Studying Wuhan Lockdown's Impact on Airline, Vaccine and Mask Industry in The Chinese Stock Market Through Empirical Models

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Abstract. In this paper, our group shows the effect of Covid-19 on the Chinese stock market as well as stock prices of the airline, mask, and pharmaceutical industries. We targeted three companies from each industry. For airlines: Air China (601111), China Eastern airline (600115), China Southern Airlines (600029). For masks, Mask: Tianjin Economic-technological Development Area Co Ltd (000652), Shanghai Dragon Corp (600630), Xinlong Holding Group Co Ltd (000955) Medical: Shenzhen Kangtai Biological Products (300601), Chongqing Zhifei Bio Products (300122), Walvax BioTech (300142). Through the Event Study Methodology, we first compared the actual return with the expected return on a signal stock. We derived our expected return by a linear regression model, then subtracted the expected return from the actual return in order to find the abnormal return. Next, we deduced a confidence interval to test the significance of the abnormal return. Our null hypothesis is Covid-19 has no impact on a certain industry. If the abnormal return exceeds the confidence interval, there is sufficient evidence to support that Covid-19 has a significant impact on the industry. If the abnormal return does not exceed the confidence interval, the null hypothesis is accepted.

Keywords: Covid-19, Airline Industry, Masks Industry, Pharmaceutical Industry, Event Study

1 Introduction

The coronavirus disease (COVID- 19) pandemic has been a serious issue in since 2020. On January 30, the World Health Organization (WHO) [1] classified Covid- 19 as a "Public Health Emergency of International Concern" (PHEIC). This pandemic spread rapidly as panic drove people to diffuse to safer areas; this phenomenon was further exacerbated as people changed locations during the Spring festival [2]. To contain the disease, the Chinese government set stricter travel restriction policies for the Airline industry [3]. As a result, the demand for aviation experienced a significant decline. The deficit amounted to 170.6 billion yuan since the beginning of the covid in 2019 [4].

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For the pharmaceutical industry, this is because that virus is untreatable and spread over 200 countries within several months. People we're afraid of the uncertain situation, society pays closer attention to the medical industry and masks can prevent people from infecting covid. The country needs some measures to prevent the rapid increase of new infections, like, doing the covid test and wearing the mask. Then the country also needs advanced medicine and vaccination to destroy the disease in the future. So, the pharmaceutical industry has experienced a huge increase.

In this essay, we aimed to determine to what extent the Wuhan lockdown influenced the Chinese airline industry and pharmaceutical industry's stock market prices through examining the abnormal fluctuations of the market's stock price in the period following the announcement of the lockdown. The topic we intended to discuss is a new one and not over yet. There is not much research on this topic, so our main direction is to use mathematical methods and models to evaluate the effect of Covid-19. The methodology used is as followed: we use actual return minus expected return to give us the abnormal return of the stock. Then we use the confidence interval to test the significance. If the level of cumulative abnormal return (CAR) exceeds that of the confidence interval, it suggests that the market is in an abnormal period, which is what we plan to investigate through such research. We let H0: Covid-19 not affect the stock price. Additionally, the stock market has recovered with mass vaccination and the recovery of the airline industry. So far, our study is not like other studies, we choose three companies from each industry to evaluate the impact due to the Covid-19. The remainder of the paper is structured as follows: in section two, we will describe our methodology to analyze the impact. In section three we will analyze quantitative results obtained through our method and conclude our research in section four.

2 Methodology

Before analyzing the level of impact, the Wuhan lockdown has on the stock market through empirical analysis, we need to first establish our hypothesis for the outcome of this study:

Null-hypothesis: The Wuhan lockdown due to COVID- 19 had no significant effect on the respective Chinese industries we chose (Vaccine Industry, Mask Production Industry and Airline Industry)

Alternative Hypothesis: The Wuhan lockdown due to COVID- 19 had significant effects on the respective industries mentioned above

To determine the impact of the pandemic on the stock market, we employed the traditional method of Event Study Analysis, which was first introduced by James Dolly in 1933 [5]. The method is commonly employed to examine the level of impact a specific event has on a certain company or industry, most commonly through measuring the levels of cumulative abnormal return before and after the event. To further conduct our studies, we must make two further assumptions: 1) No other significant event has affected the stock price apart from the event that's being studied during the window; 2) The level of impact of the Wuhan lock down is reflected through the level of abnormal return in the stock market.

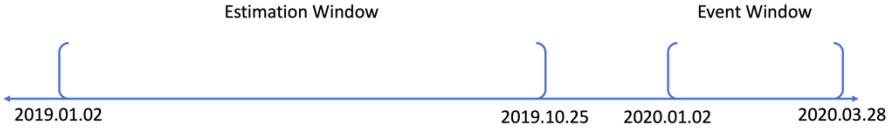
Throughout the paper, we will calculate the level of normal return (NR), level of abnormal return (AR) and find the level of Cumulative Abnormal Return (CAR) by comparing the actual return, collected from Investing.com, with the level of Expected Return we've obtained by establishing a model in the prediction window.

Our process of data analyzation involves three major steps:

1) Identifying the specific event to study by outlining the date and the interval of event window.

2) Identifying the interval for predicted window and establishing a model that correlates the market return and individual stock return. This allows us to predicted future expected returns based on the market return during the event window.

3) Calculating the cumulative abnormal return during the event window. We will use the confidence interval to determine whether the cumulative abnormal return is significant or not. If the CAR exceeds the confidence interval, we can deduce that the original model no longer fits the respective firms, and a huge impact has been made on the industry by the event selected.



Our Estimation Window starts from 2019.01.01 and ends 2019.10.28
Our Event Window starts from 2020.01.01 and ends 2020.03.01

Fig. 1. Estimation and Event Window (self-painted)

We carefully chose the Estimation Window when the market hasn't been affected by the rise in COVID- 19. According to news [6], COVID started in December of 2019. Considering the possibility that there might be leakage of inside information, we specifically left a gap between the estimation window and the event window to decrease the chances of our result being affected. The period for Estimation window and Event Window has been displayed in the Figure 1 above.

We found the Actual Rate of Change by subtracting the closing price of the previous trade day from the current and dividing it by the closing price of the previous day.

$$AR = \frac{PTice_{Current} - PTice_{prev}}{PTice_{prev}} \tag{1}$$

After calculating the Actual Return, we deduced a linear model that estimates the expected future return of a stock from average return of the Chinese stock market. We will use the Chinese Security Index 300 (CSI 300 index, Shanghai Shenzhen 300 Index)as an indicator of the performance of the overall Chinese stock market. The Expected Return E(x), by definition, is the return of the stocks if the event did not occur. To estimate future stock prices, we needed to determine the relationship between the market and the respective firms in absence of the event. We obtained the data for the Actual Return during the Estimation window and used the Least Square Method to determine the regression model. After solving, we obtained relationships:

$$Rt = \alpha + \beta \times Rmt + \varepsilon t \quad (2)$$

Where Rt denotes the actual return of the firm at a time t, Rmt is the return of the Chinese stock market, reflected by CSI 300 index. εt accounts for potential error or residual of the model. To demonstrate, below is the graph for China Eastern Airline (600115):

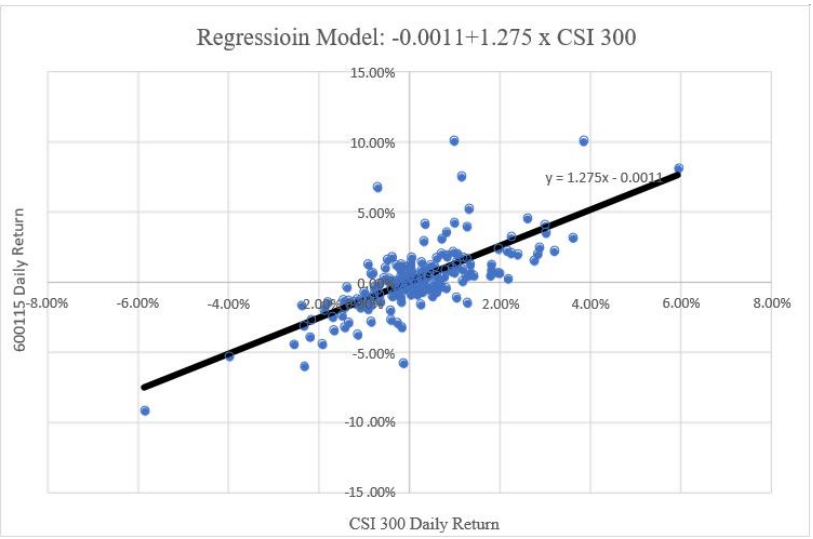


Fig. 2. Regression model of CSI 300 and China Eastern Airline (self-painted)

As shown in Figure 2, the X-axis represents the return rate of CSI 300, and the Y-axis represents the daily return of stock 600115. The black line represents the linear regression, which is accurate considering it has a variance of only 0.000253605.

After obtaining the linear regression model, we deduce the variance of our model through the formula:

$$\sigma = \sum_{t \in D} \left(\frac{(Actual\ Return - Expected\ Return)^2}{Total\ Days - 1} \right) \quad (3)$$

The variance would be later used to calculate the confidence interval and to compare the significance of the event.

Once we've obtained the model, our next step is to find the level of abnormal return that occurred during the event window. To do so, we will estimate the normal level of return by substituting the CSI 300 daily return into the constructed model. After calculating the expected return, we will find the Abnormal Return by subtracting the expected value from the actual daily return of the stock:

$$AR = R_t - E(x) = R_t - (\alpha + \beta \times R_{mt}). \quad (4)$$

The difference between the two values would account for the abnormal return. In order to see whether the stock market was significantly impacted, we accumulated the level of return within the interval. In consideration of possibility of inside information leakage,

we also included 15 trade days prior to the announcement of Wuhan lockdown to have a further view of the stock return.

To get cumulative abnormal return (CAR), we simply add the result of daily abnormal return, which was obtained through formula 4.

The CAR during the event window is calculated as:

$$CAR(t) = \sum_{s=1}^{t} AR_s \tag{5}$$

Where S represents the first day of the event window and t represents the total number of days included in the event window. The cumulative abnormal return at time T would be the Abnormal Return on every trade day before T.

After obtaining CAR, we can measure the significance of the event by comparing it with the confidence interval. If our null hypothesis, no effect has taken place on the respective sectors, is true, then the cumulative abnormal return should take place within:

$$(-1.96 \times \sqrt{TG_e^2}, 1.96 \times \sqrt{TG_e^2}\ ) \tag{6}$$

with T representing Trade Day after the event. We decided to use 1.96 times the standard deviation since it should represent where 95% of the abnormal return should be; exceeding the confidence level would suggest that the original model is no longer appliable. However, if cumulative abnormal return exceeds this interval, it is implied that the original model no longer fits the firm as changes have occurred. As a result, we would have the confidence to reject the null-hypothesis and conclude that the event of Wuhan lockdown did indeed influence the industries' stock price. As demonstration, below is the CAR diagram constructed for China Eastern Airline:

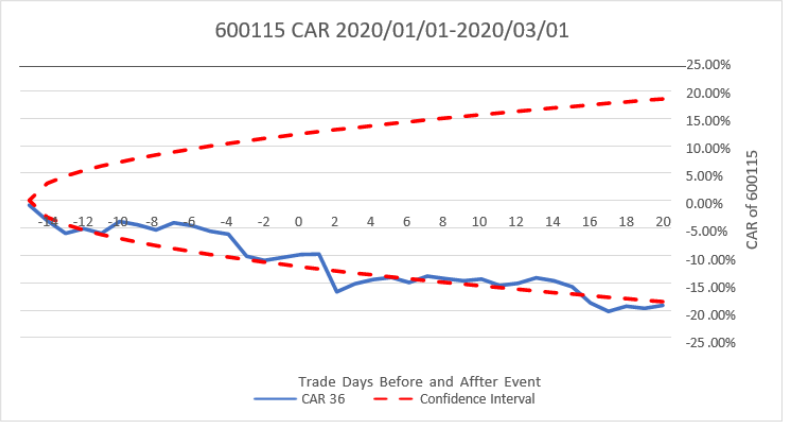


Fig. 3. Cumulative Abnormal Return Graph of China Eastern Airline (self-painted)

As demonstrated in Figure 3, the blue line indicates the cumulative abnormal return over the interval of 36 trade days, while the red dashed line indicates the confidence interval. Since the blue line immediately crossed the confidence boundary after the occur of the event, we can reject our null hypothesis and conclude that the Wuhan lockdown has had a significant effect on the stock price of this firm.

3 Empirical Results

In this section, results are discussed based on the methodology used. This section also gives us an overview of how the conclusion should be. The figure 4 above shows the change in price between January 2019 and October 2019.

Fig. 4. Stock Price of Market (self-painted)

3.1 Mask Stocks

For mask production firms, we focused on those that produced civilian-use masks. We chose Tianjin Economic-technological Development Area Co Ltd (000652), Shanghai Dragon Corp (600630) and Xinlong Holding Group Co Ltd (000955). Stock 000652, 600630, and 000955 have been represented by Figure 5, Figure 6 and Figure 7 respectively below.

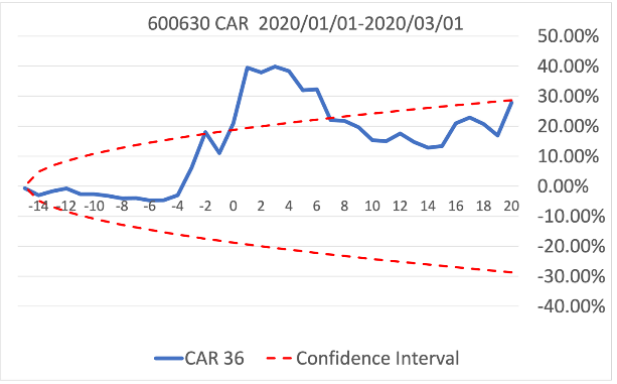


Fig. 5. The cumulative abnormal return of stock 600630. (self-painted)

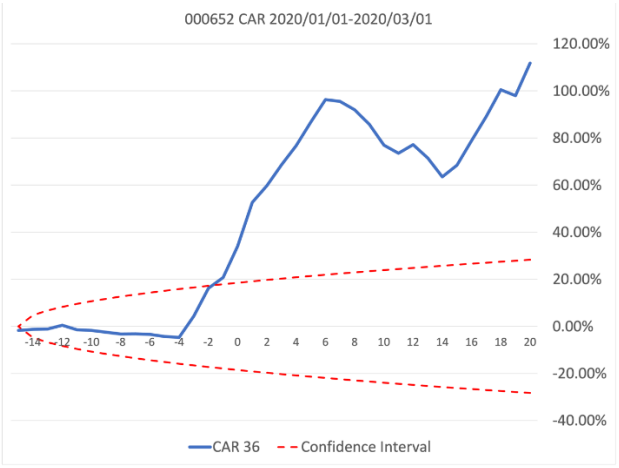


Fig. 6. The cumulative abnormal return of stock 600652 (self-painted)

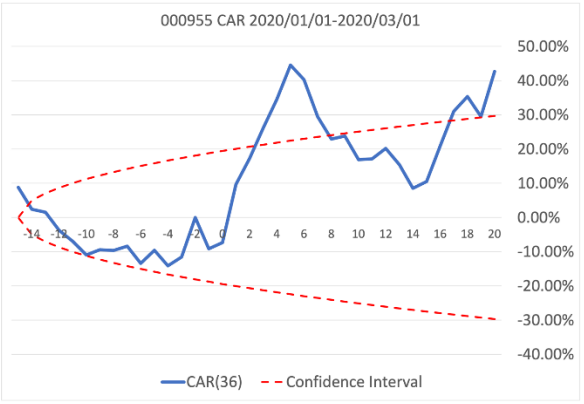


Fig. 7. The cumulative abnormal return of stock 000955 (self-painted)

After choosing the stocks to reflect the mask industry, we constructed the cumulative abnormal returns for the 3 mask stocks. There is a noticeable upwards trend in cumulative abnormal return around the time T=0, indicating a strong response of all the stocks towards the Wuhan lockdown. All three stocks' CAR sky-rocketed above the confidence interval immediately after the announcement of Wuhan lockdown and have fluctuated around the upper confidence level from then on. At the end of the event window, stock 600630, 000652 and 000955 experienced an average cumulated abnormal return of 60.78%, far exceeding the average confidence level of 28.88 %. This indicates that the event of Wuhan lockdown did have a significant effect on the demand for masks, which is reflected through the abnormal levels of stock prices. Thus, we can accept our alternative hypothesis and reject the null hypothesis.

3.2 Airline Stocks

For the airline stocks, we selected firms that accounted for the largest percentages for civilian airline flights in 2020 as demonstrated in figure 8 below. With China Southern Airline (600029) occupying 23%, followed by China Eastern Airline (600115) and Air China (601111). These three account for over half of all Chinese airlines in 2020 and we believe they can effectively reflect the airline industry in China.

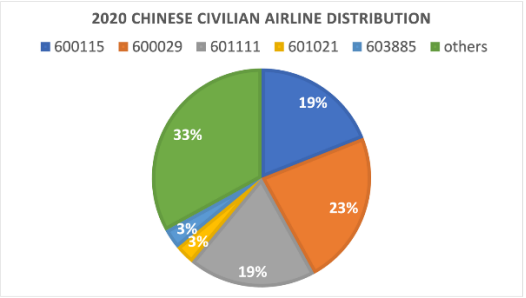


Fig. 8. Percentage of Civilian Flights of Firms in 2020 (self-painted) (@Forward-The Economist)

After selecting the firms with highest percentage, we constructed diagrams to model the cumulative abnormal return. Figure 9, Figure 10, and Figure 11 shows the cumulative abnormal return of the stocks 600115, 600029 and 601111 respectively.

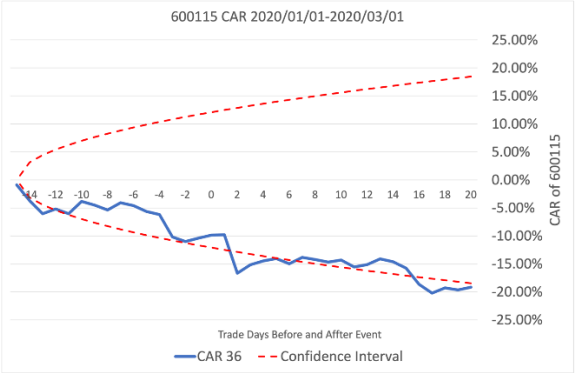


Fig. 9. The cumulative abnormal return of stock 600115 (self-painted)

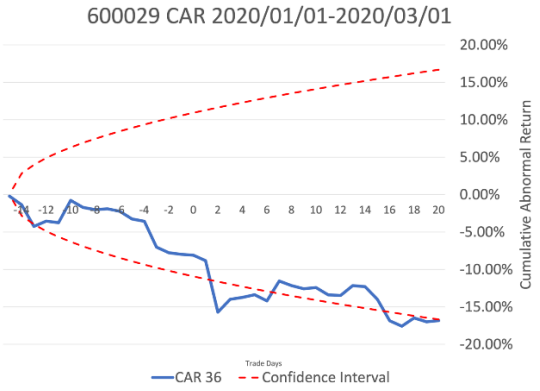


Fig. 10. The cumulative abnormal return of stock 600029 (self-painted)

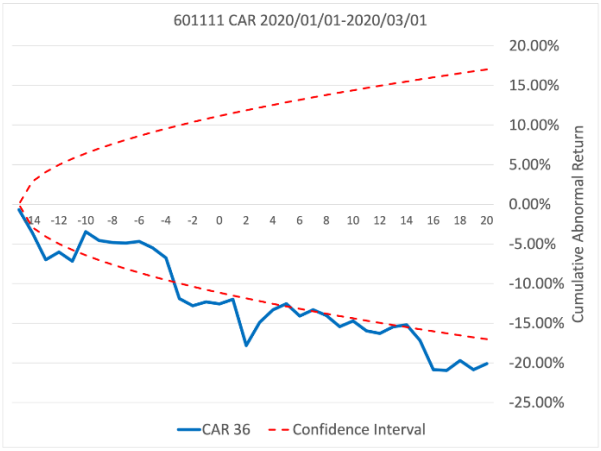


Fig. 11. The cumulative abnormal return of stock 601111 (self-painted)

Over the period of the event window, the airline stocks' CAR showed downward trends and soon exceeded the confidence interval. After exceeding the confidence level, they lingered around the lower boundary. As shown in all the above graphs: at the start of the event window, negative CAR has already taken place, indicating that there might be inside information before the announcement of the Wuhan lockdown. The three stocks had an - 18.7% cumulated abnormal return, exceeding the average confidence interval of - 17.39%. This proves our hypothesis that the lockdown event did have an impact on the airline industry and thus supports our Alternative hypothesis.

3.3 Vaccine Stocks/Pharmaceutical Stocks

For Pharmaceutical stocks, we selected firms with most of their business focused on vaccine production: Shenzhen Kangtai (300601), Chongqing Zhifei BioProducts

(300122) and Walvax BioTech (300142) all have vaccines occupying over 98% of their business (99.90%, 99.97% and 98.46% respectively).

Table 1. Activities of Pharmaceutical Companies

Stock	Pharmaceutical Economic Activity%	Vaccine Activity%	Produced Vaccine(10k)	Sold Vaccine (10k)	Revenue via Vaccine (100MRMB)
300601	99.91%	99.90%	2558.44	1955.78	22.59
300142	100%	98.46%	4457.07	4245.4	28.94
300122	100.00%	99.77%	1613.46	2945.01	151.56

Data from: General Administration of Civil Aviation of China Forward-The Economist

We believe there will be a strong surge in demand for vaccines during the pandemic. After determining the stocks, we successfully constructed the model regarding cumulative abnormal return. The graphs are shown below:

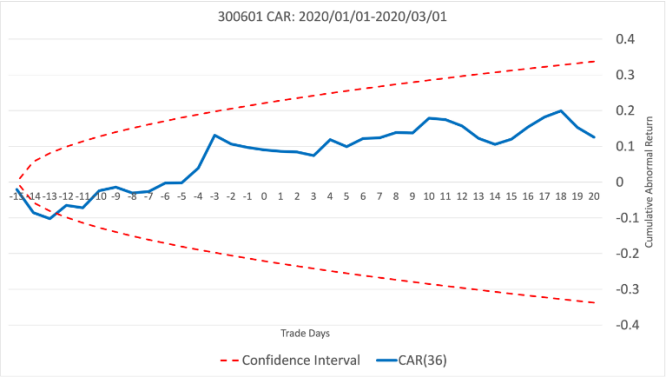


Fig. 12. The cumulative abnormal return of stock 300601 (self-painted)

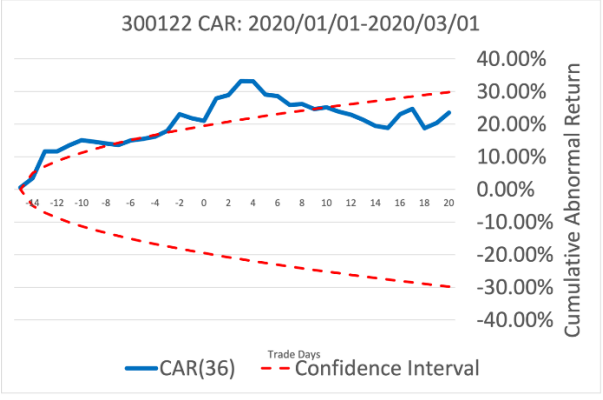


Fig. 13. The cumulative abnormal return of stock 300122 (self-painted)

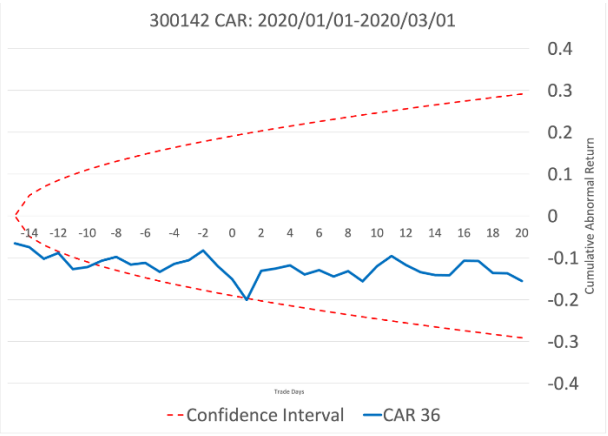


Fig. 14. The cumulative abnormal return of stock 300601 (self-painted)

While figure 12 and figure 13 both displayed an increasing Cumulative Abnormal Return, the CAR in figure 12 lied within the interval of confidence. Furthermore, stock 300142(figure 14) displayed negative abnormal return. The three diagrams did not display a strong reaction to the Wuhan lockdown as the average CAR didn't exceed the average confidence interval. As a result, our hypothesis was inaccurate, and we rejected our Alternative Hypothesis.

4 Conclusion

In this paper, we explored on the impact of the Covid-19 and proved that Covid-19 has had a substantial effect on both the airline and mask industry, both of which rejects our null-hypothesis. While an affect has taken upon the pharmaceutical industry, the levels of abnormal return varied between firms.

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