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## Article

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# The Impact of the COVID-19 Pandemic on the Performance and Risk Profile of Airline Stocks

Huan Huu Nguyen<sup>1</sup>, Truc Thi Nha Phan<sup>2</sup>, Vu Minh Ngo<sup>1</sup>

## ABSTRACT

The COVID-19 outbreak dealt a severe blow to the global economy, especially to the airline industry, due to worldwide lockdown measures implemented by the authorities. This paper aims to investigate the impact of the COVID-19 pandemic on the airline stock performance of seven markets in Asia and three other markets in Australia, Germany and the United States. The data is collected from 42 airline firms from 2019 to 2020. The research outcomes indicate that: (a) COVID-19 only temporarily impacts stock returns; (b) Market values plunge immediately after the first confirmed case, and it still shows no evidence of returning to the price levels before the outbreak; (c) COVID-19 has a significant impact on stock volatility; (d) Most stocks do not illustrate any higher exposure to systematic risks.

## KEY WORDS:

COVID-19, pandemic, airline stock return, risk performance.

**JEL Classification:** G14, G15, L93.

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## 1. Introduction

The Severe Acute Respiratory Syndrome (SARS-1) event, which the World Health Organisation (WHO) announced in March 2003, had significant impacts on the global economy. SARS-1 swept on many countries and left the consequence not only on human health but also on many industries, especially the aviation sector (Nippani & Washer, 2004; Loh, 2006). Humanity currently faces the new global pandemic announced by WHO as the SARS -COVID-19 (COVID-19). Firstly, Wu Han, a city in China, announced the outbreak. Then, Korea, Japan, Singapore, and Asia recorded the increasing numbers each hour. It becomes unstoppable when the number of infected people rises in Italy, England, France, then escalate in Europe and the Americas and Africa.

The new influenza pandemic is unlike the previous ones, in which its trend hits the peak and stops dead

in its tracks. More than half a year after the outbreak in China, COVID-19 still wreaks havoc on nearly all continents. The lockdown decision from governments, aiming to stop spreading the epidemic to the public, hurts the aviation industry hardly because most international and domestic flights were not allowed. Around 95% of the flights were cancelled in eighteen airports in the Middle East and the Asia Pacific (Airports Council International [ACI], 2020). The US airline stock prices were dropped by 30% in three months (Assis, 2020). International air transport association reported loss worse than the 2008 financial recession and predicted that the profits in 2021 are approximately minus \$390 billion (Dunn, 2020; WorldBank, 2020).

The adverse effects of COVID-19 do not contain in one country or one continent but spread out of the nation's border. People were deep in crisis when governments worldwide decide to protect their countries

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with strong measures such as social isolation, closing economy for months. These actions would have a significant influence on the aviation industry. The Airport Council International predicts that the number of passengers will fall to less than half the last year's figure. Comparing to 2019, the sales of airports plunge 57% (-137.7 in billion US. Dollar) and continue negative profit at -51.8 billion US. Dollar at the end 2020 (International Civil Aviation Organization [ICAO], 2020). The revenue passenger kilometers of both domestic and international drops down 54.7% and 75% compared to 2019 volume (Airports Council International (ACI, 2021) The fall in global tourism is 75.6% because travel restrictions were enacted all over the world (International Monetary Fund [IMF], 2020); the plunge of the global logistic volume is 32% (World Trade Organization [WTO], 2020); the world GDP reduces 5.2% during the epidemic crisis. Moreover, the disease is still enduring and does not show any downtrend.

Although some articles debate the harm of COVID-19 on various economic activities, a little effort has been made to investigate the impact of COVID-19 on aviation stock performance by using event studies to check the occurrence before and after the first case announcement. For instance, Loh (2006) examines the airline stocks that have been affected by the Severe Acute Respiratory Syndrome (SARS). Furthermore, a recent study conducted the influence of COVID-19 on employment in the airline industry (Sobieralski, 2020). Maneenop and Kotcharin (2020) use the event research methods to investigate the short-term impact of the COVID-19 epidemic on 52 publicly traded airline firms worldwide.

Given the gap in the empirical evidence, this paper aims to test the relationship between COVID-19 and aviation stock performance. The H1N1 virus pandemic of 1918–1920 is still the deadliest pandemic of the modern era. Estimates of how many people died from the pandemic range from 17 million to 100 million, which is about a third of the world's population at the time (Taubenberger et al., 2006). COVID-19 has killed over 2.1 million people; however, these figures could be significantly higher because of reporting inconsistencies between nations and how people in many parts of the world report symptoms and deaths. About 100 million people have been infected with

SARS-CoV-2, and 2.1 million people have died with COVID-19 (WHO 2021). Many people have perished due to COVID-19, but the exact death toll will take years to determine. The Coronavirus pandemic (COVID-19) can be seen as the third outbreak of a coronavirus, after SARS and MERS-CoV. Moreover, the market values are at low levels immediately after the outbreak, as shown in Figure 1, suggesting that it is necessary to examine the influence of COVID-19 on the performance, market value, volatility and return of the aviation stocks.

Our paper contributes to the related literature in several aspects. First, the study seeks to address how the disease affects aviation stock's return and market value. Second, we undertook this study to broaden current knowledge on the impacts of COVID-19 on airline stocks volatility. Finally, the paper sheds new light on the stability of the systematic risk component of airline stocks related to the epidemic crisis.

The findings comprehend all research questions and can be encapsulated as follows: (a) COVID-19 has a short-term effect on aviation stock returns; (b) since WHO announced the pandemic, the market returns of aviation listed firms of six countries dropped down immediately and show no signs of recovery; (c) there is a strong relationship between stock volatility and COVID-19; and (d) Not all stocks have a high systematic risk factor (beta) during the epidemic crisis.

The paper's structure is categorised as follows: The second section discusses the literature review and hypotheses development, the methodology and data are presented in the next section, followed by the empirical results, last, but not least is the conclusion and implication of the research.

## 2. Literature Review and Hypotheses Development

The efficiency market hypothesis (EMH) is a standard financial theory that states that stock prices reflect all available information and arbitrage activities that lead to market equilibrium (Fama, 1970). Neither individual nor institution can get abnormal returns on the market unless undervalued or overvalued stocks. Therefore, investors are assumed to be rational investors since published information can immediately impact the stock price. Numerous studies are investigat-

ing the influential efficiency market hypothesis and the price of stock return when facing global shocks such as the financial recession, oil crisis, and disasters crisis. Since the informational market efficiency during a global shock is critical, investors rely on the news to decide profitable results.

Moreover, a less restrictive interpretation of EMH allows market participants who invest resources in acquiring information that may assist them in forecasting returns (Grossman & Stiglitz, 1980). However, it has been discovered that such return predictability is limited to concise time horizons, and an efficient market can not be adopted in the long term (Chordia, Roll & Subrahmanyam, 2005). Ghazani and Ebrahimi (2019) analyse the responsive market hypothesis theory of the oil market. El Khamlichi et al. (2014) analyse a financial market study to investigate the random walk hypothesis. Lazăr et al. (2012) examine the effects of the 2008 global financial crisis on the degree of information efficiency in currency markets. Qiao et al. (2019) conclude that when oil prices fall, oil stocks tend to be overvalued, which contradicts the efficient market hypothesis. These theories have been blamed for the financial crisis due to their part in the “chronic underestimate” of the risks that bubble assets offer to individual investors and financial executives, and regulators. The bubble formed because the financial system was dominated by efficiency market hypothesis obsessed price-takers who failed to check actual asset values appears to be at odds with reality, despite academic and empirical studies proving that active managers fail to beat the market (Ball, 2009). Over the years, several anomalies (asymmetric information, investor sentiment, timing anomalies, and crises) have been observed that contradict the idea of efficient markets. Nevertheless, fewer papers investigate the link between the efficient market hypothesis and airline's stock return during the global crisis, especially in this case is COVID-19.

This paper investigates the relationship between the contagious COVID-19 and the stock returns. When WHO announces the pandemic, how does this information affect the airline stock prices and returns? Does the market follow EMH? Several studies show that COVID-19 touches the global

economy and individual markets and firms. Especially in the tourism industry, the prolongation of the disease significantly influences its growth (Holland et al., 2003). The aviation industry is expected to drop 51% seats if the virus remains in Dec 2020 (ICAO, 2020).

The adverse consequence of COVID-19 causes fluctuation in share prices in many stock exchanges, where the aviation sector has been hit hard in recent times (Gormsen & Kojien, 2020; Ramelli & Wagner, 2020). According to ITA (2020), COVID-19 is unlike any previous diseases humanity has gone through in the past two decades. Typically, during a world health recession, the stock price of American Airlines chokes off an average of 11% on June 25 (Fonda, 2020). United Airlines finishes at 23.3%; Southwest airline declines around 4%; China Eastern airline drops about 24% over the past three months; China Southern airline is down around 22% compared to January. Qantas shares bead 54% in March 2020; Virgin airline is an Australian aviation company down 51%, Air New Zealand fails 41% over this month (Josephs, 2020; Rapoza, 2020; Cullinane, 2020). Therefore, the testable hypotheses are:

**H1:** The disease news does not affect stock returns

**H2:** COVID-19 does not affect the market values of the airline listed firms

The information about the coronavirus affects the stock market volatility more than previous diseases (Gormsen & Kojien, 2020; Yilmazkuday, 2020; Baker et al., 2020). From the moment of the first confirmed case in China in December 2019 until now, more than 15 million people in 60 countries have been infected. The daily report about new infections knocks out the Shanghai stock market about -8,05% in February 2020 and steadily affects other securities markets. The US stock market recorded the lowest Dow Jones Industrial Average level in March 2020, and it is the worst day in the US stock market saga.

Since investors are afraid of the new influenza pandemic, the wave of selling off stocks causes market fluctuations and leads to extraordinary

volatility. Although the Fed conducts the fiscal stimulus package to soothe the market, COVID-19 still affects the stock stability (Gormsen & Kojien, 2020).

After an initial market meltdown, global financial markets' surprising behaviour raises several intriguing concerns. The COVID-19 epidemic began in China in January 2020 and quickly spread to South Korea, Iran, and Italy in late February. The United States declared a national emergency on March 13 to combat the alarming increase of cases. Approximately 35% of the market value of the G20 stock markets was wiped out over this brief period (Smales, 2021). However, major stock markets began to reverse course around a week later. By early June, most markets had recovered more than half of the value lost during the market meltdown, suggesting the possibility of a classic V-shaped rebound.

A similar pattern could be seen in Vietnam, which borders China, which is among the successful cases of COVID-19 prevention and control. Vietnam's stock market index (VN-index) dropped dramatically on March 24, 2020, at 39.23%, when the Vietnam Government announced a social distance policy. However, after finding the last person who had COVID-19 infection, market sentiment was a bit stable. Individual and institutional investors believe more in government policies. As a result, the VN-index climbs up 16.86% after several months, resulting from the stimulus packages of the Vietnam Government used to control market volatility. Therefore, for the third hypothesis, we try to test whether the volatility of stock returns is affected by COVID-19.

This research hypothesises that variations in public attitude on the COVID-19 pandemic are to blame for the extreme volatile behaviour of stock markets throughout the world. One explanation for this phenomenon comes from the intensive coverage of the pandemic on news, multimedia, and social media platforms which create chaos in public sentiments. Existing research, such as Baker and Wurgler (2006), argued that significant low investor sentiment at the outset for specific types of companies might result in better returns in the end, provided that these stock valuations mainly

were subjective. In the context of COVID-19, such an approach was used in a variety of research to investigate not just public attitudes on the pandemic's progression, but also the interconnections between public sentiments and market volatilities in the severe situation of the present financial markets (Sun et al., 2020; Corbet et al., 2020). It can be postulated that:

**H3:** COVID-19 does not affect stock volatility

When observing the COVID-19 influence on the performance of airline stocks, it is necessary to investigate the relationship between the risk component and stock returns. According to Sharpe (1964), the Capital Asset Pricing Model (CAPM) illustrates the relationship between risk and stock return, and the beta coefficient of investment is the measure to value the sensitivity of stock to the market portfolio. The outbreak of COVID-19 is not a unique, idiosyncratic risk that affects only a specific firm, sector or country that can be eliminated using diversification. COVID-19, however, can be seen as a systematic risk. Hence, COVID-19 can increase the sensitivity of stock returns concerning the market portfolio returns, especially the airline stocks return. The results of Loh (2006) and Nippani and Washer (2004) agree that the systematic risk component impacts the aviation industry during the SAR-1 epidemic. Thus, we postulate the fourth hypothesis:

**H4:** COVID-19 does not influence the systematic risk component of airline stocks

### 3. Methodology and Data

#### 3.1. Empirical Methodology

To test the first hypothesis that the COVID-19 does not influence the mean returns of airline stocks, we apply the conventional t-test. This hypothesis is tested using actual return for some reasons. First, because abnormal returns are dependent on the fundamental structure of the local financial market in which the stock is listed (beta, risk-free rate, and mean return on market portfolio), comparing structural changes in returns between airline stocks across different financial

markets using abnormal returns could be biased. Because the sample includes airline stocks from both developing and well-developed financial markets, utilising actual returns allows for a more focused examination of the impacts of the COVID-19 epidemic on the returns of airline stocks independent of the structure of financial markets where they are listed. Second, in this study, we strike to test the structural changes in returns and volatility separately to see different impacts of the COVID-19 pandemic on different components of the risk-return ratio. Using abnormal return compromises this objective because risk (measures by volatilities of stock return) is crucial when calculating abnormal returns.

$$H_0 : E(r_t)_{normal} = E(r_t)_{covid}$$

$$H_1 : E(r_t)_{normal} \neq E(r_t)_{covid}$$

Where  $r_t = \log(P_t/P_{t-1})$  and  $P_t$  is the stock price in period  $t$ . When the standard deviations in the two periods are unknown and different from each other, that is,  $\sigma_{normal} \neq \sigma_{covid}$  the test statistic is given by:

$$t = \frac{\bar{r}_{normal} - \bar{r}_{covid}}{\sqrt{\left(\frac{s_{normal}^2}{n_{normal}} + \frac{s_{covid}^2}{n_{covid}}\right)}} \quad (1)$$

Where  $\bar{r}$  and  $s^2$  are the sample mean return and sample variance.  $T$  follows a Student  $t$  distribution with  $k$  degrees of freedom. According to Welch (1947),  $k$  is given by:

$$k = -2 + \frac{(h_{normal} + h_{covid})^2}{\frac{h_{normal}^2}{n_{normal}+1} + \frac{h_{covid}^2}{n_{covid}+1}}$$

For the second hypothesis, we test whether the volatility of stock returns is affected by the COVID-19.

$$H_0 : \sigma_{normal} = \sigma_{covid}$$

$$H_1 : \sigma_{normal} \neq \sigma_{covid}$$

The test statistic is :

$$F = \frac{s_{normal}^2}{s_{covid}^2} \quad (2)$$

Under the null,  $F$  follows a  $F$  distribution with  $n_{normal} - 1$  and  $n_{covid} - 1$  degrees of freedom. We also use Levene (1961) and Brown and Forsythe (1974) for equal variances. For Levene (1961) 's test, the statistic is given by:

$$W_0 = \frac{\sum_i n_i (\bar{Z}_i - \bar{Z})^2 / (g - 1)}{\sum_i \sum_j (Z_{ij} - \bar{Z}_i)^2 / \sum_i (n_i - 1)} \quad (3)$$

where  $Z_{ij} = |X_{ij} - X_i|$ ,  $X_{ij}$  is the  $j^{th}$  observation of group  $I$ ,  $g$  is the number of groups. The critical values of  $W_0$  can be derived from the Snedecor  $F$ -table with  $g - 1$  and  $\sum_i (n_i - 1)$  degrees of freedom. Brown and Forsythe (1974) propose another robust test for the equality of variance by replacing  $X_i$  with the 10% trimmed mean for group  $i$ .

For the third hypothesis, we test the equality of the systematic risk component of airline stocks, commonly known as the  $\beta$  coefficient. This coefficient compares the covariance between stock return and market's return with the variance of the market's return, thus representing the systematic risk component of stocks. The  $\beta$  coefficient for stock  $i$  can be estimated from the following market model:

$$r_{i,t} - r_{f,t} = \beta_i (r_{m,t} - r_{f,t}) + \epsilon_{i,t} \quad (4)$$

where  $r_{i,t}$  is the return of stock  $i$  at time  $t$ ,  $r_{f,t}$  denotes the risk-free rate,  $r_{m,t}$  is the market return at time  $t$ .

We split our data into two periods: before and after the announcement of the 1st case. Then, we regress Equation 4 for each period:

$$r_{i,t} - r_{f,t} = \beta_{i,normal} (r_{m,t} - r_{f,t}) + \epsilon_{i,t} \quad (5)$$

(before the first case)

$$r_{i,t} - r_{f,t} = \beta_{i,covid} (r_{m,t} - r_{f,t}) + \epsilon_{i,t} \quad (6)$$

(after the first case)

Next, we apply the Chow (1960) stability test:

$$H_0 : \beta_{i,normal} = \beta_{i,covid}$$

$$H_1 : \beta_{i,normal} \neq \beta_{i,covid}$$

with the test statistic

$$F = \frac{(RSS_{full} - (RSS_{normal} - RSS_{covid})) / k}{(RSS_{normal} + RSS_{covid}) / (n_{normal} + n_{covid} - 2k)}$$

where  $RSS_{full}$ ,  $RSS_{normal}$ ,  $RSS_{covid}$  is the sum of squared residuals of Equations 4, 5 and 6, respectively.  $k$  is the number of parameters. This  $F$  follows the  $F$  distribution with  $k$  and  $(n_{normal} + n_{covid} - 2k)$  degrees of freedom.

### 3.2. Data

We select airline stocks listed in ten stock exchanges around the globe. Seven markets in Asia include China, Hong Kong, Japan, the South Korea, Singapore, Thailand, and Vietnam. Three other markets are Australia, Germany, and the United States. The stocks must be traded on a daily basis before and during the COVID-19 outbreak.

For each market, we select the following indices: The Shanghai Stock Exchange (SSE) Composite Index for China, the Hang Seng Index for Hong Kong, The Nikkei 225 Index for Japan, The KOSPI Composite Index for South Korea, The Straits Times Index (STI) for Singapore, The SET Index for Thailand, the Vietnam Index for Vietnam, The S&P/ASX 200 index for Australia, the DAX Index for Germany, and the S&P 500 Index for the United States. The airline stocks collected for each stock market are reported in Table A1 in the Appendix.

We collect daily closing prices from the site <https://finance.yahoo.com/> and calculate daily returns for each stock from January 01 2019, to June 26 2020. The dates of the first confirmed COVID-19 case in each country are reported in Table A2 in the Appendix.

Figure 1 shows the stock prices patterns in the entire

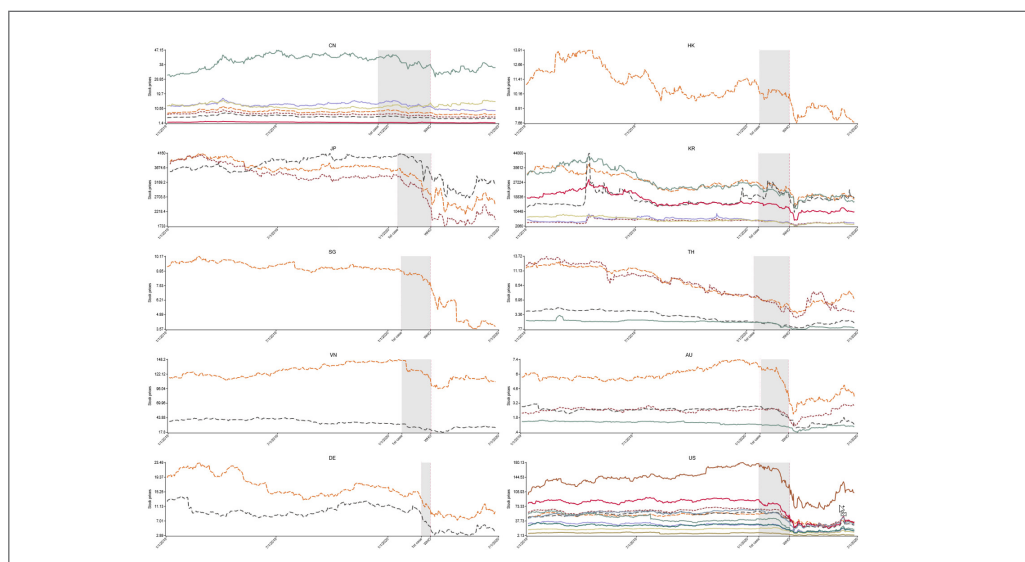
sample. For each market, we highlight the period between the first confirmed case in that market and the time of the official announcement of WHO about the COVID-19 pandemic. It is apparent from Figure 1 that the prices in all markets show a downward trend right after the first discoverer case of COVID-19. Furthermore, it can be seen that this declining trend has not been reversed. Stock prices reached the lowest point in March, after the official announcement of WHO about the pandemic. Figure 2 depicts the volatility of the stock returns. The graph shows that stock returns fluctuated dramatically during the COVID-19 outbreak. Volatility during the pandemic is higher than in the period before. We observe a significant difference in volatility in Japan, Singapore, Thailand, Vietnam, Australia, Germany, and the United States.

## 4. Empirical results

### 4.1. Does COVID-19 Hit Stock Returns and the Firm's Market Capitalisation?

Table 1 summarises the results of the t-test for equality of mean returns in two sub-samples. For conciseness, we only report the two-tailed test statistic defined in Equa-

**Figure 1**  
*Stock Prices of Airline Firms in Asia 2019–2020*





tion 1 for each stock in Table 1. More details are shown in Table A3 in the Appendix. Table A3 will report the sample mean returns for all the sub-samples. Moreover, we test the equality of mean returns using two different windows to check robustness: the short window is defined as the period spanning ten days after the discovery of the first case in each country, and the long window is the period from the confirmation of the first case to the last day of the sample. The t statistics are reported for both short and long windows.

The results from Table A3 show that most stocks have negative mean returns after discovering COVID-19 in their country. However, our study has only 14 over 42 airline stocks with significantly unequal mean returns prior to and during the COVID-19 pandemic. Airline stock returns are severely affected by the COVID-19 discovery in Japan, Vietnam, Australia, Germany, and the United States. Australia and the United States are the two most vulnerable markets to the COVID-19 outbreak.

The efficient market hypothesis postulates that stock prices reflect all available information, and stock returns tend to return to equilibrium when an exogenous shock hits the market. Thus, it is also essential to look at the be-

haviour of stock prices. We note from Figure 1 that stock prices in most countries in the study have a common tendency to stay at a lower equilibrium price after the announcement of the first case of COVID-19. Therefore, if stock prices stay at a lower equilibrium during the outbreak, airline firms will suffer considerable market capitalisation losses. Consequently, it is relevant to test inequality in mean price prior to and during the outbreak.

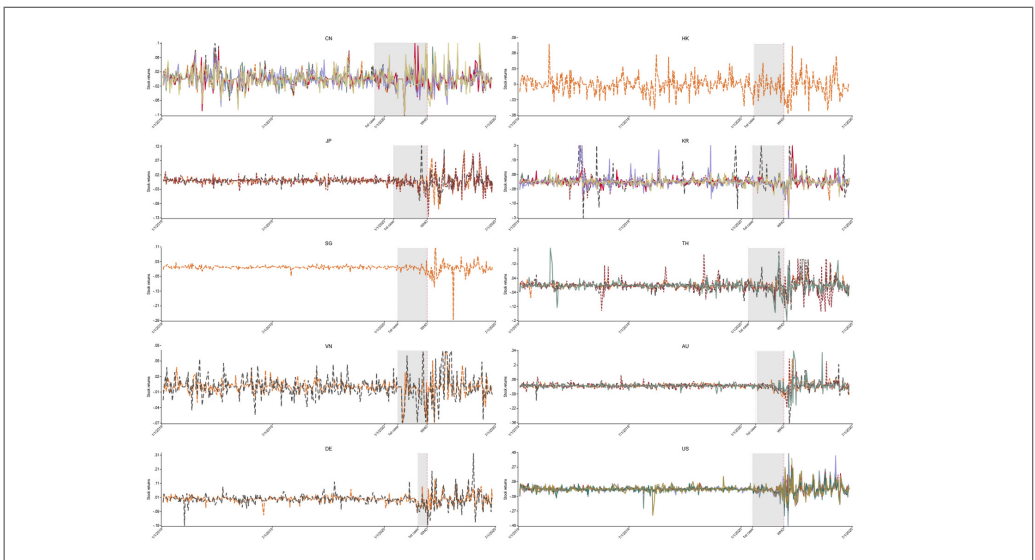
$$H_0 : E(p_t)_{normal} = E(p_t)_{covid}$$

$$H_1 : E(p_t)_{normal} \neq E(p_t)_{covid}$$

Table 2 reports the results for the test of difference in the mean prices of 42 airline firms in the sample. The findings show a significant difference in mean prices before and after the announcement of the first case. It appears that the COVID-19 outbreak has a severe impact on the market capitalisation of airline firms. Table A4 details the results of the difference in the mean prices test. We detail the mean prices in both periods and the test statistics.

In contradiction with earlier findings Loh (2006); Nippani and Washer (2004), we find that the discovery of COVID-19 severely hit the stock markets, especially the market values of airline firms. Loh (2006) argues that the

**Figure 2**  
Stock Returns of Airline Firms in Asia 2019–2020





**Table 1***Mean Returns of Airline Stocks Before and During COVID-19*

China						
CN601111SS	CN600115SS	CN600029SS	CN601021SS	CN600221SS	CN603885SS	CN002928SZ
.672	.798	.63	1.004	-.37	.482	-.93
Hong Kong						
HK0293HK						
.479						
Japan						
JP9202T	JP9206T	JP9201T				
1.968*	.934	2.995***				
South Korea						
KR003490KS	KR003495KS	KR020560KS	KR089590KS	KR272450KS	KR298690KS	KR091810KS
.642	.08	1.639	.902	1.227	1.412	1.546
Singapore						
SGSGXC6L						
1.276						
Thailand						
THBABK	THAAVBK	THTHAIBK	THNOKBK			
.668	.5	1.13	1.391			
Vietnam						
VNVJC	VNHVN					
2.248**	1.565					
Australia						
AUQANAX	AUAIZAX	AUAQZAX	AUREXAX			
2.01*	2.792***	2.008*	1.007			
Germany						
DELHADE	DETUI1DE					
1.518	3.433***					
US						
USLUV	USDAL	USALK	USSAVE	USUAL	USAAL	USJBLU
1.254	1.89*	1.518	1.979*	1.909*	1.435	1.235
USALGT	USSKYW	USHA	USMESA			
1.84*	2.115**	2.462**	2.046**			

SARS outbreak only causes emotional distress and does not significantly impact the economy. However, this argument is not valid for the case of COVID-19. As can be seen from the results, the consequences of COVID-19 are more severe, notably for the airline industry because lockdown measures have been implemented worldwide. The same results from Endri et al. (2021) conclude that COVID-19 has a negative impact on abnormal returns, and JCI volatility fluctuates significantly during the COVID-19 event.

#### **4.2. Does Stock Return Become More Volatile During the COVID-19 Pandemic?**

We continue by investigating the risk of individual airline stocks during the COVID-19 outbreak. As can be seen from Figure 2, stock returns in most markets become extremely volatile after the announcement of the first COVID-19 case, especially after 11 March 2020, when WHO officially admitted that COVID-19 had become a world pandemic.

**Table 2**  
Mean Prices of Airline Stocks Before and During COVID-19

China						
PCN601111SS	PCN600115SS	PCN600029SS	PCN601021SS	PCN600221SS	PCN603885SS	PCN002928SZ
12.625***	16.932***	19.983***	8.555***	21.871***	10.311***	-7.123***
Hong Kong						
PHK0293HK						
21.226***						
Japan						
PJP9202T	PJP9206T	PJP9201T				
24.159***	11.524***	24.635***				
South Korea						
PKR003490KS	PKR003495KS	PKR020560KS	PKR089590KS	PKR272450KS	PKR298690KS	PKR091810KS
21.587***	-4.86***	16.517***	25.413***	22.858***	21.619***	25.32***
Singapore						
PSGSGXC6L						
18.839***						
Thailand						
PTHBABK	PTHAABK	PTHTHAIBK	PTHNOKBK			
31.036***	31.115***	29.773***	25.027***			
Vietnam						
PVNVJC	PVNHVN					
10.904***	32.671***					
Australia						
PAUQANAX	PAUAIZAX	PAUAQZAX	PAUREXAX			
14.108***	17.101***	5.275***	23.463***			
Germany						
PDELHADE	PDETUIIDE					
35.577***	35.777***					
US						
PUSLUV	PUSDAL	PUSALK	PUSSAVE	PUSUAL	PUSAAL	PUSJBLU
13.602***	14.786***	15.805***	19.758***	20.713***	20.98***	11.828***
PUSALGT	PUSKYW	PUSHA	PUSMESA			
9.932***	16.011***	16.988***	17.627***			

Table 3 details the standard deviations of stock returns before and after the outbreak and the difference in variance test results. We report three test statistics for equality of variance: the F statistics in Equation 2, the Levene (1961) statistic in Equation 3 and the Brown and Forsythe (1974) statistic. Except for three Chinese market stocks and two in the South Korean market, all remaining stocks show significantly higher volatility during the COVID-19 pan-

demic. The findings are consistently significant across all three statistics.

Standard deviation is a measure of total financial risk for a specific stock. Therefore, the results suggest the overall risk of airline stocks has been increased considerably during the COVID-19 pandemic.

Our findings contradict prior results about the impact of a pandemic on stock returns Loh (2006). Previous evi-

**Table 3**  
*Volatility Differences Before and During COVID-19*

Stock	$\sigma_{bf}$	$\sigma_{at}$	F-test	Levene	Brown-Forsythe
China					
CN601111SS	.022	.024	.84	2.376	2.498
CN600115SS	.02	.020	.969	.74	.856
CN600029SS	.019	.020	.939	.298	.313
CN601021SS	.017	.024	.493***	10.949***	11.165***
CN600221SS	.015	.024	.39***	20.382***	20.69***
CN603885SS	.02	.025	.656***	5.798**	5.917**
CN002928SZ	.02	.031	.421***	13.823***	12.014***
Hong Kong					
HK0293HK	.016	.022	.526***	12.716***	12.802***
Japan					
JP9202T	.008	.034	.059***	131.935***	132.952***
JP9206T	.007	.028	.066***	96.909***	97.937***
JP9201T	.010	.034	.08***	95.052***	96.191***
South Korea					
KR003490KS	.018	.045	.16***	38.364***	37.39***
KR003495KS	.058	.071	.684**	4.382**	4.868**
KR020560KS	.042	.046	.823	1.4	1.513
KR089590KS	.022	.046	.223***	19.773***	19.457***
KR272450KS	.025	.059	.174***	23.523***	23.488***
KR298690KS	.050	.047	1.115	.14	.129
KR091810KS	.024	.048	.248***	25.728***	25.266***
Singapore					
SGSGXC6L	.008	.040	.04***	66.395***	64.75***
Thailand					
THBABK	.014	.036	.15***	97.499***	97.241***
THAAVBK	.018	.050	.124***	73.51***	74.643***
THTHAIBK	.026	.064	.167***	68.579***	68.336***
THNOKBK	.023	.051	.206***	38.384***	38.162***
Vietnam					
VNVJC	.009	.022	.163***	46.239***	45.309***
VNHVN	.016	.032	.249***	44.849***	44.357***
Australia					
AUQANAX	.015	.053	.084***	98.326***	98.424***
AUAIZAX	.016	.059	.072***	63.16***	62.8***
AUAQZAX	.020	.058	.121***	38.004***	37.612***
AUREXAX	.016	.073	.047***	65.555***	66.824***
Germany					
DELHADE	.019	.050	.144***	107.863***	106.54***
DETUIIDE	.027	.080	.116***	94.841***	91.901***
United State					
USLUV	.014	.051	.076***	145.287***	145.286***
USDAL	.014	.066	.047***	120.864***	121.194***

**Table 3**  
*Volatility Differences Before and During COVID-19 (Continued)*

Stock	$\sigma_{bf}$	$\sigma_{at}$	F-test	Levene	Brown-Forsythe
USA					
USALK	.014	.065	.047***	134.723***	134.679***
USSAVE	.026	.097	.07***	114.436***	115.032***
USUAL	.014	.087	.026***	183.789***	181.219***
USAAL	.022	.087	.063***	105.85***	105.685***
USJBLU	.015	.073	.044***	131.464***	127.62***
USALGT	.015	.070	.045***	117.694***	117.381***
USSKYW	.016	.096	.028***	122.584***	122.601***
USHA	.025	.074	.114***	81.681***	81.639***
USMESA	.035	.092	.141***	98.143***	95.322***

dence about extreme volatility during a pandemic is weak. For example, in the case of the SARS pandemic, Loh (2006) finds that only a small portion of airline stocks in the sample has extreme risk during the outbreak. Most of the airline stocks in Loh (2006) do not deviate from their normal volatility. However, the situation is different in the case of COVID-19 in our study. Extreme volatility tends to persist for a long period after discovering the first case.

#### 4.3. Exposure to Systematic Risks

In the previous section, we see that the total financial risks of listed airline firms increase in most countries. Total financial risks can be decomposed into idiosyncratic and systematic risks. This section further investigates the exposure to systematic risks of airline stocks. Table 4 reports the estimations of the full-sample  $\beta$  in Equation 4, the  $\beta_{i,normal}$  in Equation 5 and the  $\beta_{i,covid}$  in Equation 6. Besides, we also show the result of the stability Cho's test for each airline firm.

As can be seen from Table 4, 31 over 42 airline stocks in our sample have higher  $\beta$  during the pandemic than in the period before the pandemic. Among them, the stability

Cho's test indicates that the structural changes in systematic risk are significant for 11 stocks (one for China, three for Japan, two for South Korea, one for Singapore, one for Vietnam, one for Australia, and two for the United States). It is noteworthy that all the Japanese and Singaporean airline stocks have significantly higher exposure to systematic risk during the pandemic.

The results for exposure to systematic risk show some

degree of heterogeneity. For example, while several stocks become more vulnerable to undiversifiable risks, most airline firms in our sample show no significant changes in their components of systematic risks.

## 5. Conclusion

This paper aims to investigate the effect of COVID-19 on several aspects of 42 listed airline stocks around the globe. The evidence from this study stressed the severe consequences of COVID-19 on the airline industry. Our results indicate that (a) COVID-19 only temporarily impacts stock returns. The average return quickly returns to its equilibrium level after the first case event; (b) Market values plunge immediately after the first confirmed case and still show no evidence of returning to the price levels before the outbreak; (c) COVID-19 has a significant impact on stock volatility. The extreme volatility of stock returns is undeniable during the pandemic, and (d) Most stocks do not illustrate any higher exposure to systematic risks.

The present findings have important implications for both investors and firm managers. Unlike previous results in the related literature stating that infectious diseases have negligible impacts on stock markets, this work has proved that COVID-19 can cause considerable damages to financial markets. COVID-19 can lower the market value of airline stocks, which can adversely impact investors' portfolios. Furthermore, investors and managers should pay attention to the increasing idiosyncratic risk of the airline industry during the outbreak.

**Table 4**  
*Systematic Risks of Airline Stocks Before and During COVID-19*

Stock	$\beta_{full}$	$\beta_{bf}$	$\beta_{at}$	Chow's test
China				
CN601111SS	1.344***	1.413***	1.248***	1.423
CN600115SS	1.236***	1.323***	1.115***	2.949*
CN600029SS	1.162***	1.21***	1.094***	.880
CN601021SS	.866***	.702***	1.095***	7.281***
CN600221SS	.971***	.915***	1.05***	1.026
CN603885SS	1.222***	1.145***	1.329***	1.522
CN002928SZ	1.187***	1.26***	1.086***	.912
Hong Kong				
HK0293HK	.847***	.835***	.856***	.030
Japan				
JP9202T	.711***	.521***	.783***	3.344*
JP9206T	.486***	.203*	.592***	9.164***
JP9201T	.914***	.486***	1.075***	19.765***
South Korea				
KR003490KS	1.307***	1.113***	1.358***	1.573
KR003495KS	1.212***	.61	1.37***	2.088
KR020560KS	1.292***	.825***	1.414***	3.001*
KR089590KS	1.154***	1.14***	1.157***	.005
KR272450KS	1.603***	1.242***	1.698***	2.841*
KR298690KS	1.314***	1.292***	1.319***	.005
KR091810KS	1.331***	1.212***	1.363***	.417
Singapore				
SGSGXC6L	1.07***	.679***	1.156***	5.346**
Thailand				
THBABK	.997***	1.06***	.988***	.132
THAAVBK	1.349***	1.453***	1.334***	.183
THTHAIBK	1.222***	1.439***	1.191***	.361
THNOKBK	1.053***	.635**	1.112***	1.969
Vietnam				
VNVJC	.594***	.383***	.666***	4.627**
VNHVN	1.135***	.968***	1.192***	1.49
Australia				
AUQANAX	1.149***	.962***	1.181***	.777
AUAIZAX	.609***	.209	.677***	2.176
AUAQZAX	.932***	.755***	.962***	.432
AUREXAX	.725***	.168	.821***	2.927*
Germany				
DELHADE	1.224***	1.06***	1.275***	2.002
DETUIIDE	1.556***	1.456***	1.587***	.243
United State				
USLUV	1.082***	.986***	1.096***	.318
USDAL	1.305***	1.135***	1.331***	.589

**Table 4***Systematic Risks of Airline Stocks Before and During COVID-19 (Continued)*

Stock	$\beta_{full}$	$\beta_{bf}$	$\beta_{ot}$	Chow's test
USALK	1.406***	.942***	1.478***	5.123**
USSAVE	1.815***	1.391***	1.881***	1.512
USUAL	1.531***	1.085***	1.601***	2.284
USAAL	1.36***	1.575***	1.326***	.431
USJBLU	1.173***	.864***	1.221***	1.38
USALGT	1.539***	.839***	1.648***	10.886***
USSKYW	1.757***	1.289***	1.829***	2.115
USHA	1.295***	1.061***	1.331***	.660
USMESA	1.639***	1.262***	1.698***	1.061

This research has several limitations that could be exploited in future research on the subject. First, a significant constraint of this research is that we could not perform a global survey of the airline business, and COVID-19 may impact our subsequent research in the airline industry in the coming years. Second, this research examines the impact of the COVID-19 epidemic on the global airline sector solely via the lens of stock prices. Thus, future studies might combine additional data sources, such as firms' financial performance and sentiment indexes derived from social media data, to paint a complete picture of the pandemic's influence on the airline industry. Finally, this study investigated the short-term shocks associated with the COVID-19 pandemic via the lens of an event study approach. Future studies could extend the sample duration and employ novel approaches to examine the pandemic's long-term effects, resulting in structural changes in the aviation industries.

## Declarations

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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## Appendix

Table A1

NO	QUOTE	FIRM	NATION
1	QAN.AX	Qantas Airways Limite	AU
2	AIZ.AX	Air New Zealand Limited	AU
3	AQZ.AX	Alliance Aviation Services Limited	AU
4	REX.AX	Regional Express Holdings Limited	AU
5	601111.SS	Air China Limited	CN
6	600115.SS	China Eastern Airlines Corporation Limited	CN
7	600029.SS	China Southern Airlines Company Limited	CN
8	601021.SS	Spring Airlines Co., Ltd.	CN
9	600221.SS	Hainan Airlines Holding Co., Ltd.	CN
10	603885.SS	Juneyao Airlines Co., Ltd	CN
11	002928.SZ	China Express Airlines Co.,LTD	CN
12	LHA.DE	Deutsche Lufthansa AG	DE
13	TUI1.DE	TUIfly	DE
14	0293.HK	Cathay Pacific Airways Limited	HK
15	9202.T	ANA Holdings Inc.	JP
16	9206.T	Star Flyer Inc.	JP
17	9201.T	Japan Airlines Co., Ltd.	JP
18	003490.KS	Korean Air Lines Co.,Ltd.	KR
19	003495.KS	Korean Air Lines Co.,Ltd.	KR
20	020560.KS	Asiana Airlines, Inc.	KR
21	089590.KS	Jeju Air Co., Ltd.	KR
22	272450.KS	Jin Air Co., Ltd.	KR
23	298690.KS	Air Busan Co., Ltd.	KR

**Table A1***Lists of Airline Stocks in Ten Stock Exchanges (Continued)*

NO	QUOTE	FIRM	NATION
24	091810.KS	T'Way Air Co., Ltd.	KR
25	SGXC6L	Singapore Airlines Limited	SG
26	BA.BK	Bangkok Airways Public Company Limited	TH
27	AAV.BK	Asia Aviation Public Company Limited	TH
28	THAI.BK	Thai Airways International Public Company Limited	TH
29	NOK.BK	Nok Airlines Public Company Limited	TH
30	LUV	Southwest Airlines Co.	US
31	DAL	Delta Air Lines, Inc.	US
32	ALK	Alaska Air Group	US
33	SAVE	Spirit Airlines, Inc.	US
34	UAL	United Airlines Holdings, Inc.	US
35	AAL	American Airlines Group Inc.	US
36	JBLU	JetBlue Airways Corporation	US
37	ALGT	Allegiant Travel Company	US
38	SKYW	SkyWest, Inc.	US
39	HA	Hawaiian Holdings, Inc.	US
40	MESA	Mesa Air Group, Inc.	US
41	VJC	Vietjet Aviation Joint Stock Company	VN
42	HVN	Vietnam Airlines JSC	VN

**Table A2***Announcement of the First Confirmed Case in Each Market*

Nation	COVID-19 First Victims
AU	1/25/2020
CN	12/16/2019
DE	2/25/2020
UK	1/31/2020
HK	1/22/2020
JP	1/16/2020
KR	1/20/2020
SG	1/23/2020
TH	1/13/2020
TW	1/21/2020
US	1/20/2020
VN	1/23/2020

**Table A3**  
*Volatility Differences Before and During COVID-19*

Stock	$r_{normal}$	$r_{short}$	$r_{long}$	t-test short	t-test long
China					
CN601111SS	.001	.006	-.002	-1.015	.798
CN600115SS	.000	.004	-.002	-.94	.630
CN600029SS	.001	.003	-.002	-.463	1.004
CN601021SS	0.00	.003	.001	-.678	-.370
CN600221SS	.001	.014	-.001	-2.805**	.482
CN603885SS	.02	.025	.656***	5.798**	5.917**
CN002928SZ	.02	.031	.421***	13.823***	12.014***
Hong Kong					
HK0293HK	.000	-.002	-.002	.307	.479
Japan					
JP9202T	.000	-.005	-.006	.937	1.968*
JP9206T	.001	-.001	-.004	.474	.934
JP9201T	.000	-.009	-.009	1.821*	2.995***
South Korea					
KR003490KS	.000	-.011	-.004	1.357	.642
KR003495KS	.003	.018	.002	-.497	.0800
KR020560KS	.002	-.011	-.006	2.097*	1.639
KR089590KS	-.001	-.013	-.005	1.466	.9020
KR272450KS	.000	-.006	-.007	.495	1.227
KR298690KS	.001	-.006	-.007	.83	1.412
KR091810KS	-.001	-.014	-.01	1.504	1.546
Singapore					
SGSGXC6L	.000	-.002	-.004	.491	1.276
Thailand					
THBABK	-.002	-.008	-.005	.887	.668
THAAVBK	-.002	-.012	-.006	.966	.500
THTHAIBK	-.002	-.007	-.009	.896	1.130
THNOKBK	.000	-.004	-.012	.61	1.391
Vietnam					
VNVJC	.001	-.012	-.007	1.575	2.248**
Australia					
AUQANAX	.001	-.003	-.012	.519	2.010*
AUAIZAX	.000	-.007	-.013	1.157	2.792***
AUAQZAX	.001	-.001	-.008	.222	2.008*
AUREXAX	-.001	-.003	-.006	.42	1.007
Germany					
DELHADE	-.001	-.022	-.022	1.518	1.518
DETUIIIDE	-.001	-.044	-.044	3.433***	3.433***
United State					
USLUV	.001	.001	-.005	.025	1.254
USDAL	.001	-.009	-.008	1.942*	1.890*
USALK	.000	-.003	-.009	.591	1.518

**Table A3***Volatility Differences Before and During COVID-19 (Continued)*

Stock	$r^{\text{normal}}$	$r^{\text{short}}$	$r^{\text{long}}$	t-test short	t-test long
USSAVE	-.001	-.002	-.016	.179	1.979*
USUAL	.000	-.016	-.013	1.965*	1.909*
USAAL	.000	-.003	-.012	.300	1.435
USJBLU	.001	.004	-.007	-.397	1.235
USALGT	.002	-.006	-.008	.939	1.840*
USSKYW	.002	-.016	-.014	1.729	2.115**
USHA	.001	-.007	-.014	.92	2.462**
USMESA	.001	-.01	-.013	1.507	2.046**

**Table A4***Mean Prices of Airline Stocks After the First Case*

Stock	$r^{\text{normal}}$	$r^{\text{short}}$	$r^{\text{long}}$	t-test short	t-test long
China					
PCN601111SS	8.853	9.12	7.572	-3.335***	12.625***
PCN600115SS	5.723	5.485	4.654	4.042***	16.932***
PCN600029SS	7.311	6.934	5.811	7.207***	19.983***
PCN601021SS	40.75	42.685	37.224	-6.103***	8.555***
PCN600221SS	1.96	1.72	1.621	18.326***	21.871***
PCN603885SS	13.215	14.19	11.286	-5.738***	10.311***
PCN002928SZ	11.769	11.472	12.753	2.046*	-7.123***
Hong Kong					
PHK0293HK	11.475	10.028	9.091	14.266***	21.226***
Japan					
PJP9202T	3778.476	3536.273	2786.44	8.351***	24.159***
PJP9206T	3856.394	4109.545	3347.692	-15.728***	11.524***
PJP9201T	3569.059	3248.273	2340.209	8.502***	24.635***
South Korea					
PKR003490KS	29310.48	24986.36	20798.69	9.472***	21.587***
PKR003495KS	17001.84	19140.91	18956.7	-3.885***	-4.86***
PKR020560KS	5278.566	4850.455	4075.261	5.337***	16.517***
PKR089590KS	30484.01	23054.55	19402.7	15.104***	25.413***
PKR272450KS	18452.57	14895.45	11507.91	12.15***	22.858***
PKR298690KS	6056.618	5354.545	4021.087	8.653***	21.619***
PKR091810KS	6374.798	5111.364	3782.955	10.372***	25.32***
Singapore					
PSGSGXC6L	9.356	8.644	5.984	15.751***	18.839***
Thailand					
PTHBABK	10.133	6.309	5.54	27.226***	31.036***
PTHAABVK	3.515	2.000	1.712	26.674***	31.115***
PTHTHAIBK	10.217	6.445	5.028	24.828***	29.773***
PTHNOKBK	2.223	1.982	1.278	15.932***	25.027***

**Table A4**  
*Mean Prices of Airline Stocks After the First Case* (Continued)

<b>Stock</b>	<b><math>r_{normal}</math></b>	<b><math>r_{short}</math></b>	<b><math>r_{long}</math></b>	<b>t-test short</b>	<b>t-test long</b>
Vietnam					
PVNVJC	129.641	137.427	115.532	-2.664**	10.904***
PVNVHN	38.541	29.964	25.537	9.363***	32.671***
AU					
PAUQANAX	6.08	6.509	4.335	-8.264***	14.108***
PAUAIZAX	2.642	2.713	1.599	-2.734**	17.101***
PAUAQZAX	2.558	2.594	2.288	-1.772*	5.275***
PAUREXAX	1.377	1.117	.924	27.739***	23.463***
Germany					
PDELHADE	17.338	11.73	9.248	17.114***	35.577***
PDETUIIDE	10.209	6.902	4.473	9.987***	35.777***
United States					
PUSLUV	53.198	55.523	39.403	-5.534***	13.602***
PUSDAL	55.536	58.266	35.412	-4.098***	14.786***
PUSALK	63.529	65.829	41.284	-6.245***	15.805***
PUSSAVE	46.704	42.19	21.579	8.265***	19.758***
PUSUAL	86.916	80.269	44.26	4.267***	20.713***
PUSAAL	30.739	27.354	16.502	11.567***	20.98***
PUSJBLU	17.988	20.006	12.71	-10.952***	11.828***
PUSALGT	146.676	170.029	111.832	-14.562***	9.932***
PUSKYW	58.029	61.896	36.803	-3.39***	16.011***
PUSHA	28.027	28.374	17.167	-1.063	16.988***
PUSMESA	8.484	8.851	4.842	-2.87***	17.627***