

# The Ongoing Recovery of U.S. Airline Stocks Through the COVID-19 Pandemic: An Event Study Approach

Wendi Fan<sup>1,\*</sup>

<sup>1</sup>College of Arts and Science, New York University, New York City, United States

\*Corresponding author: wf2071@nyu.edu

**Abstract.** The COVID-19 pandemic hit the airlines, both business and leisure travels, hard due to severe travel restrictions imposed by governments around the world to combat the virus. The stock prices of major airline companies have dropped more than the broader market. This paper aims to quantify the impact of a shock to the COVID-19 pandemic on U.S. airline stock prices by examining ten specific events evenly spread through January 2020 and August 2022. Seven airline stocks are selected, including JetBlue, American, Delta, Alaska, United, Hawaiian and Spirit. It is observed that the stock prices react to public information quickly by the Efficient Market Hypothesis in most but not all situations, and to varying degrees. Simple regression analysis was performed as a supplement to understand the factors affecting the performance of transportation stocks in general. The result of this study will be useful to airline investors and stock market participants to react quickly when making investment decisions. Moreover, these results shed light on guiding regulators and policymakers to implement financial support amid catastrophic shocks from a pandemic or likewise.

**Keywords:** Linear Regression; Stock Price; Airline Business; COVID-19.

## 1. Introduction

The COVID-19 transmission has seriously impacted the design and management of the air transport network that has led to restriction policies against international and domestic travelers. In many cases, travelers are prevented from using direct flights, returning to their origin, or departing from their current location, at least it is immensely difficult to do so. However, more than two years into the pandemic, with the surge of the “Delta” and “Omicron” variants and the proliferation of the COVID-19 vaccines some restrictions have been lifted and countries are adopting various policies in order to return to the pre-pandemic levels of air travel. For instance, China is now the last major country in pursuing the “zero-tolerance strategy”, forcing residents to enter quarantine in order to halt the spread of the virus, after countries like Malaysia, Philippines and Australia pivoting to opening cautiously most recently [1]. As of January 2022, international traffic to China has experienced more than 90% decline than pre-pandemic levels. It then begs the question of whether such policy had been more restrictive than effective, and concerns whether China is becoming increasingly isolated with the rest of the world. While some believe such policy would be much less costly than “living with the virus”, which entails disrupted economic development and social stability, large majorities consider such policy to be not feasible or sustainable for a long period. Given the distinct COVID-19 government policies and that historically the aviation industry is highly subject to a large number of external factors, the ongoing recovery of the aviation industry are not comparable across different countries. As a result, this study only focuses on the performance of U.S. airline stocks, which aids the development of a U.S. aviation preparedness plan against possible future disease threats.

The prior literature addresses the vulnerability and robustness of the air transport network system [2], and the impact of the initial Wuhan travel ban on the global spread of COVID-19 has been extensively studied [3]. A study that monitors market changes by applying sentiment analysis to news articles from Flight Global concludes that sentiment trends aligned with the real-world development of the pandemic [4]. In addition, a paper published on the Journal of Air Transport Management examines the impact of new information arrivals on airline firms around the world, contributing to the understanding of catastrophes in the airline business, which informs the methodology of this study [5]. However, it was carried out in October 2020, and many key events were excluded as the coronavirus continued to evolve. In order to fill this gap, this study aims to examine the correlation

and causal association between the decline of number of commercial flights, the price of airline stocks (mainline flights) and the epidemic trajectory between January 2020 and August 2022, which remains a relatively untouched area of research.

The very much on-going pandemic has led to massive layoffs and in many cases bankruptcies of airline companies, which calls for attention to regulators and policymakers. The evolving COVID-19 air travel guidelines makes it difficult for stakeholders to continuously monitor the market changes due to unpredictable new variants. Thus, not only can stakeholders use the results to facilitate their investment decisions, but this research can also provide insights for air traffic planning and management in emergency situations. The results could also outline potential alternative relationships that play a role in preserving the performance of the flight network and airline companies' financial health during pandemics. Finally, state, and national agencies may use the results of this study as a reference for public health response planning. The remainder of the paper is organized as follows. Sec. 2 covers the methodology of this study and makes hypothesis based on economic theory and prior literature. Subsequently, Sec. 3 presents the results from the study. Afterwards, Sec. 4 discusses the major findings in the real-world context. Then, the Sec. 5 will demonstrate the limitations and prospects. Eventually, a brief summary will be given in Sec. 6.

## 2. Methodology

### 2.1 Data Collection and Processing

The main data source for air traveling data are from Flightradar24, which is made accessible the number of commercial flights per day from 2019 to 2022 via a CSV-formatted data dump that is updated every night. The daily COVID-19 cases in the U.S. by state/territory are provided by the Centers for Disease Control and Prevention (CDC) since January 23, 2020, after the first laboratory-confirmed case of COVID-19 in the U.S. on January 20, 2020 [6]. The Dow Jones Transportation Average (DJTA) is a price-weighted average that represents the stock performance of 20 U.S. companies within the transportation industry. In addition to airlines, the stock market index includes railroads, trucking, marine transportation, delivery services and logistics stocks (Kenton, 2022). DJTA is taken at market close (4P.M. ET) on a daily basis, and is openly available on the Federal Reserve Economic Data. The aviation components of the DJTA include:

- Alaska Air Group, Inc. (ALK)
- American Airlines Group Inc. (AAL)
- Delta Airlines, Inc. (DAL)
- JetBlue Airways Corp. (JBLU)
- Southwest Airlines Co. (LUV)
- United Airlines Holdings, Inc. (UAL)

Other mainline flights include:

- Hawaiian Holding, Inc. (HA)
- Spirit Airlines, Inc. (SAVE)
- Sun Country Airline Holdings, Inc. (SNCY)
- Frontier Group Holdings, Inc. (ULCC)

However, not all of these airline firms are publicly traded through January 2020 and August 2022. Thus, this study will only focus on 7 aviation stocks (JBLU, UAL, DAL, ALK, AAL, HA, SAVE) traded in the U.S. 10 key events were identified that are considered significant on the COVID-19 timeline and could have an impact on making investment decisions on aviation stocks, listed as follows:

- January 20, 2020 – CDC reports the first laboratory-confirmed case of COVID-19 in Washington state;
- March 11, 2020 – WHO declares COVID-19 a pandemic;
- June 8, 2020 – World Bank forecasts that the global economy will shrink by 5.2%, entering the deepest recession since World War II [7];

- September 14, 2020 – CDC removes health screening for passengers from 15 designated airports;
- December 23, 2020 – The Trump Administration purchases 100 million additional doses of COVID vaccines from Pfizer;
- January 12, 2021 – CDC expands COVID-19 negative test requirement for all air passengers to the U.S.;
- April 2, 2021 – CDC recommends that people who are fully vaccinated are at lower risk of infection to travel domestically;
- June 1, 2021 – The “Delta” variant becomes the dominant variant in the U.S.;
- November 26, 2021 – The “Omicron” variant becomes the dominant variant in the U.S.;
- February 15, 2022 – Masks are no longer required indoors in California.

As for each event studied, an event window of 5 days before and 5 days after the event date is used as suggested to be consistent with prior literature [5]. Moreover, given the evolving and complex development of COVID-19, a shorter event window will prevent the possible cascading of events, and attempt to minimize the impact of normal market fluctuations. In addition, regression analysis is carried out to investigate whether there is a correlation between the number of commercial flights and the DJTA index, and between new daily COVID cases and the DJTA index. A further drill down is also conducted as to understand when and where the correlation was greatest by month of the year and state/territory.

## 2.2 Hypothesis

If a relationship exists for the regression exercise, then it is assumed that as the number of commercial flights increases, the DJTA index becomes greater. As stated in Ref. [8], as many companies see the (at least near) future of work a hybrid environment of accelerated digital transformation, business travel will take longer to recover. Thus, the resumption of domestic and international flights heralds the recovery of the airline business, which has a greater impact to the transportation industry, e.g., to railroad services that continue to serve as an important transportation link. On the other hand, based on similar reasoning, it is hypothesized that the as COVID-19 daily infections increase, the DJTA index becomes smaller instead. However, it should be noted that these correlations do not necessarily suggest any causation.

In addition, the stock price of the selected aviation stocks is hypothesized to align well with the real-world development of the pandemic by the semi-strong form efficiency, which is a form of the well-known Efficient Market Hypothesis (EMH). It assumes that current stock prices adjust quickly and accordingly after all new public information is released. In other words, there is no monopolistic access to relevant information in the stock market. However, argument against the EMH points out that it fails to explain market anomalies such as overconfidence, information bias and excess volatility [9]. Thus, it is interesting to examine the movement of the stock prices in the context of the compact release of new public information during the pandemic.

## 3. Results

### 3.1 Simple Regression Analyses

In this exercise, simple (or linear) regression is performed to predict the correlation between the value of the two variables, and technically without the commonly named “dependent” and “independent” variable. The results for different models are listed in Tables. 1-6. Some key statistics generated by the regression analysis are presented as follows:

- Multiple R is the correlation coefficient that measures the strength of the linear relationship, that is, how closely the variables move in tandem with each other.
- The standard error tells you how wrong you can be using this regression equation to make predictions.

- Significance F indicates the probability that the coefficients in the regression output are actually zero (accept the null hypothesis), i.e., no relationship exists between the variables. A significance F level that is smaller than the significance level of  $5\% = 0.05$  means that 95% of the time the regression equation holds.

**Table 1.** Regression Analyses Between the Number of Commercial Flights and the Dow Jones Transportation Average by Year

|                | 2019    | 2020     | 2021    | 2022    |
|----------------|---------|----------|---------|---------|
| Multiple R     | 0.077   | 0.469    | 0.624   | 0.618   |
| Standard Error | 395.103 | 1407.298 | 874.525 | 763.404 |
| Significance F | 0.222   | 0.000    | 0.000   | 0.000   |

**Table 2.** Regression Analyses Between the Number of Commercial Flights and the Dow Jones Transportation Average by Months in 2020

|                | March 2020 | June 2020 | December 2020 |
|----------------|------------|-----------|---------------|
| Multiple R     | 0.545      | 0.333     | 0.124         |
| Standard Error | 733.060    | 327.442   | 123.140       |
| Significance F | 0.009      | 0.129     | 0.592         |

**Table 3.** Regression Analyses Between the Number of Commercial Flights and the Dow Jones Transportation Average by Months in 2021

|                | January 2021 | June 2021 | December 2021 |
|----------------|--------------|-----------|---------------|
| Multiple R     | 0.051        | 0.777     | 0.522         |
| Standard Error | 321.845      | 198.287   | 242.383       |
| Significance F | 0.836        | 0.000     | 0.013         |

**Table 4.** Regression Analyses Between New Daily COVID-19 Cases and the Dow Jones Transportation Average by Year

|                | 2020     | 2021     | 2022    |
|----------------|----------|----------|---------|
| Multiple R     | 0.667    | 0.033    | 0.291   |
| Standard Error | 1214.834 | 1118.266 | 928.556 |
| Significance F | 0.000    | 0.600    | 0.000   |

**Table 5.** Regression Analyses Between New Daily COVID-19 Cases and the Dow Jones Transportation Average by State/Territory in 2020

| 2020           | California | Massachusetts | New York City | Atlanta  | Chicago  |
|----------------|------------|---------------|---------------|----------|----------|
| Multiple R     | 0.529      | 0.405         | 0.037         | 0.562    | 0.616    |
| Standard Error | 1383.522   | 1491.468      | 1630.011      | 1349.518 | 1284.490 |
| Significance F | 0.000      | 0.000         | 0.569         | 0.000    | 0.000    |

**Table 6.** Regression Analyses Between New Daily COVID-19 Cases and the Dow Jones Transportation Average by State/Territory in 2021

| 2021           | California | Massachusetts | New York City | Atlanta  | Chicago  |
|----------------|------------|---------------|---------------|----------|----------|
| Multiple R     | 0.274      | 0.112         | 0.062         | 0.201    | 0.263    |
| Standard Error | 1383.522   | 1087.274      | 1092.074      | 1095.983 | 1079.430 |
| Significance F | 0.000      | 0.083         | 0.339         | 0.001    | 0.000    |

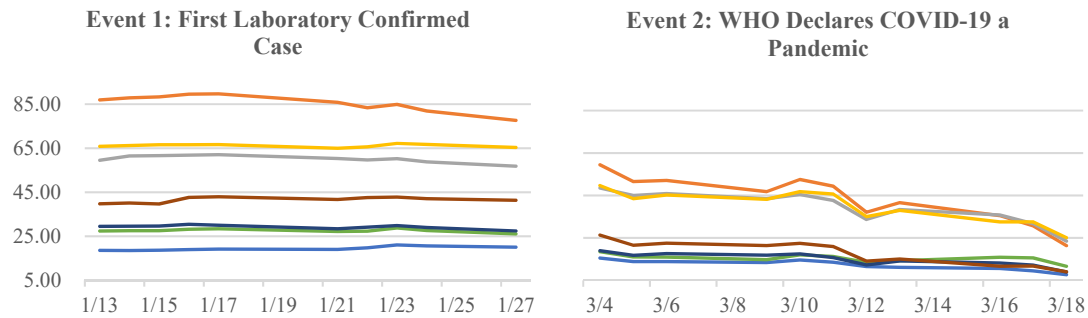
### 3.2 Stock Price Event Studies

The stock market does not operate during the weekend, which explains the situation where a designated 10-day event window may extend to 15 days. The Fig

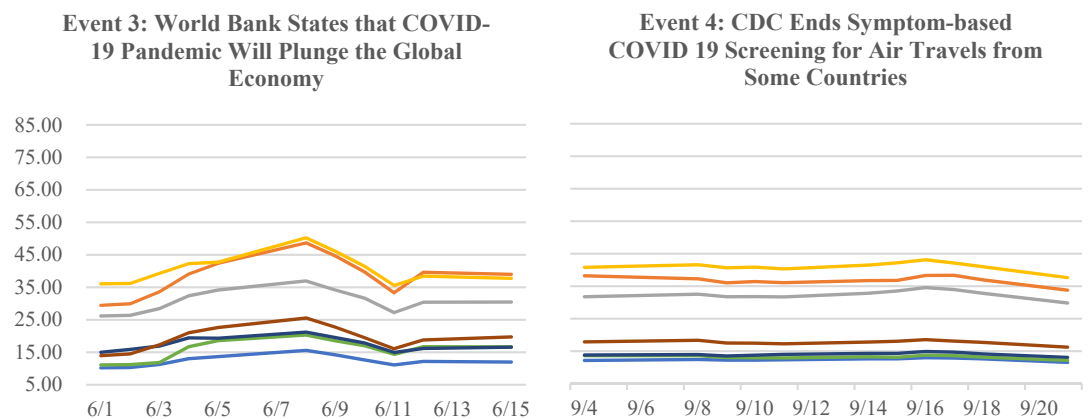
1-5 compare the stock prices of the 7 airline stocks in each elected event. Due to space limitations, the charts only indicate the date of the event but not the year, with the first 5 events occurring in 2020, the next 4 events in 2021 and the last event in 2022. The meanings of color coding of airline stocks are given as follows

- JetBlue Airways Corp. (light blue)

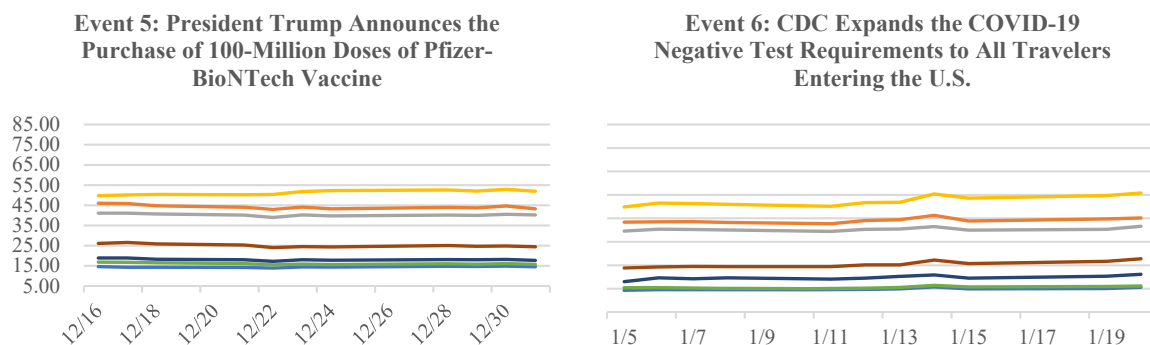
- American Airlines Group, Inc. (green)
- Delta Airlines, Inc. (grey)
- Alaska Air Group, Inc. (yellow)
- United Airlines Holdings, Inc. (orange)
- Hawaiian Holding, Inc. (dark blue)
- Spirit Airlines, Inc. (redish-brown)



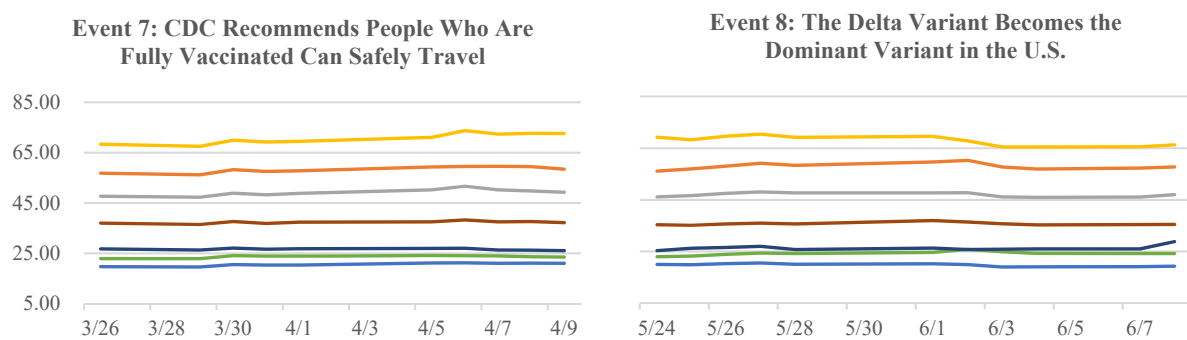
**Fig. 1** Stock Price Comparison of Event 1 and Event 2.



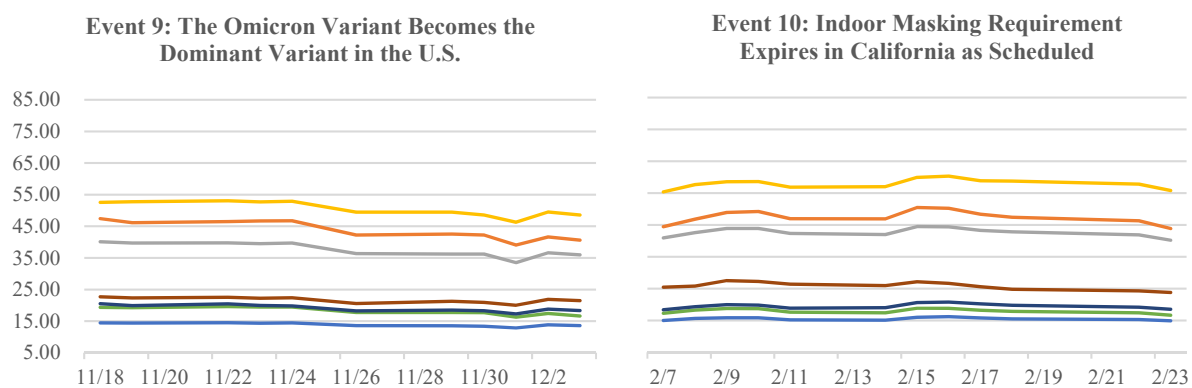
**Fig. 2** Stock Price Comparison of Event 3 and Event 4.



**Fig. 3** Stock Price Comparison of Event 5 and Event 6



**Fig. 4** Stock Price Comparison of Event 7 and Event 8



**Fig. 5** Stock Price Comparison of Event 9 and Event 10

The results were generally consistent with the hypothesis, but there were some differences, which will be discussed in the next section. Generally, an R square above 0.7 would be seen as showing high level of correlation, however, none of the regression analyses run above reached 0.7. Thus, multiple R is used to compare the strength of the linear relationship. As the pandemic progressed, the DJTA became increasingly dependent on the number of commercial flights, and this correlation became higher during months when the variant-driven wave stuck. The second regression analysis shows that the relationship between new daily COVID-19 cases and the DJTA diminished year by year. The top three busiest airports in the U.S. are Atlanta, Los Angeles and Chicago O'Hare International Airport, which have the highest amount of passenger traffic [10]. New York City and Boston in Massachusetts are two of the largest cities on the east coast. The results show that new daily COVID-19 cases in states with one of the busiest airports are relatively more likely to be associated with the DJTA.

The line graphs presented on this section are configured to have the same range on the y-axis and the same color representing the same airline stock. The event studies confirm that investors' reaction to COVID-19 pandemic events led to movements in airline stock prices depending on the nature of the event (positive/negative), and that they react most strongly on the day of the event, with residual effects spreading over a 5-day period after the event. In addition, for events like a scheduled expiration of indoor mask mandate, investors reacted most strongly on the day of the announcement than on the day of implementation.

## 4. Discussion

### 4.1 Regression Analyses

Before COVID-19 hit, the number of commercial flights and the DJTA are almost completely independent of each other, as shown by the data in 2019, displayed in Table 1. However, their

relationship begins to reveal itself as Americans accept the pandemic life as the new reality, and this study also breaks down month by month to try to understand the reasons behind it. In March 2020, WHO declared COVID-19 a pandemic and President Trump declared COVID-19 a national emergency. As shown in Table 2, the calculated multiple R is higher and significance F is lower for this month, comparing to the calculated values for the other months of the year (June and December in Table 2). Moreover, the highly contagious variants Delta and Omicron began spreading rapidly and making news around the middle of June and December of 2021. The multiple R is much higher in these two months, as shown in Table 3, while standard error and significance F both decrease, compared to other months of 2021 (January in Table 3). Therefore, it is probable to conclude that the correlation between the number of commercial flights and the DJTA is very high during a period when a new variant concern scientists due to the potential for increased transmissibility. This makes sense because during these periods, not only the high risk of contracting COVID-19 on board would lead to significant aircraft re-routing and re-scheduling, but also investors would lose confidence in transportation stocks. However, given the small number of observations in the regression analysis by month (19 to 22 observations), it is possible that this is simply due to the power of statistics.

On the other hand, as shown in Table 4, the correlation between the new daily COVID-19 cases in the whole country and the DJTA is only sizable in 2020, in the first year of the pandemic. This study also breaks down to one of the nation's busiest international airports to examine whether the correlation was stronger. The top three busiest airports show a stronger correlation by the results in Table 5 and Table 6, which means that investors in transportation stocks have likely incorporated the new daily COVID-19 cases in states like California, Atlanta and Chicago into their investment decisions. This result has economic implications because the Omicron variant, for example, were 30 times more infectious than the ancestral SARS-CoV-2 and has overwhelmed the air/railroad traffic management [11]. In addition, a survey shows that 4 in 10 Americans have decided that the COVID-19 pandemic is over [12]. This also explains the independence between the two variables. It should be noted that the DJTA is a stock market index of the transportation sector and not just airline business. Therefore, it is inaccurate to use the new daily COVID-19 case to predict the performance of transportation stocks since 2021.

## 4.2 Stock Price Event Studies

Ten events were selected to investigate the performance of airline stock prices during the event window. In general, the stock prices were not affected during pre-event window, and that a "positive" event (on the current pandemic situation) would lead to an uptick in stock prices while a "negative" event would lead to a decrease in stock prices above their positive counterparts. The events are summarized as follows:

- Event 1: January 20, 2020 (Monday) left panel of Fig. 1. All 7 airline stocks experienced a drop in stock price on January 21, 2020, as did the DJTA. However, stock prices quickly returned to their previous levels and no sustained downward trend was observed during this event window. The drop in stock price on the event date may be expected as a daily fluctuation in the stock market.
- Event 2: March 11, 2020 (Wednesday), right panel of Fig. 1. This event has triggered a freefall in share prices of the airline stocks during the extended 15 event window. On the event date, all selected stocks except the American Airlines Group (decreased 17.3%) experienced more than 20% decrease in stock price. On March 13, 2020 (Friday), U.S. suspended incoming travel from Europe, this news further decreased investors' confidence level in the stock market, and led to most airline stock prices decline immediately by another 15% or more. During this event window, all 7 stocks are negative impacted by around 50%, United Airlines lost 64% while American Airlines fell 37.1%. WHO's declaration is an acknowledgment that the virus will very likely spread to a wide geographic area and affect a significant proportion of the population, which has led to the strongest reaction of the stakeholders.

- Event 3: June 8, 2020 (Monday), left panel of Fig. 2. The June forecast of the World Bank, as a vital international financial institution, says the pandemic is expected to plunge most economies into recession. Since the date of the event, the stock price has continued to fall for four days until June 11, 2020 (Thursday), reaching a cumulative total of about 30%.
- Event 4: September 14, 2020 (Monday), right panel Fig. 2. A lot of minor volatilities surrounds this event window, mostly around 2% to 3%. The selected airline stocks perform differently on different days of the event window. The primary target for lifting air travel restrictions is foreign travelers, and investors may not have taken steps to extrapolate the message behind this decision made by the CDC.
- Event 5: December 23, 2020 (Wednesday), left panel Fig. 3. With this agreement, the Trump administration have purchased a total of 200 million doses of Pfizer BioNTech vaccine, which was first administered on December 11, 2020 (Gumbrecht and Homes, 2020). However, this news did not instill additional confidence to the stock market, mainly because of early skepticism and vaccine hesitancy in the U.S. Again, another “positive” news, as vaccines help people to develop immunity, that did not receive the expected change in share price.
- Event 6: January 12, 2021 (Tuesday), right panel Fig. 3. A slight uptick in the stock price is observed since the event date and lasted until January 14, 2021 (Wednesday), with a 5% cumulative change for most stocks. This news could have been interpreted by stakeholders with either positive or negative connotation. While stricter air travel testing restrictions may alleviate the domestic COVID situation, they may also mean a very bad COVID-19 wave internationally. Given the mixed response, the change in stock prices was barely noticeable.
- Event 7: April 2, 2021 (Friday) – left panel Fig. 4. One year into the pandemic, CDC officials’ message confirmed that fully vaccinated people can resume travel at “low risk”. This is a positive sign to the airline business and an ever-self-quarantining population, providing momentum for a gradual recovery in stock performance.
- Event 8: June 1, 2021 (Tuesday) right panel Fig. 4 and Event 9: November 26, 2021 (Friday) left panel Fig. 5, Both events have to deal with the emergence of a new COVID-19 variant-of-concern. However, the “Delta” and “Omicron” variant did not take over and become dominant in on day, or strictly in the 5-day post-event window. Additionally, studies that estimate the transmissibility of the new variants and news that concerns about decreased vaccine protection take time to reach the public. Thus, while stock prices do not appear to have declined much during the specified event window, the downticks were significant during the full months of June and November 2021.
- Event 10: February 15, 2022 (Tuesday), right panel Fig. 5. The lifting of the indoor mask mandate in California is scheduled on February 15th, the only event where investors reacted before the event date. The uptick is around 5% - 8% for all 7 airline stocks.

## 5. Limitations & Prospects

The above regression analyses only evaluate the correlation between the variables, but does not prove their causation. However, in the stock market, it is hard to conduct controlled studies to establish causality. The stock market is closed on weekends and holidays, and so is somewhat flawed by design for the event studies. In simple words, investors are unable to realize the impact of a Friday event until next Monday, when effects may have dissipated. Moreover, all the event studies are constrained by a specified 10-to-15-days event window and within the special context of COVID-19, so stock performances are naturally more volatile than traditional cash investments.

As an extension of this study, data filters such as the number of commercial flights for each state/territory can be added for possibly better regression results. Other components of the DJTA such as railroad, trucking, marine transportation can be investigated and used as parallel studies [13]. While the American economy depends on railroad for many reasons and marine transportation of people



sounds minor, it is crucial to investigate the share price of marine companies necessarily less volatile than railroad companies.

## 6. Conclusion

To conclude, the DJTA, its airline business components and other airline stocks (mainline flights) align with the real-world development of the pandemic most of the time. The correlation between the number of U.S. commercial flights and DJTA increased with the year and was stronger in months when a new variant or new wave of COVID-19 hit. The correlation between new daily COVID-19 cases and DJTA weakens over time, although a stronger relationship is observed in states with busy international airports. This study is most up-to-date by the time it is written but is limited in scope, where finding alternative data sets or adding data filters will help resolve the challenges. This study is useful for airline investors and stock market participants to make short-term investment decisions in likewise situations. Overall, these results offer a guideline for regulators and governments to provide financial assistance when deemed necessary to alleviate the economic fallout.

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