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Stock Market Returns and Announcements of COVID-19 Vaccine: An Event Study Analysis of Vaccine Companies

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Abstract. For vaccine companies, the announcements of the beginning and ending of COVID-19 vaccine development are milestones of vaccine companies. Few studies have explored how announcements of COVID-19 vaccine affect stock market returns of vaccine companies. In this work, we match the announcements of the beginning and ending of COVID-19 vaccine development with three leading vaccine companies and adopt the event study methodology to examine the relationship between COVID-19 vaccine development events and changes in stock returns. We identify the 6 public announcements related to 3 beginning and 3 ending as well as 3 vaccine companies. The majority of the events were associated with stock prices increases when those events happened. Our study shows that Covid-19 vaccine R&D have material economic *implications* and the result shows that investors can use biological company announcements as a solution for determining when to invest in the company and its competitors.

Keywords: stock market returns, COVID-19 vaccine, event study methodology

1. Introduction

The announcements of the beginning and ending of COVID-19 vaccine development are milestones of vaccine companies. The value of these two endpoints is high because they not only increase the profitability of these biopharmaceutical companies but also provide a prospect to relieve sickness and suffering.

Many industry commentators have stated that the vaccine companies face a research and development (R&D) 'productivity dilemma' [1]. On the one hand, enormous payback of the COVID-19 vaccine is foreseeable. On the other hand, since late-stage clinical trials (Phase II and Phase III) are expensive, any distraction such as a pause of the R&D process and releases from competitors will have a subtle and profound impact on the vaccine company [2].

Given the risks and returns, the releases of the beginning and ending of COVID-19 clinical trials are important moments in the whole COVID-19 vaccine development process. Since the stock price

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of a company reflects its current and future earning capability, the announcements of beginning and ending are expected to have a positive effect on the stock prices.

2. Literature Review

Several industry commentators pointed out that the biopharmaceutical industry faces a Research and Development productivity crisis since the Phase 3 trials typically cost up to 40% of the total Research and Development costs [3]. That is why one goal of this study is to investigate the impact of the endpoint of COVID-19 vaccine development on the stock prices.

To measure the market value effects of our sample of beginning and ending, we used event study methodology, an approach widely used in financial economics. A number of studies investigate the impact of vaccine R&D on the company's stock price. In Maximilian Vierlboeck's view, the company announcing R&D typically gets significant positive abnormal returns, but the effect of R&D announcements on rival companies is not clear [4]. Abnormal returns of the rival company reacted to the R&D information of the announcing company may be either positive, negative, or may be no abnormal returns. Besides, we believe that a vaccine race exists among vaccine companies. Unlike follow-on competitors, the first company to research a new product or process reaps disproportionate profits. Therefore, every company is eager to complete the development of new products or new processes in the first place relative to its competitors [5]. To contribute to this scarce field, we not only study the impact of announcements of beginning and ending on the company that released the announcement but also determine whether the announcement significantly affected the stock returns of other competitor companies.

3. Methodology

3.1. Sample Selection

Our sample of firms was formed from three premier biopharmaceutical and biotechnology companies (Pfizer, AstraZeneca, and Johnson & Johnson) that actively developed their own COVID-19 vaccine from 2020 to 2021. For our events, we focused on two types. The first type of event is public announcements that companies determined to develop potential vaccines. The second type is papers issued regarding results from Phase 3 trials. We searched the official website of Pfizer, AstraZeneca, and Johnson & Johnson for those events. The keywords for the search were: ‘co-develop,’ ‘covid-19 vaccine,’ ‘clinical trials,’ ‘Phase 3,’ and ‘Journal.’ Description of all events we studied are provided in Table 1.

Table 1: Events of COVID-19 Vaccine Selected in the Study.

Firm	Date	Event
Pfizer	03/17/2020	Pfizer and BioNTech announce to co-develop potential COVID-19 Vaccine
Johnson & Johnson	04/23/2020	Johnson & Johnson announces collaboration to expand manufacturing capacity for its COVID19 Vaccine candidate
AstraZeneca	04/30/2020	AstraZeneca and Oxford University announce landmark agreement for COVID-19 Vaccine
AstraZeneca	12/08/2020	AZD01222 Oxford Phase 3 Trials interim analysis results published in The Lancet
Pfizer	12/10/2020	Pfizer and BioNTech announce publication of results from Landmark Phase 3 Trial of COVID-19 Vaccine candidate in the New England Journal of Medicine

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Table 1: (continued).

Johnson & Johnson	04/21/2021	Johnson & Johnson publish results from Landmark Phase 3 Trial of COVID-19 Vaccine candidate in the New England Journal of Medicine

Notes: Sample announcements were manually matched with unique clinical trials. Every single piece of event information came from company official websites.

3.2. Data Collection and Event Study Methodology

We are able to study how specific events change the company's prospects by quantifying the impact of events on company stocks. In this study, it was examined whether the major biotechnology companies that work with COVID-19 vaccines during the pandemic period have different returns than the period when they are not involved in developing vaccines. This paper used the event study to determine abnormal returns (ARs) and cumulative abnormal returns (CARs) and then identified the effects of the vaccines.

First, we defined the 6 different event windows as 7 trading days before and after event dates listed in the above table, and the estimation window as 300 trading days (from 12/26/2018 to 03/05/2020), before the date when the first announcement regarding cooperative R&D claimed by Pfizer.

To estimate ARs during the event windows, we need to build the expected model. The market model, chosen for the study, builds on the actual return on the reference market and the correlation between the company's stock and the reference market. In the market model,

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

where R_{it} is the actual daily return for firm i on day t and R_{mt} is the stock market index return on day t, here S&P 500 stock index is used as the market portfolio. α_i and β_i, two market model parameters, were estimated by OLS using stock price data during the estimation period from the website, Investing. ε_{it} is the one-day risk-adjusted residual for firm i. We also defined the expected stock return for company i on day t:

$$\hat{R}_{it} = \alpha_i + \beta_i R_{mt} \quad (2)$$

Next, we calculated the AR_{it} within the event window as follows:

$$\mathrm{AR}_{it} = R_{it} - \hat{R}_{it} \quad (3)$$

Finally, each firm's cumulative abnormal returns (CAR_i) for each time interval within the event window (t_1, t_2) was computed by:

$$\mathrm{CAR_i}(t_1, t_2) = \sum_{t_1}^{t_2} \mathrm{AR}_{it} \quad (4)$$

In our study, if each event date were defined as day 0, firm-level CAR would be calculated for the (-7, -7+n) windows separately, where $n \in [1, 14]$

3.3. Statistical Analysis

The answer about statistical significance is given by means of hypothesis testing, where the null hypothesis ($\mathrm{H_0}$) states that the mean of cumulative abnormal returns within the event window equals to zero and the alternative hypothesis ($\mathrm{H_1}$) states the opposite.

Here we used a two-sided T test, with significant levels $\alpha = .01, .05, .1$. In order to obtain t statistics, we standardized $\mathrm{CAR}_i(t_1, t_2)$ using the standard error of residuals ($\hat{\sigma}_i$) to obtain t statistics:

$$T = \frac{\mathrm{CAR}_i(t_1, t_2)}{\hat{\sigma}_i \sqrt{N}} \quad (5)$$

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where $N = t_2 - t_1 + 1$, $\hat{\sigma}_i^2 = \frac{\sum_{t_1}^{t_2}(R_{it} - \hat{R}_{it})^2}{N-2}$

4. Empirical Results

Our sample includes 6 public announcements related to 3 beginnings and 3 endings as well as 3 vaccine companies. These vaccine companies are Pfizer, AstraZeneca, and Johnson & Johnson.

4.1. Stock Returns Analysis

The majority of events were associated with stock prices increases when those events happened (T = 0). In the majority of cases, the signs of the cumulative abnormal return (CAR) ±7 days were positive.

For Pfizer's beginning of development, the CARs of Pfizer for 10/13 days and Johnson & Johnson for 7/13 days were positive, while the CARs of AstraZeneca for 11/13 days were negative (Figure 1). The CARs of Pfizer and Johnson & Johnson were significantly positive one day after the event happened, whereas the CAR of AstraZeneca was significantly negative.

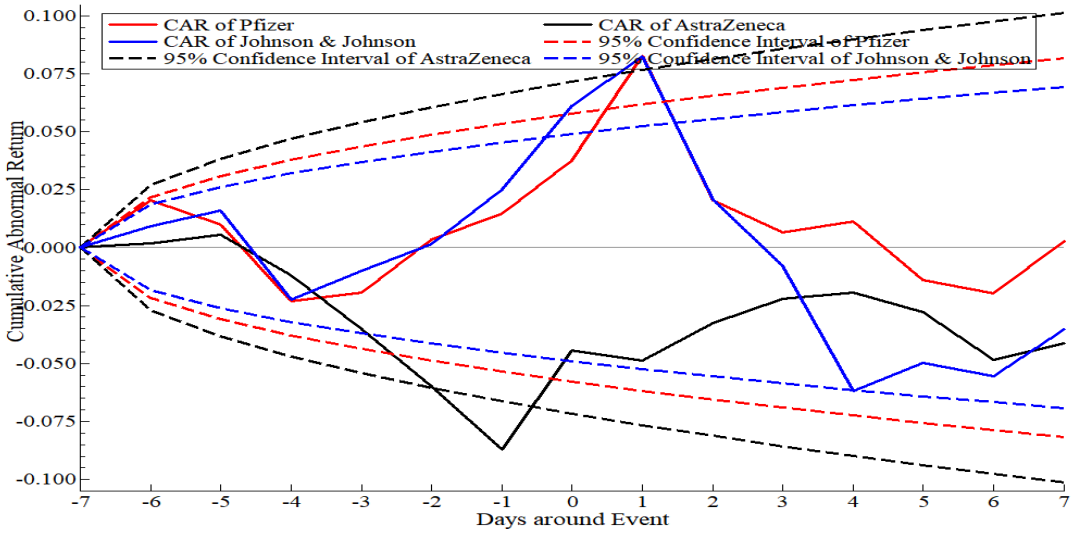

Figure 1: Cumulative abnormal return of Pfizer's announcement of COVID-19 vaccine development.

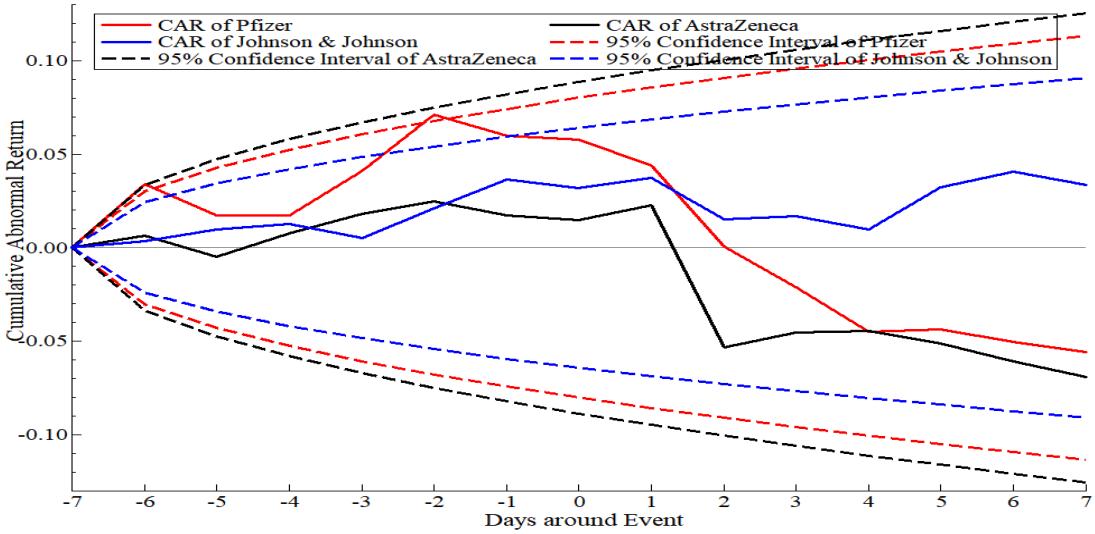

Figure 2: Cumulative abnormal return of Pfizer's publishment of results from phase III clinical trial.

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For Pfizer's ending of development, the CARs of Pfizer for 9/13 days, Johnson & Johnson for 13/13 days, and AstraZeneca for 7/13 were positive (Figure 2). The CARs of Pfizer were significantly positive at day -6 and day -2, whereas the CARs of Johnson & Johnson and AstraZeneca were moderate.

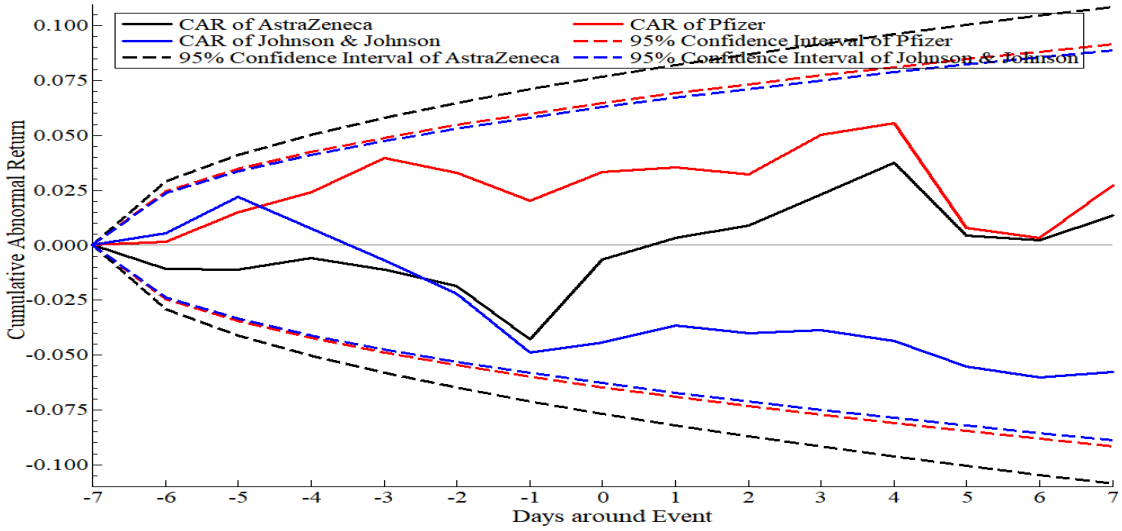

Figure 3: Cumulative abnormal return of AstraZeneca's announcement of COVID-19 vaccine development.

For AstraZeneca's beginning of development, the CARs of AstraZeneca for 7/13 days and Pfizer for 13/13 days were positive, while the CARs of Johnson & Johnson for 11/13 days were negative (Figure 3). All CARs were moderate.

For AstraZeneca's ending of development, the CARs of AstraZeneca for 9/13 days, Pfizer for 13/13 days, and Johnson & Johnson for 13/13 were positive (Figure 4). The CARs of Pfizer were significantly positive from day -6 to day 3 (10/14), whereas the CARs of Johnson & Johnson and AstraZeneca were moderate.

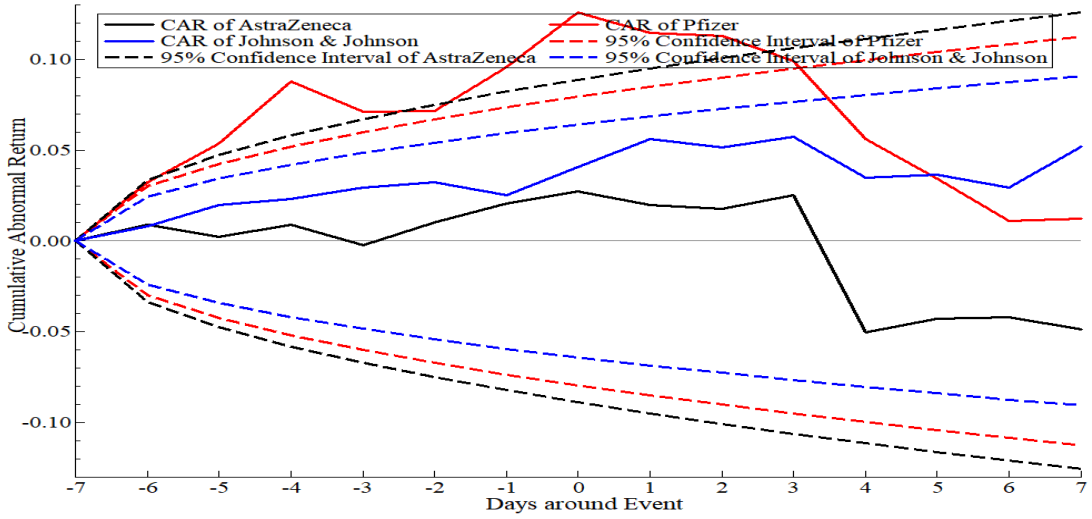

Figure 4: Cumulative abnormal return of AstraZeneca's publishment of results from phase III clinical trial.

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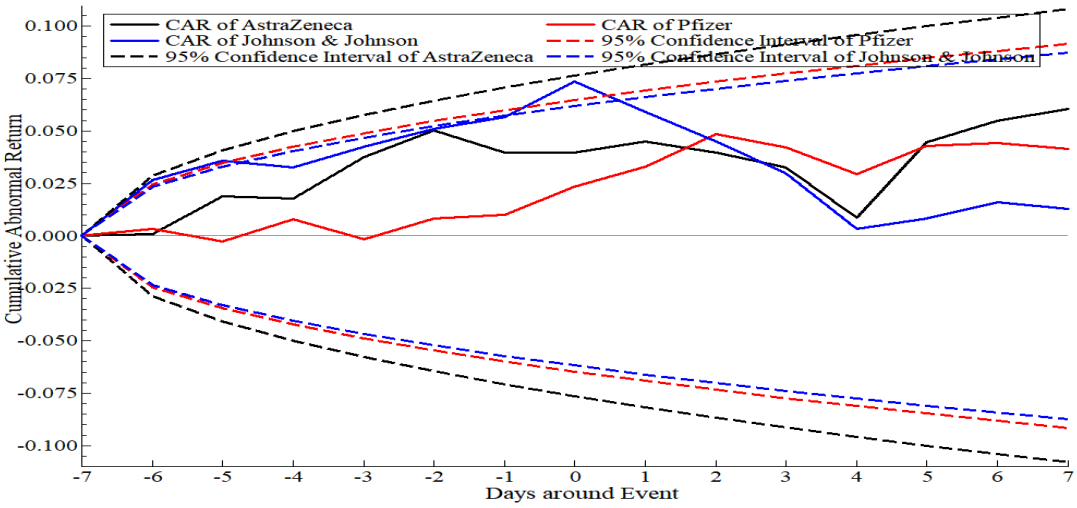

Figure 5: Cumulative abnormal return of Johnson & Johnson's announcement of COVID-19 vaccine development.

For Johnson & Johnson's beginning of development, all CARs of Johnson & Johnson and AstraZeneca were positive, while the CARs of Pfizer for 11/13 days were positive (Figure 5). The CARs of Johnson & Johnson at day -6, -5, and 0 were significantly positive, while the CARs of Pfizer and AstraZeneca were moderate.

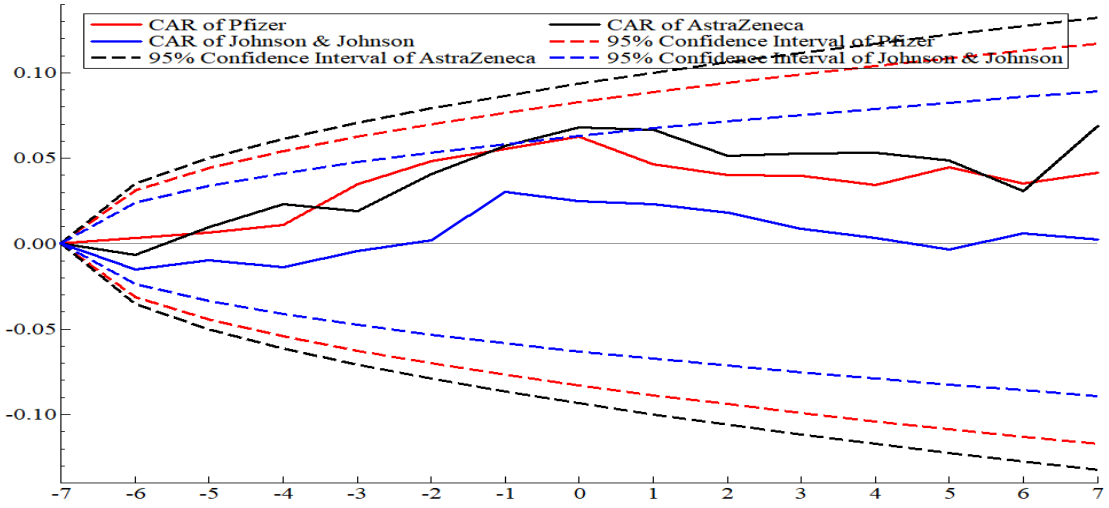

Figure 6: Cumulative abnormal return of Johnson & Johnson's publishment of results from phase III clinical trial.

For Johnson & Johnson's ending of development, the CARs of Johnson & Johnson for 9/13 days, Pfizer for 13/13 days, and AstraZeneca 12/13 were positive (Figure 6). The CARs of AstraZeneca were significantly positive when the event happened, whereas the CARs of Johnson & Johnson and Pfizer were moderate.

5. Conclusion

In this essay, we evaluated the impact of coronavirus vaccine R&D on the share price fluctuations of three of the biggest biopharmaceutical companies. This paper used empirical study methodology to

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connect daily share price with the results from clinical trials. Empirical results showed that public announcements of the development of potential vaccines exert more influence on the stock market than the release of Phase 3 test results. According to the results of our research data (Figure 1-6), there were 5 of the 18 events in the vaccine clinical trial process having significant effects on stock return of the company, with only one (ps: In Form 2 and Form 4, Pfizer's time coincides, so we believe that the AstraZeneca's research result for Pfizer has none research value) corresponding to Phase 3 clinical trial and four related to the announcement of the beginning of the research. We believe this is because that the insider trading will cause the stock price to react in advance relative to the event, thereby reducing the stock price volatility within the event window. Insider trading in Phase III trials is simpler than when companies announced the beginning of a vaccine development, due to the fact that Phase III trials are open to the public. In fact, before vaccine trial results are released, many people who participate in the phase 3 trial process are likely to have information regarding the result [6].

In addition, our findings also suggested that the announcements of the start of the vaccine development typically led to increases in stock prices of the firms that made those announcements, which was consistent with our hypothesis. Besides, we found support for the contagion or competitor effect. As the first pharmaceutical company among the three companies to announce the development of a vaccine, Pfizer's stock price has increased significantly and had a positive contagion effect on Johnson & Johnson. On the contrary, AstraZeneca as a competitor has received significant negative abnormal returns. We believe that the opposite effect is due to AstraZeneca's indifferent attitude towards vaccine development in the early stages of the epidemic. (Before March 17,2020, there was no related entry about AstraZeneca vaccine in google search). By contrast, Johnson & Johnson showed a strong interest in developing vaccines at the beginning of the outbreak [7]. Pfizer has increased the confidence of vaccine investors and has produced positive spillover benefits for other companies expressing the hope to develop vaccines, while AstraZeneca was perceived by investors to be unable to capture future profits from covid-19 vaccine market. These findings support the efficient market hypothesis proposed by Burton G. Malkiel in 2003 [8]. He believes that the stock market is remarkably efficient and investors react rapidly to the new information.

Overall, our study shows that Covid-19 vaccine R&D have material economic implications and the result shows that investors can use biological company announcements as a solution for determining when to invest in the company and its competitors

Acknowledgment

Yichen Luo and Yiwei Wang contributed equally to this work and should be considered co-first authors.

References

[1] *Scannell, J.W. et al. (2012) Diagnosing the decline in pharmaceutical R&D efficiency. Nat Rev Drug Discov, 11(3): 191-200.*

[2] *Munos, B. (2009) Lessons from 60 years of pharmaceutical innovation. Nat Rev Drug Discov, 8(12): 959-968.*

[3] *Hwang, T.J. (2013) Stock market returns and clinical trial results of investigational compounds: an event study analysis of large biopharmaceutical companies. PloS ONE, 8(8).*

[4] *Maximilian Vierlboeck. (2021) Effects of COVID-19 Vaccine Developments and Rollout on the Capital Market -- A Case Study. https://arxiv.org/abs/2105.12267.*

[5] *Hosseini, A., Soltani, S. and Mehdizadeh, M. (2018) Competitive Advantage and Its Impact on New Product Development Strategy (Case Study: Toos Nirro Technical Firm). Journal of Open Innovation: Technology, Market, and Complexity, 4(2).*

[6] *Ferguson, J. (1997) Biomedical Research and Insider Trading. New England Journal of Medicine, 337(9): 631-634.*

DOI: 10.54254/2753-7048/3/2022295

[7] *CNBA news. (2020) J&J scientific officer 'pretty confident' they can create coronavirus vaccine as outbreak widens. https://www.cnbc.com/2020/01/27/jj-pretty-confident-it-can-create-china-coronavirus-vaccine.html.*

[8] *Malkiel, B. (2003) The Efficient Market Hypothesis and Its Critics. Journal of Economic Perspectives, 17(1): 59-82.*