
	(4.75e-11)	(5.29e-09)	(1.41e-10)	(3.62e-10)	(2.80e-10)
RPK*SIZE	5.61e-11	-1.70e-09	2.18e-10	1.41e-10	1.98e-10
	(5.16e-11)	(5.74e-09)	(1.53e-10)	(3.93e-10)	(3.04e-10)
PLF*SIZE	-0.00000254	0.0000913	-0.0000748***	-0.00000820	-0.0000312
	(0.00000704)	(0.000783)	(0.0000209)	(0.0000536)	(0.0000415)
ACT*SIZE	6.89e-09*	-6.49e-08	3.00e-09	2.17e-08	-8.23e-09
	(2.96e-09)	(0.000000330)	(8.80e-09)	(2.26e-08)	(1.75e-08)
Constant	-0.298*	8.025	-0.0528	-0.311	0.712
	(0.128)	(14.25)	(0.380)	(0.976)	(0.756)
N	144	144	144	144	144
R-sq	0.247	0.013	0.137	0.061	0.049
Adj. R-sq	0.185	-0.069	0.065	-0.017	-0.030

Notes: *, **, and *** represent p<0.05, p<0.01, p<0.001; ROA represents the return on assets, ROE represents the return on equity, CR represents current ratio, TATR represents total asset turnover, DR represents debt ratio, PAX represents the number of passengers, ASK represents available seat kilometers, RPK represents revenue passenger kilometers, PLF represents passenger load factor, ACT represents the number of aircraft, and SIZE represents the size of the airline.

4.1. Analysis of Factors Affecting the Financial Performance of Airlines during COVID-19

This section shows the results on factors affecting the financial performance of the airlines during COVID-19. Table 4 focuses on the non-financial variables affecting return on assets (ROA), return on equity (ROE), current ratio (CR), total asset turnover (TATR), and debt ratio (DR) for 2015–2020 using panel data regression.

According to Table 4, from 2015 to 2020, the passenger load factor (PLF) positively affects the current asset ratio (CR) at a significance level of 0.05. This means that airlines with higher passenger load factors affect the current ratio (CR). Moreover, PLF positively affects the total asset turnover (TATR) at a significance level of 0.001 in 2015-2020. This means that an increase in the passenger load factor will increase the current ratio and total asset turnover. Because the companies can obtain more liquidity, they can operate their business more efficiently.

Among the pre-COVID-19 data in Table 5, only one factor, the passenger load factor (PLF), positively affected the total asset turnover (TATR) at a significance level of 0.05. The number of aircraft (ACT) harms the return on assets (ROA) at a significance level of 0.05. Because the aircraft is a high-value asset, the company will return the capital from the investment in the purchase or lease of the aircraft, which may take up to 5-10 years. Therefore, increasing the number of aircraft negatively affects the return on assets. Another hand, an increase in the number of aircraft and the interaction term between the number of aircraft (ACT) and the size of the airlines (SIZE) has a positive effect on the return on assets (ROA) at a significance level of 0.05. This is because the difference in the size of the company means that full-service carriers (FSC) have more ability to purchase or lease aircraft than low-cost carriers (LCC). Thus, airlines' size (SIZE) is essential for increasing the number of aircraft (ACT) because of its positive effects on the return of assets.

Moreover, the passenger load factor (PLF) positively affects the current ratio (CR) at 0.05. The airlines' size (SIZE) positively impacts the current ratio (CR) at 0.001. In comparison, the interaction term between the passenger load factor (PLF) and the size of the airlines (SIZE) negatively affected the current ratio (CR) at a significance level of 0.001 during the pandemic crisis.

To increase the load factor, airlines should consider various service innovations. For example, some airlines carried cargo in the passenger seats, which boosted their load factor and contributed to positive financial performance. In the post-pandemic era, the air transport sector should adopt more diverse revenue models, such as introducing premium on-board shopping or private tour packages.

Airlines could also provide exotic travel experiences to customers without the need to travel overseas. As most airline companies reduced or suspended flights to other countries due to COVID-19 restrictions, customers miss the sensation and excitement of traveling abroad. Therefore, "Themed Travel Experience" would satisfy the needs of such a segment of customers.

Another way to increase the number of flights is to provide a unique experience throughout the flight. While the domestic travel package aims to satisfy consumers' needs to travel and invigorate the economy

of the local community, air duty-free shopping service aims to increase the revenue of airlines. Customized recommendation service is aimed at providing suggestions for products that suit the needs of a specific customer. Through an efficient and effective recommendation system, airlines can imitate the customer experience received in shopping malls and increase the number of sales. The recommendation process would require more flight attendants and the intensification of the entire aircraft crew, which would help many employees to return from unpaid leaves. Diversifying the products in a duty-free catalog is another way to increase the demand for in-flight shopping as customers often complain about limited options in duty-free catalogs on board. Moreover, because the information about the product in a catalog is not detailed enough, consumers are often dissatisfied with their purchase experience as they are ultimately misled by the picture they see firsthand. Thus, expanding the range of products sold on board could differentiate flight experiences with certain airlines. For specific customers who prefer shopping online, there is a duty-free sales pickup zone outside the departure gate. In this way, customers can purchase any duty-free goods without traveling abroad.

The findings of this study align with prior research (Anh & Gan, 2021; Budd et al., 2020; Devi et al., 2020; Maneenop & Kotcharin, 2020; Rababah et al., 2020; Achim et al., 2022; Dagli, 2021; Thepchalerm & Ho, 2021), which demonstrates that the financial performance of companies, particularly airlines, is adversely impacted by the COVID-19 pandemic. The restrictions and temporary suspension of airline operations due to the virus's spread result in significant revenue losses.

Comparatively, historical events such as financial crises, the September 11 terrorist attacks, and the severe acute respiratory syndrome (SARS outbreak) have also demonstrated negative associations with companies' financial performance, as evidenced by Drakos (2002), Scheraga (2004), Flouris and Walker (2005), Lee and Warner (2005), Barros and Couto (2013), Stepanyan (2014), and Yaghi (2015).

Additionally, this study reveals a positive correlation between passenger demand and total asset turnover (TATR) because passengers play a vital role in the commercial airline sector, as supported by Ittner and Larcker (1998), Kalemba and Campa-Planas (2019). However, measures imposed by the World Health Organization (2020) during the pandemic, such as mandatory mask-wearing and seat distancing on flights, severely impact airline revenue.

Furthermore, the study identifies interactions between factors such as revenue passenger kilometers and airline size negatively affecting return on equity (ROE), while the number of aircraft (ACT) has adverse effects on both ROA and TATR, as seen in the works by Kalemba and Campa-Planas (2019), Lee (2019). This outcome may be attributed to partial lockdown lifts, enabling airlines to resume operations and making the passenger load factor (PLF) beneficial to TATR. Airlines may need to reduce their aircraft fleet (ACT) to control costs, even incurring parking fees.

This outcome differs from Teker et al.'s (2016) findings, suggesting a positive effect of the number of aircraft (ACT) on ROA.

Conversely, the results of this study contradict Stepanyan (2014) by showing a negative impact of the interaction between passenger load factor (PLF) and airline size (SIZE) on the current ratio (CR), possibly due to airlines facing challenges with working capital and cash flow during the pandemic.

Lastly, the study indicates that passenger load factor (PLF) positively influences total asset turnover (TATR), in contrast to Yaghi (2015), suggesting that airlines may have effectively adapted to optimize asset deployment in the COVID-19 era.

5. Conclusion and Recommendations for the Innovation Strategy

This study analyzed factors affecting the financial performance of 72 airlines during the COVID-19 pandemic. The results show that various operational factors, such as aircraft types and passenger load factors, affected the financial performance during COVID-19. The airline industry has one of the most complex value chains, which has been severely damaged by the pandemic restrictions. Considering this massive impact on domestic livelihoods, additional research is necessary to find solutions for the rehabilitation of local economies through major partnerships of airline companies with domestic airports, hotels, and other businesses. Governments should support efforts for airlines, such as soft loans, to keep the companies running and help the employees survive the crisis. Additionally, airlines must adapt to survive the pandemic by reducing the seat capacity to match the passengers' demand when there is a tendency for another crisis.

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Authors' Contributions

Natthanicha Siriphot conducted this research, including the data analysis, and wrote the initial draft of the manuscript. Ploypailin Kijkasiwat conducted this research, including the literature review and conceptual framework, and wrote the initial and revised draft of the manuscript. Joosung Lee conducted the innovation research and wrote the recommendations in the revised draft of the manuscript.

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