Research on the Airline Industry Airfare Pricing Factors under Difficult Circumstances

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ABSTRACT
Current academic research on airline ticket pricing mechanisms has largely determined that passenger numbers are impacted by a range of variables since various airlines have varied operational expenses. Many concerns have led to substantial changes in airline price for aircraft tickets in the context of the Russian and Ukrainian hostilities and the onset of the COVID-19 pandemic. The purpose of this paper is to examine the variables that affect airline ticket costs. A regression model on airline ticket pricing was attempted after collecting current market data and business annual reports to analyze the characteristics that may be presented in current airline ticket prices, and then doing rigorous data analysis using Python. Results show that this model can be used to calculate 'Airline,' 'Date of Journey,' 'Source,' 'Destination,' 'Total Stops times,' 'Oil price,' 'Dep hour,' 'Dep min,' and 'Arrival hour' in connection to airfare, hopefully supplying airlines with pricing suggestions.

Keywords: *Airline industry, Socioeconomics, Airline ticket pricing, Impact of the epidemic, Covid-19 affect.*

1. INTRODUCTION

The issue that all companies in the airline industry cannot avoid encountering is concerning the pricing of airline tickets. The price of an airline ticket will directly influence the future consumer demand, creating an external incentive for the consumer [1]. In order to ensure that the dynamic pricing can be achieved by airlines, the revenue management (RM) technology is widely used in the airline industry. It can be used to calculate the best offer per seat based on the circumstances that arise during the sale of the ticket, such as route, date and oil price. The application of RM to the dynamic pricing of airline tickets has been proven to increase airline revenues by 2% to 8% [2]. Since the onset of the Covid-19 pandemic, this has impacted the operations and survival of many airlines around the world and has led to the closure of many airlines [3]. The application of RM technology to the dynamic pricing of airline tickets, therefore, seems to need to be re-evaluated.

The goal of this paper is to investigate what elements influence airline dynamic pricing in the current market so that airlines can better match a profit-maximizing airfare offer. This paper will analyze the present airline business using a SWOT model to assist airlines in identifying current market circumstances and providing the foundation for the pricing model estimates provided below for each of the elements that arise. Second, this paper will use Qantas Airline as a case study to improve the dependability of the concerns encountered via various financial data in order to guarantee that it is not unduly concerning. The last section of the paper will be a regression evaluation of the elements that affect the airline price, with the Forward and Backward selection approach utilized to establish the optimum predict model and provide a sound recommendation for the outcome.

2. FACTORS AFFECTING THE AIRLINE INDUSTRY (SWOT ANALYSIS)

2.1 Airline's industry strengths

The emergence of aviation as the most significant industry in the capitalist market has had far-reaching consequences. Despite the fact that passengers may find the flying experience unpleasant, that aircraft punctuality is lower than that of other forms of transportation, and that communication devices should be turned off as much as possible during the trip, airplanes, as an important method of transportation for cross-country travel, are the quickest of all types of transportation and can reduce trip time. According to Figure 1, airplanes go four times

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quicker than high-speed railroads and eight times faster than vehicles on highways. Furthermore, the flight is prepared for take-off using a variety of high-tech testing procedures to assure the safety of the flight, reducing the danger of flying [4]. As a result, airplanes are currently the best means of transport in the world in terms of speed, safety and mass availability.

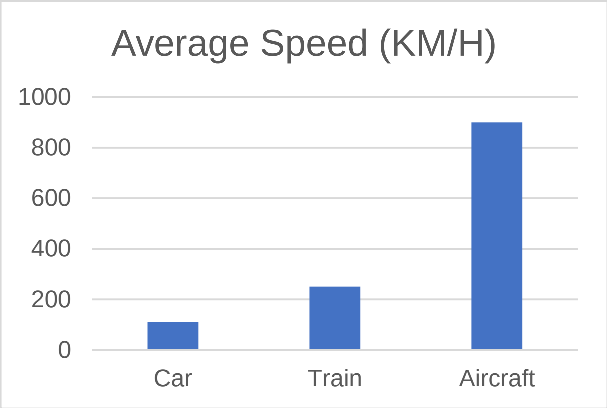

Figure 1 Speed comparison of three vehicles.

2.2 Airline's industry weakness

According to Lee (2013) [5], oil price changes have a positive moderating effect on airlines' operation-related (OR) activities and performance, but a negative moderating effect on non-operation-related (NOR) activities and performance, NOR including interest rate swap and inventory write-downs etc. Therefore, as the impact of oil prices changes, the airlines NOR business will deteriorate the company's performance and therefore oil price volatility is a key factor in airline ticket pricing forecasts. With the current war between Russia and Ukraine and the economic sanctions imposed on Russia by the West, the oil market has been subjected to severe "external shocks", with supply disruptions and increased market uncertainty pushing oil prices to new heights (as shown in Figure 2) [6]. This has led to a need for airlines to re-evaluate the cost of operating each flight and determine whether to radically reduce oil consumption by reducing flight frequency. In addition, airlines need to consider reducing NOR activities to help the company control its financial fundamentals.

Beginning with the COVID-19 outbreak in 2020, the International Air Transport Association called on governments to take bailout measures to help national airlines out of financial crisis and to avoid mass unemployment of airline workers [7]. With the spread of the epidemic, many airlines are being required to maintain social distances on flights, wear masks and test body temperature, among other mandatory measures [5]. This has undoubtedly reduced the consumer demand for travel and made the demand for airfares more inelastic, with only a small number of potential customers choosing to travel because of the compulsions and most consumers being less inclined to travel. In addition, the small space in which aircrews work and the need to be in regular contact with passengers greatly increase the exposure of aircraft crews to health problems that can be caused by viral outbreaks [8]. All these disadvantages show the difficult situation faced by airlines in the event of an epidemic and war.

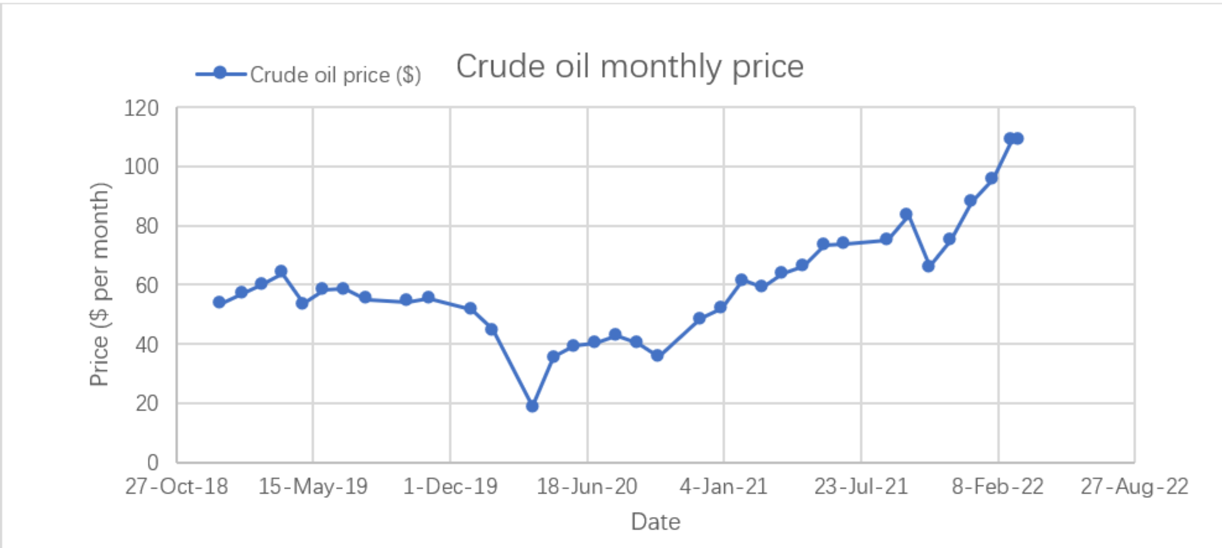

Figure 2 Crude Oil Monthly Price [9].

2.3 Existential opportunity

Several countries have now identified the use of government subsidies for their local aviation industry, mainly in the form of government-backed commercial loans and government guarantees, flight subsidies, tax deferrals or exemptions, and recapitalization of airlines through national equity [10]. Although government subsidies will disguise an increase in government spending and budgets in the coming years, the financial impact of an airline bankruptcy on the country as a local airline company and the high unemployment rate and loss of talent in the airline industry are unacceptable to the national government. Therefore, the fact that the airline is protected by a national macro policy is certainly a strong guarantee. And given that the airline industry itself is a highly competitive market, with each local airline having its own planned international routes, consumers' pre-epidemic ticketing choices could be based on their own preferences. In the aftermath of the epidemic, after the liquidation of the small and medium sized airlines, the larger airlines will have a greater share of the market and with the support of government policy, it will be extremely beneficial for the airline industry to repair its performance [10]. In this sense, air carriers that are currently operating well would be an option that could bring long-term benefits.

2.4 Hidden threats

Following the outbreak, travel restrictions and home-based orders in various countries have undoubtedly had an immediate impact on the airline industry, with some airlines already reducing their expected routes by 90% in 2020 [11]. IATA forecasts that the recovery of air travel is not expected until 2024 [12]. This information will be reflected in the company's share price and financial statements, making airlines underperform in the market for bond issues and fixed income, and investors have low expectations for the current airline industry, preferring to invest in volatile sectors such as healthcare and non-ferrous metals. Despite the support of local governments for airlines, free cash flow for all airlines has become difficult during the epidemic, with more leveraged companies facing greater hardship. Most of the small and medium-sized airlines are now at risk of being bought out or liquidated in bankruptcy. The ability to maintain basic operations until the epidemic returns is now the biggest danger facing airlines [11].

3. CASE: QANTAS AIRLINE

3.1 Background

Registered in Queensland, Australia in 1920, Qantas is one of the world's leading long-haul carriers and the strongest brand in the Australian aviation industry [13]. It employs around 29,000 people worldwide and operates primarily in Australia, New Zealand, and Asia, with branches in the United States and the United Kingdom [14]. Qantas has opened a special branch, Jetstar, to provide a full range of services to short and long-haul travelers, to provide low-cost short haul services and to expand Qantas' market share in its home country [15].

Figure 3 Qantas Group's Brand Matrix [15].

3.2 Financial data

For Qantas' financial position, the following assumptions need to be made. Firstly, for the Debt/Equity (D/E) ratio, all data collection for debt and equity is calculated using market prices. Secondly, as Qantas debt information is not available in the market, it is not possible to measure the market value of debt for the D/E ratio calculation, so it is necessary to assume that the debt booking value of the company is used, calculated by using long term debt plus short-term debt, and to ensure that the debt calculated is the best bearing debt. Thirdly, when collecting equity data, it is assumed that the annual share price cut-off date is 30 June and the stock close price is used to determine the share price. Finally, it is assumed that the current market value of the company is equal to the market value of equity. The analysis of the company is based on these assumptions.

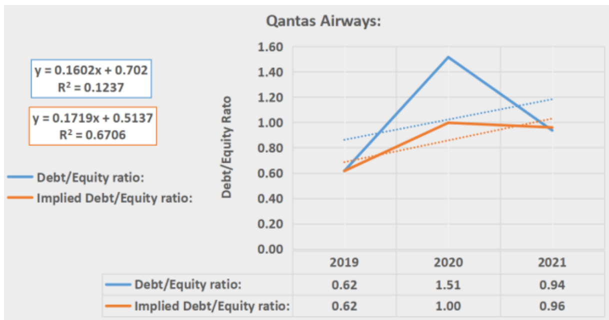

Figure 4 Qantas Airline Debt/Equity ratio (Implied) [17].

As seen in Figure 4, the calculation gives Qantas airline a Debt/Equity ratio of 0.62, 1.51 and 0.94 for 2019, 2020 and 2021 respectively. It is clear to see that Qantas airline's leverage has increased significantly after the Covid-19 outbreak and has reached twice its pre-epidemic level. Trade-off theory is the optimal capital structure that seeks to minimize a firm's cost of capital by striking a balance between the increase in enterprise value achieved through debt issuance and the risk cost associated with rising debt. Each company has a target D/E ratio and strives to achieve it [16]. The company's short-term cost of risk has increased due to the epidemic and may not achieve its target D/E ratio in the short term, but the data for 2021 demonstrates that Qantas airline has a user trade-off theory and is doing its best to bring the cost of risk level back to the target level.

4. AIRFARE REGRESSION MODEL ANALYSIS

4.1 Basic data generalization

In order to better understand and predict the fluctuations in airfares due to the factors that influence them, this paper uses the "Flight Fare Perdition" (n.d.) [18] data to ensure the authenticity of the data source, as the official public database discloses the data to the public. The data was obtained and processed using python tools to remove any invalid values, leaving total 7920 valid data sets. As the above analysis shows that the impact of oil prices on airfares is significant, this paper uses Yahoo Finance's historical oil price order to match the Crude Oil price for a given date using excels VLOOKUP algorithm, making the use of the data more reliable [9]. Therefore, the following factors influence the price of a ticket: airline, travel dates, source, destination, total stop time, oil price, duration time and arrival time.

4.2 Original regression model

To continuously optimize the model and to confirm the validity of the forecast data, a base model with price as the dependent variable and oil price as the independent variable was developed and the 7,920 data sets were divided into a training set and a testing set. The model does not fit well, the adjust R-squared analysis shows that the model only fits 2.8% of the data and the root mean square (RMS) is 4689.0362, so there is still room for improvement in the base model.

4.3 Predict optimal regression model algorithm – Forward and Backward selection

The Forward and Backward selection algorithms were used to optimize the model in this paper. The Forward selection algorithm guarantees that the regression model is a good match for the data by adding additional components to the base model in order to attain a better adjusted R-square value. Consequently, an optimum pricing model that is far more matched to the data is produced. To produce the optimal model, the backward selection process adds all of the components to the base model and removes those that result in lower adjusted R-square values. In other words, reducing components improves the model's fit. The identical final price regression model was developed in this article by applying the Forward and Backward selection techniques.

5. RESULTS AND ANALYSIS

As shown in Figure 5, by using Forward and Backward analysis and testing on the training data set, a final Adjusted R-square of 0.724 was obtained, demonstrating that the optimal prediction model was able to fit 72.4% of the data, a significant improvement on the base model of 2.8%. To ensure the integrity of the test, the final model was used to test the testing data set and the final Adjusted R-square was 0.744, similar to that obtained from the training data, demonstrating that the factors obtained from this model can be applied to the true prediction. In addition, assuming a significance level of α=0.05, the null hypothesis that the difference between samples is due to sampling error is set at a P_value of 0.000, thus rejecting the null hypothesis. Finally, the root-mean-square error was also significantly reduced compared to the base model, from 4689.0362 to 2496.9385, which means that the deviation between the expected and true values of this model was significantly reduced.

The optimal linear regression model is shown below.

$$
\begin{aligned}
&\text{Price} \\
&= 1782.1068\ \text{Airline(T. Air India)} \\
&+ 137.1068\ \text{Airline(T. GoAir)} \\
&+ 416.5254\ \text{Airline(T. IndiGo)} \\
&+ 4689.0544\ \text{Airline(T. Jet Airways)} \\
&+ 44590\ \text{Airline(T. Jet Airways Business)} \\
&+ 3868.4306\ \text{Airline(Carriesrs)} \\
&+ 6614.2289\ \text{Airline(T. Multiple carriesrs Premium economy)} \\
&- 13.1519\ \text{Airline(T. SpiceJet)} \\
&- 4773.6655\ \text{Airline(T. Trujet)} \\
&+ 2524.5267\ \text{Airline(T. Vistara)} \\
&- 4181.1196\ \text{Airline(T. Vistara Premium economy)} \\
&- 9718.0002\ \text{DateOfJourney(T. 2019.3.12)} \ldots \\
&- 206.3122\ \text{Destination(T. Cochin)} \\
&- 907.2817\ \text{Destination(T. Delhi)} \\
&- 2093.0823\ \text{Destination(T. Hyderabad)} \\
&- 560.7469\ \text{Destination(T. Kolkata)} \\
&+ 483.2310\ \text{Destination(T. New Delhi)} \\
&- 46.5910\ \text{OilPrice} + 2607.7908\ \text{TotalStop} \\
&- 14.5710\ \text{ArrivalHour} - 3.6778\text{DepMin} \\
&+ 11.7928\ \text{DepHours} + 16530.4
\end{aligned}
$$

OLS Regression Results

Dep. Variable:	Price	**R-squared:**	0.726
Model:	OLS	**Adj. R-squared:**	0.724
Method:	Least Squares	**F-statistic:**	363.6
Date:	Sun, 06 Mar 2022	**Prob (F-statistic):**	0.00
Time:	16:42:27	**Log-Likelihood:**	-58615.
No. Observations:	6345	**AIC:**	1.173e+05
Df Residuals:	6298	**BIC:**	1.176e+05
Df Model:	46		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	1.653e+04	381.510	43.337	0.000	1.58e+04	1.73e+04
Airline[T.Air India]	1782.1068	212.825	8.374	0.000	1364.897	2199.317
Airline[T.GoAir]	137.7618	305.122	0.451	0.652	-460.381	735.905
Airline[T.IndiGo]	416.5254	205.962	2.022	0.043	12.769	820.282
Airline[T.Jet Airways]	4689.0544	199.785	23.470	0.000	4297.408	5080.701
Airline[T.Jet Airways Business]	4.459e+04	1145.386	38.932	0.000	4.23e+04	4.68e+04
Airline[T.Multiple carriers]	3686.4306	220.731	16.701	0.000	3253.723	4119.139
Airline[T.Multiple carriers Premium economy]	6614.2289	760.620	8.696	0.000	5123.154	8105.304
Airline[T.SpiceJet]	-13.1519	224.487	-0.059	0.953	-453.222	426.918
Airline[T.Trujet]	-4773.6655	2512.739	-1.900	0.058	-9699.490	152.159
Airline[T.Vistara]	2524.5267	248.046	10.178	0.000	2038.273	3010.781
Airline[T.Vistara Premium economy]	-4181.1196	2521.986	-1.658	0.097	-9125.072	762.833
Date_of_Journey[T.2019/3/12]	-7918.0002	305.785	-25.894	0.000	-8517.443	-7318.557
Date_of_Journey[T.2019/3/15]	-3.625e-11	2.05e-11	-1.766	0.077	-7.65e-11	3.98e-12
Date_of_Journey[T.2019/3/18]	-8705.6617	292.186	-29.795	0.000	-9278.445	-8132.878
Date_of_Journey[T.2019/3/21]	-1.104e+04	251.889	-43.838	0.000	-1.15e+04	-1.05e+04
Date_of_Journey[T.2019/3/24]	-8885.3415	259.701	-34.214	0.000	-9394.444	-8376.239
Date_of_Journey[T.2019/3/27]	-1.123e+04	276.788	-40.584	0.000	-1.18e+04	-1.07e+04
Date_of_Journey[T.2019/3/3]	2.417e-11	2.62e-12	9.209	0.000	1.9e-11	2.93e-11
Date_of_Journey[T.2019/3/6]	-5417.1010	256.089	-21.153	0.000	-5919.124	-4915.078
Date_of_Journey[T.2019/3/9]	3.23e-13	3.5e-12	0.092	0.927	-6.54e-12	7.19e-12
Date_of_Journey[T.2019/4/1]	-1.047e+04	281.714	-37.175	0.000	-1.1e+04	-9920.517
Date_of_Journey[T.2019/4/12]	-1.441e-12	3.18e-12	-0.453	0.650	-7.67e-12	4.79e-12
Date_of_Journey[T.2019/4/15]	-9659.0987	364.162	-26.524	0.000	-1.04e+04	-8945.218
Date_of_Journey[T.2019/4/24]	-9815.9288	349.979	-28.047	0.000	-1.05e+04	-9129.851
Date_of_Journey[T.2019/4/27]	-3.66e-12	1.37e-12	-2.675	0.007	-6.34e-12	-9.78e-13
Date_of_Journey[T.2019/4/3]	-1.044e+04	347.353	-30.056	0.000	-1.11e+04	-9759.242
Date_of_Journey[T.2019/4/6]	-8.595e-12	3.06e-12	-2.805	0.005	-1.46e-11	-2.59e-12
Date_of_Journey[T.2019/4/9]	-1.028e+04	332.164	-30.956	0.000	-1.09e+04	-9631.376
Date_of_Journey[T.2019/5/1]	-9195.6020	276.750	-33.227	0.000	-9738.126	-8653.078
Date_of_Journey[T.2019/5/12]	-9225.7455	284.627	-32.413	0.000	-9783.712	-8667.779
Date_of_Journey[T.2019/5/15]	-9093.8985	258.153	-35.227	0.000	-9599.967	-8587.830
Date_of_Journey[T.2019/5/18]	8.022e-12	1.15e-12	6.949	0.000	5.76e-12	1.03e-11
Date_of_Journey[T.2019/5/21]	-8968.1362	254.590	-35.226	0.000	-9467.220	-8469.052
Date_of_Journey[T.2019/5/24]	-4.065e-12	3.2e-12	-1.269	0.204	-1.03e-11	2.21e-12
Date_of_Journey[T.2019/5/27]	-9135.1447	267.915	-34.097	0.000	-9660.350	-8609.939
Date_of_Journey[T.2019/5/3]	-1.556e-12	1.38e-12	-1.125	0.261	-4.27e-12	1.15e-12
Date_of_Journey[T.2019/5/6]	-9312.5325	278.440	-33.445	0.000	-9858.370	-8766.695
Date_of_Journey[T.2019/5/9]	-9002.1348	256.273	-35.127	0.000	-9504.516	-8499.753
Date_of_Journey[T.2019/6/1]	5.729e-13	3.27e-13	1.753	0.080	-6.78e-14	1.21e-12
Date_of_Journey[T.2019/6/12]	-1.017e+04	274.328	-37.059	0.000	-1.07e+04	-9628.622
Date_of_Journey[T.2019/6/15]	-4.214e-13	2.37e-13	-1.780	0.075	-8.85e-13	4.26e-14
Date_of_Journey[T.2019/6/18]	-9752.7140	366.664	-26.599	0.000	-1.05e+04	-9033.928
Date_of_Journey[T.2019/6/21]	-1.601e-13	9.69e-14	-1.652	0.099	-3.5e-13	2.99e-14
Date_of_Journey[T.2019/6/24]	-9818.0878	275.299	-35.663	0.000	-1.04e+04	-9278.408
Date_of_Journey[T.2019/6/27]	-9903.5219	272.199	-36.383	0.000	-1.04e+04	-9369.920
Date_of_Journey[T.2019/6/3]	-9535.8962	286.774	-33.252	0.000	-1.01e+04	-8973.721
Date_of_Journey[T.2019/6/6]	-9443.1753	269.604	-35.026	0.000	-9971.690	-8914.660
Date_of_Journey[T.2019/6/9]	-9489.1192	271.885	-34.901	0.000	-1e+04	-8956.133
Destination[T.Cochin]	-206.3122	97.122	-2.124	0.034	-396.705	-15.920
Destination[T.Delhi]	-907.2817	134.228	-6.759	0.000	-1170.414	-644.150
Destination[T.Hyderabad]	-2093.0823	151.183	-13.845	0.000	-2389.452	-1796.713
Destination[T.Kolkata]	-560.7469	202.612	-2.768	0.006	-957.935	-163.559
Destination[T.New Delhi]	483.2310	168.621	2.866	0.004	152.676	813.786
Oil_price	-46.5910	4.407	-10.572	0.000	-55.231	-37.951
Total_Stops	2607.7908	73.060	35.694	0.000	2464.569	2751.013
Arrival_hour	-14.5710	4.694	-3.104	0.002	-23.773	-5.369
Dep_min	-3.6778	1.762	-2.088	0.037	-7.131	-0.224
Dep_hour	11.7928	5.691	2.072	0.038	0.636	22.950

Omnibus:	4246.169	**Durbin-Watson:**	1.993
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	330215.971
Skew:	2.446	**Prob(JB):**	0.00
Kurtosis:	38.001	**Cond. No.**	4.15e+16

Figure 5 OLS Regression Results.

6. CONCLUSION

The paper concludes that the base price of airfares is $16530.4, which means that if there were no factors affecting airfares, the base price of airfares would be $16530.4, which is a deviation from the true value due to the fact that most of the data is for international flights and the reduction in prices due to other factors is significant. This is in line with Lee's (2020) [19] theory that oil price fluctuations lead to lower OR activity, but an analysis based on in-depth airline data is required to determine whether this increases the cost of spending on NOR. Based on the analysis above, this paper suggests that airlines should recognize the current trend in international oil prices, which is mainly affect for the cost of spending on airlines NOR activities. Secondly, in an epidemic environment, it may be appropriate to increase the company's D/E ratio, such as Qantas Airline, to increase debt in order to maintain the company's basic operations, which can be a critical aid to the retention of airline talent at the end of the epidemic and the recovery of the airline industry after the end of the epidemic.

This paper suffers from the fact that the regression model was only predicted on the given factors and was not optimized between individual factors and prices, and more consideration needs to be given to how individual factors can be further optimized in future analyses. The data sources used to forecast prices are not based on official disclosures and are less accurate than the airlines' internal data, so there is much room for optimization of this optimal model. In future studies, attention could be focused on the hazards that oil price fluctuations can have on airlines and how these hazards can be magnified or minimized in the case of an epidemic.

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