Statistical Analysis of COVID-19 Data with Stock Market Trends

Mary Stirling Brown[1] and **Mingwei Sun**[1]

[1]Samford University

Samford University
Howard College of Arts and Sciences

Abstract

COVID-19 has affected every aspect of society, including the economy. One way to investigate the effect of COVID-19 on the United States' economy is through the economic indicator of the U.S. stock market. This research analyzes the effects of COVID-19, specifically the daily increases in COVID-19 cases and the fully vaccinated percentage of the U.S. population, on different stock indexes and prices. We also analyze what sectors of the economy were most affected by COVID-19. Important results include that the stock market was not largely affected by the COVID-19 pandemic in the long-term, with supporting data ranging from June 1, 2018 to December 31, 2021. Further hypothesis testing proves that stock prices were only affected in the short-term. An analysis of correlation is performed to further show that COVID-19 and the stock market are weakly correlated, while vaccination efforts have a strong correlation to stock trends. The main result of this research shows that COVID-19 affected the stock market as if it was a one-time event, specifically its onset in March 2020, rather than having a long-term effect on the economy.

Collection and Organization of Data

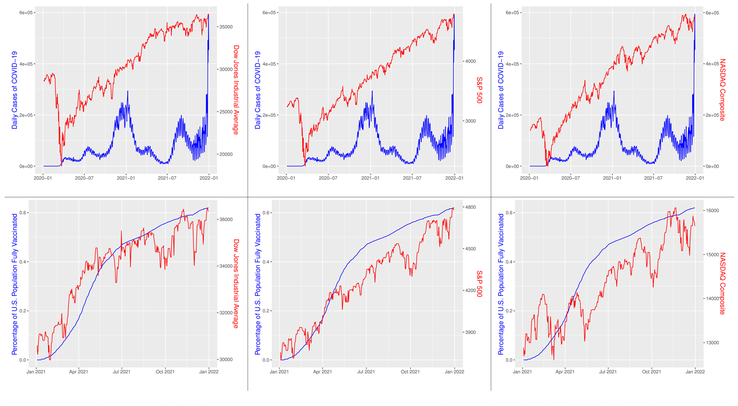
Various data was collected in this research as follows:

- Daily increase of COVID-19 cases in the U.S. (January 23, 2020 to December 31, 2021)
- Fully vaccinated percentage of the U.S. population (January 12, 2021 to December 31, 2021)
- Stock data for the three main indexes and fifteen companies (June 1, 2018 to December 31, 2021)

Fifteen companies from the Dow Jones Industrial Average were split up into five economic sectors based on their 2020 rank, as follows:

Sector	Ranking & Stock Name
Technology	#4: Microsoft Corp (MSFT) #8: Salesforce.Com Inc (CRM) #13: Apple Inc (AAPL)
Healthcare	#1: UnitedHealth Group Inc (UNH) #7: Amgen Inc (AMGN) #15: Johnson & Johnson (JNJ)
Finance	#2: Goldman Sachs Group Inc (GS) #6: Visa Inc (V) #12: American Express Co (AXP)
Industry	#9: Boeing Co (BA) #10: Caterpillar Inc (CAT) #11: Honeywell International Inc (HON)
Consumer Services	#3: Home Depot Inc (HD) #5: McDonald's Corp (MCD) #20: Walt Disney Co (DIS)

Stock Index Graphs



From the top figures, COVID-19 seems to only cause stocks to drastically fall in March 2020 at its onset. For the bottom figures, the vaccination percentages seems to have a higher correlation as they are both increasing at similar rates during the same time periods.

Hypothesis Testing (T-Test)

For hypothesis testing, the t-test was chosen since the data is assumed to follow a normal distribution due to the Central Limit Theorem. March 1, 2020 is chosen as the dividing date since that is the time when COVID-19 became an issue in the United States. The following two variables are analyzed:

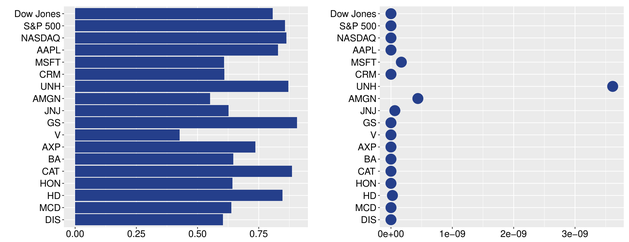
- A is the percent change of stock prices before March 1, 2020
- B is the percent change of stock prices after March 1, 2020

The results are the following hypothesis tests:

$$\text{Null Hypothesis } (H_0)\text{: } \mu_A = \mu_B$$

$$\text{Alternative Hypothesis } (H_1)\text{: } \mu_A > \mu_B$$

As seen from (a) below, the p-values vary across each stock. However, none of the p-values are less than the significant value of 0.05, so none of the null hypotheses are rejected. This concludes that the stock market was affected by other factors besides COVID-19. This information is still important because the lower the p-value, the more they were affected by COVID-19.



(a) Long-term **(b) Short-term**

Hypothesis testing was conducted to see if the stock market was affected in the short-term by COVID-19 cases, with variables as follows:

- A is the stock prices between February 18, 2020 and March 1, 2020
- B is the stock prices between March 1, 2020 and March 13, 2020

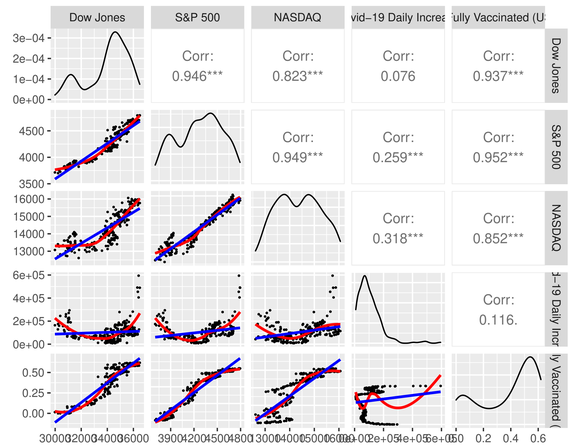
The same set of hypotheses are used as above. The results shown above in (b) prove that COVID-19 cases affected the stock market as a one-time event rather than in the long-term. This is because the p-values on the left are exponentially small, so the null hypotheses are rejected. This means that stock price was greater before March 1, 2020 compared to after in the short-term.

This concept of COVID-19 being a one-time event for the stock market can be seen in the following graph which plots the three technology companies' stock price. At the bottom of the graph, the percent change of daily stock price for the three is plotted. This percent change fluctuates the most around March 2020 and resumes normally after.

Analysis of Correlation

An analysis of correlation data is researched in order to examine the relationship between COVID-19 data and stock market trends. Based on hypothesis testing, a statistical model was not able to be developed because of the high p-values in the long term for the stock market. A linear regression model is shown in blue in the following figures, which does not align well with the data. The higher the correlation value is to 1, the more correlated the data is. The main results are:

- COVID-19 daily cases and stock market indexes have a weak correlation.
- The percentage of the U.S. population fully vaccinated and the stock market indexes have a strong correlation.



Conclusions

- As seen from hypothesis testing and correlation analysis, the growth of the stock market before and after COVID-19 were not largely affected by the pandemic cases in the long-term.
- The main effect of COVID-19 on the stock market was during March 2020 since that was the onset of the pandemic in the U.S.
- There was no particular sector of the economy that was more or less affected by COVID-19.
- Limitations to this research include only analyzing fifteen companies, which are all well-known and large corporations, so small businesses are not represented in this research.
- Future research can include analyzing the effect of COVID-19 on different size businesses.

Acknowledgements

This research is supported by the Department of Mathematics and Computer Science at Samford University.

References

"CDC Covid Data Tracker." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, https://covid.cdc.gov/covid-data-tracker/trends_dailycases.

Mathieu, Edouard. "State-by-State Data on COVID-19 Vaccinations in the United States." Our World in Data, 16 Jan. 2021, https://ourworldindata.org/us-states-vaccinations.

"Yahoo Finance - Stock Market Live, Quotes, Business amp; Finance News." Yahoo! Finance, Yahoo!, https://finance.yahoo.com/.