

The Impact of the Announcement of the Vaccine's Success on the Company's Stock

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Abstract. This article examines the impact of Pfizer's announcement of the vaccine's success within the framework of the ongoing COVID-19 situation. By constructing ARIMA model, this paper compares Pfizer's stock price change after the vaccine announcement with the forecast unannounced stock price change, so as to judge the impact on the company. This paper found that the company's stock price rose significantly, proving that the company can promote the development of vaccine research and development by announcing a positive image. This paper covers the economic and public health areas to study the impact of the company, and the use of time series to predict. Through the research conclusion, this paper suggests that investors may prefer to choose a more positive image and impact of the enterprise investment, in order to protect returns. At the same time, leaders can also lead the enterprise to create a positive image, to bring more support and opportunities.

Keywords: COVID -19; ARIMA Model; Stock Price; Predictions.

1. Introduction

As the new coronavirus epidemic spreads worldwide, it has significantly impacted all areas of the world in a negative manner. According to research and reports, Covid-19 has triggered a substantial number of infections among humans worldwide. Many people infected have lost their lives as a result [1]. At the same time, the epidemic has caused tremendous pressure on the global public health system, medical resources are strained, and health care workers are overtired. Due to the policy restrictions of the epidemic, many industries around the world have been affected to varying degrees, especially tourism, catering, entertainment, and other service industries [2]. Closures and restrictions have also led to the closure of many related businesses and a considerable diminution in employment opportunities along with a substantial jump in unemployment levels, slowing global economic growth and impeding international trade [3]. The spread of the disease has also shifted people's approach to daily life. Social distance, wearing masks and handwashing have become a part of life since the outbreak [4]. The epidemic has also exacerbated social inequalities and made some vulnerable groups more vulnerable [5].

In addition, the epidemic has had an impact on the global political landscape and has challenged the political stability of some countries. The mood around the world is gloomy because people are nervous about being infected by the virus. They have little time to think about anything else. On November 9, 2020, Pfizer and German biotech company BioNTech jointly announced that their COVID-19 vaccine candidate (codenamed BNT162B2) had achieved significant success in the first interim analysis of the phase 3 study. The vaccine showed a protective effect of more than 90% in trials, marking a major milestone in global covid-19 vaccine development [6]. Pfizer's vaccine has its controversies and challenges. On the one hand, vaccine development and production require substantial resources and time, and the equitable distribution of vaccines on a global scale also faces challenges [7]. On the other hand, some people have doubts about the security and efficacy of the vaccination. More science and publicity are needed to dispel these doubts. However, it has certainly given humans a boost. The rapid emergence of vaccines has raised hopes of defeating the COVID-19 [8]. There is no doubt that the vaccine released by Pfizer has had a positive impact on the relief of the global outbreak. The Pfizer vaccine has been shown to be more than 90 percent effective, meaning that people who get it can significantly reduce their risk of contracting the virus, slowing the spread

of the disease [9]. Vaccines diminish not only the hazard of contracting an infection, but also substantially decrease the threat of experiencing severe disease manifestations and mortality in the event of infection. It is crucial to safeguard public health and alleviate the burden on the healthcare infrastructure. With the popularization of vaccination, the pandemic has been brought under control and economic activities are expected to gradually resume. This will help boost the recovery and growth of the global economy.

After discussing the impact of Pfizer's vaccine announcement on the world as a whole, it's worth examining whether Pfizer's announcement had a significant impact on Pfizer. In order to measure the impact of the vaccine announcement on Pfizer, this paper decided to use Pfizer's short-term stock price on the day after the announcement to try to avoid other unrelated factors.

As is known to all, stock price refers to the trading price of a stock. This price is determined by market supply and demand, and is affected by many factors, including company performance, industry dynamics, market sentiment, macroeconomic environment, news and events, investor expectations, valuation factors, capital flows and geopolitical risks [10]. The real meaning of stock price is the value of enterprise assets, which reflects the market's assessment of the company's assets and profitability. Share price movements also reflect market perceptions and expectations of company performance, prospects, and industry.

The pandemic of COVID-19 has truly left a profound and significant mark on the world's economy and societal fabric, as well as on the volatility of stock prices [11]. It just so happens that Pfizer's stock fluctuated a lot after the company announced the vaccine was a success. However, only a few studies have discussed why the company's share price fluctuates. In order to fill this gap, this article intends to study the relationship between this stock price fluctuation and this announcement. As a result, some irrational investments or strategies can be avoided.

"The remainder of this paper is structured in the following manner: Detailed information about the data sources, their reliability and the models discussed in this article are described in section 2. In the section 3, the ARIMA model are comprehensively discussed, and the analysis of stock return, stock volatility, forecast and interpretation are also discussed. Then, the emphasis, objective and importance of the research are discussed. Finally, section 5 briefly reiterates the final conclusion.

2. Research Design

2.1. Data Source

For getting accurate data, this article chose to download Pfizer's final prices for daily and weekly trading sessions from January 24, 2020, to the present on the financial information website ("cn.investing.com"). Investing.com is a platform that provides global financial market information and data. The website covers real-time quotes, news, analysis, and trading tools for various financial markets such as stocks, foreign exchange, commodities, futures, funds, bonds, etc. It aims to provide investors with comprehensive financial information and trading services. On the Investing.com website, investors can find real-time prices, historical data, and charts for various financial markets, understand market dynamics and trends [12]. In addition, the website also provides a series of analytical tools, such as technical indicators, trend predictions, risk assessments, etc., to help investors make more informed investment decisions. Data from all dates were imported into Stata software for analysis, and the date on which the company announced the successful development of the vaccine was November 9, 2020 was marked. Then the logarithmic series of stock index and the logarithmic return series are generated. Data is transformed by the formula $\ln(1 + x)$, continuing analysis in the logarithmic scale. The stationarity of both the logarithmic series and the series representing the logarithmic rate of return is likewise examined. Using the updated edited data, this paper will use Stata software to scrutinize the data and build a model for deeper investigation.

2.2. Augmented Dickey–Fuller (ADF) Unit Root Test

The first step is to test whether the data is stable. Based on the ADF test executed in Stata, the p-values listed in Table 1 for both the daily and weekly first-order differentials are less than 0.05, indicating statistical significance. Because of these findings, the evidence is strong enough to deny that variables have a unit root. Hence, the model constructed from the data is practical and the data is reliable.

Table 1 Weak stationarity test

	t	p
Daily		
Ln price	-2.869	0.1726
1st order difference	-10.960	0.0000
Weekly		
Ln price	-3.388	0.0530
1st order difference	-4.168	0.0050

2.3. ARIMA Model

The autoregressive integrated moving average (ARIMA) model enjoys widespread application in the field of time series analysis and prediction. It combines three components: autoregressive (AR), difference (I) and moving average (Ma). With its strong adaptability, it is capable of addressing the unique features of various time series data, including both trends and seasonal patterns.

First, the necessity and sufficiency of weak stationarity of AR (1) model is guaranteed. When x_t is a Autocorrelation with a statistically significant interval of 1, the hysteresis x_{t-1} may be useful in predicting x_t by building the following simple model.

$$x_t = \phi_0 + \phi_1 x_{t-1} + \alpha_t \quad (1)$$

$\{a_t\}$ a White noise with an average of zero.

AR (2) model is as follows.

$$x_t = \phi_0 + \phi_1 x_{t-1} + \phi_2 x_{t-2} + \alpha_t \quad (2)$$

In the same way, this paper can generalize from AR (1) model and AR (2) model to AR (p) model.

$$x_t = \phi_0 + \phi_1 x_{t-1} + \dots + \phi_p x_{t-p} + \alpha_t \quad (3)$$

MA (q)model is as follows.

$$x_t = \phi_0 + \alpha_t - \phi_1 \alpha_{t-1} - \dots - \phi_q \alpha_{t-q} \quad (4)$$

The MA model is inherently stable due to its construction as a linear mixture of white noise. Then this article can build ARMA (p, q) model.

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + \alpha_t - \sum_{i=1}^q \phi_i \alpha_{t-i} \quad (5)$$

The $\{a_t\}$ is a White noise, p model and q are both non-negative integers, and the AR model and the MA model are special cases of ARMA(p,q).When the sequence x_t is not stationary, the ARMA model cannot be constructed. When the difference order number is d and the sequence after the difference is stationary, the ARIMA model can be constructed, the choice of p and q is the same as before.

Following the introduction of the Arima model, this paper will use the model to predict the volatility of Pfizer's stock price when the vaccine is not announced. And this paper will compare that to actual stock price fluctuations to gauge the impact on the company of announcing the vaccine's success.

3. Empirical Results and Analysis

3.1. ARIMA Model Order Estimation

After finishing the stationarity test of the order difference of the stock price, this section can construct the ARIMA model. Pertaining to the order of the logarithmic stock return, PACF and ACF can aid in deducing the appropriate lag orders for the AR(p) and MA(q) components. In the Fig.1, this paper use the daily data to make this chart. The PACF exhibits a segment that surpasses the critical values by 9, whereas the ACF plots show a segment extending beyond the critical values by 7. Fig.1 demonstrates that AR(p) has order 9 and value of p is equal to 9. MA(q) has order 7 and value of q are equal to 7.

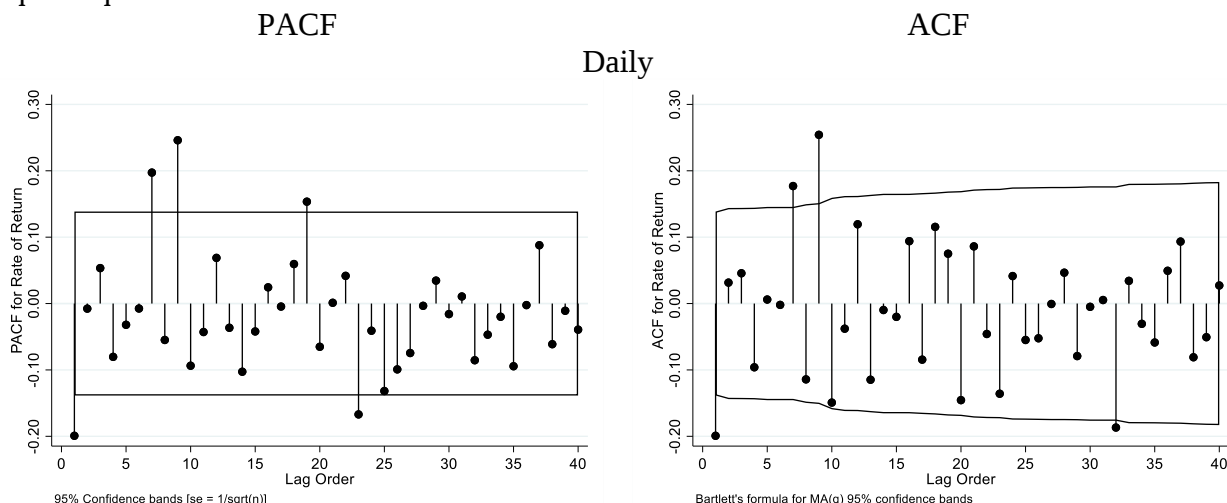


Figure 1 Daily PACF and ACF

Photo credit: Original

In the Fig.2, this article use the weekly data to make this chart. In PACF, the part that surpasses the critical values is 6. The part isn't beyond the critical values. So it is 0 for ACF plots. Fig.2 demonstrates that AR(p) has order 6 and value of p is equal to 6. The order of MA(q) is nonexistent, resulting in a value of q that equals 0.

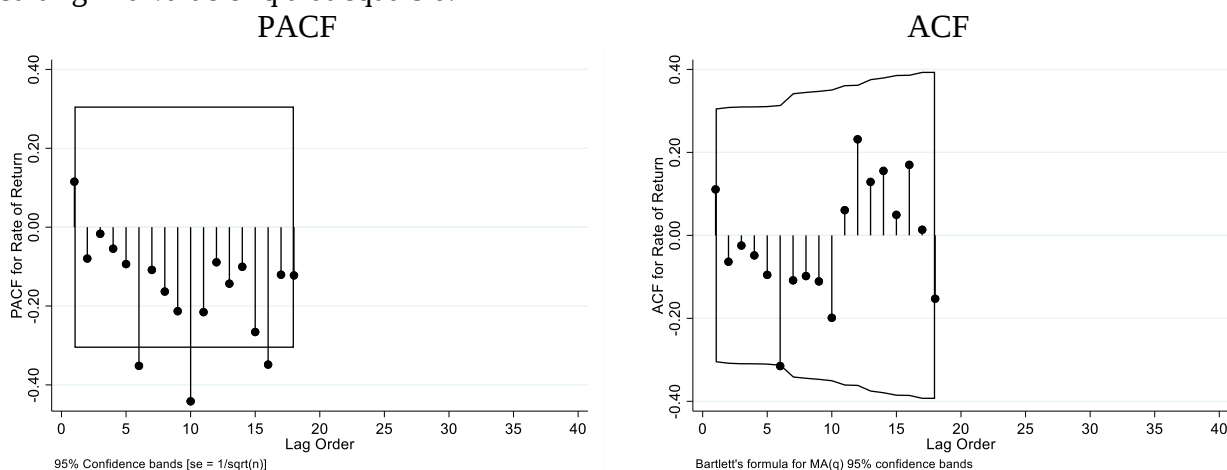


Figure 2 Weekly PACF and ACF

Photo credit: Original

3.2. Prediction and Interpretation

After determining the order of the ARIMA model, this article can start modeling. First, this paper use daily Pfizer price of stock to build ARIMA (9,1,7) model.

After building the model, the paper will use the residual test to confirm the rationality of the model. The result is as follows in Table 2.

Table 2 Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
Daily-ARIMA(9,1,7)	8398.2854	0.0000

Finally, this paper can use data from before Nov. 9,2020, to predict Pfizer's stock price after that, and compare it to actual stock prices. The result is as follows in Fig.3.

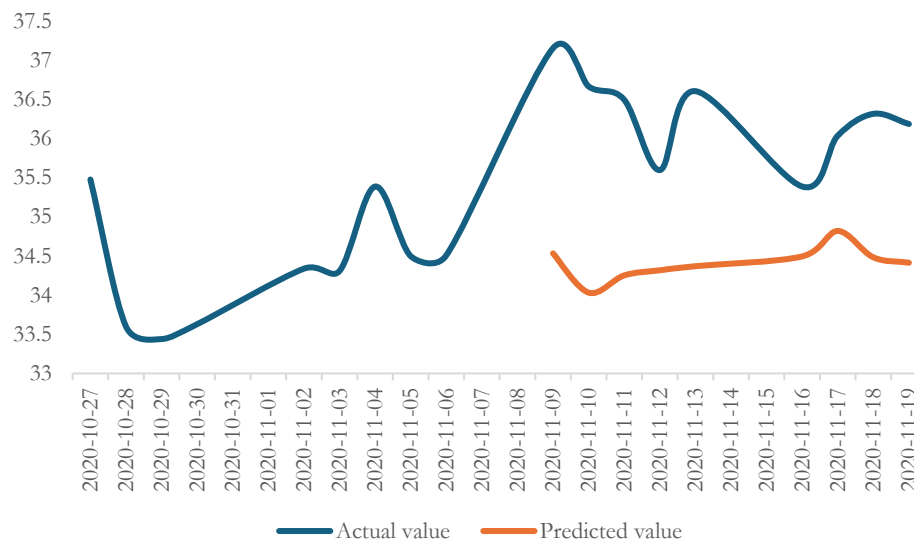


Figure 3 Actual value and predicted value, daily model

Photo credit: Original

According to the above Fig.3, stock prices rose significantly from the forecast price on the first day of trading on November 9,2020. It was up about 7.60% . From announcement day to ten days later, Pfizer's share price was significantly higher than forecast, so sudden fluctuations or other factors could be ruled out. Therefore, it can be roughly estimated that the revelation of the vaccine has a beneficial effect on the company, fuelling its growth and development.

Table 3 Actual value and predicted value, daily model

	Actual value	Predicted value	Difference	Difference (%)
2020-11-09	37.16	34.535546	2.624454	7.60%
2020-11-10	36.67	34.033342	2.636658	7.75%
2020-11-11	36.5	34.253827	2.246173	6.56%
2020-11-12	35.6	34.319076	1.280924	3.73%
2020-11-13	36.61	34.37154	2.23846	6.51%
2020-11-16	35.39	34.496778	0.893222	2.59%
2020-11-17	36.04	34.821873	1.218127	3.50%
2020-11-18	36.32	34.484922	1.835078	5.32%
2020-11-19	36.19	34.415651	1.774349	5.16%

Then, this paper uses weekly Pfizer price of stock to build ARIMA (6,1,0) model.

After building the model, the paper will use the residual test to confirm the rationality of the model. The result is as follows in Table 4.

Table 4 Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
Weekly-ARIMA(6,1,0)	70.1038	0.0023

After the residual test, this paper will use the weekly data to predict the stock price. The result is as follows in Fig.4.

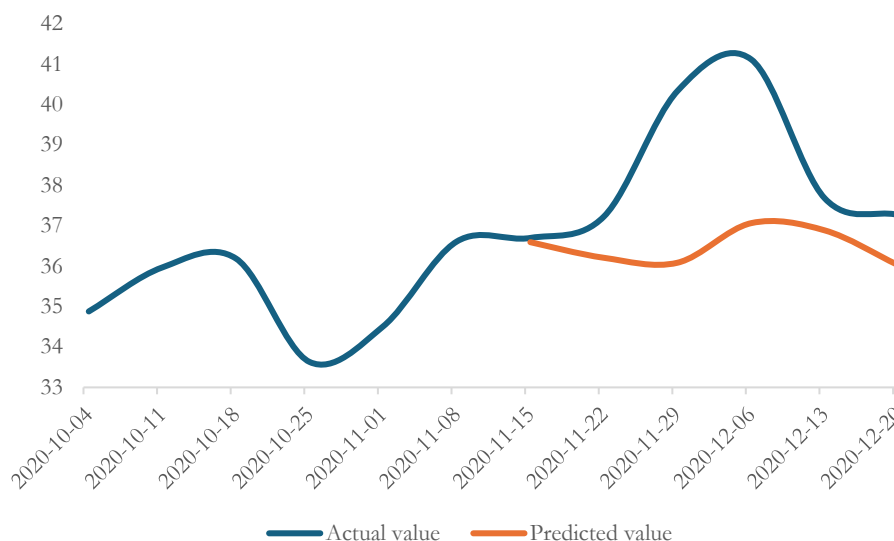


Figure 4 Actual value and predicted value, weekly model

Photo credit: Original

According to the above Fig.4, the paper found that the stock price in the third and fourth weeks of the forecast deviation is the largest, even up to 11.79%. In this paper, only seven-week predicted values were compared with actual values in order to control fluctuating factors in a short time to better judge the impact of successful vaccine development. It also avoids the interference caused by the fluctuation of other events caused by the too long selection interval. In summary, in the weekly data forecast comparison data, this paper can also judge the vaccine announcement on the company's stock price has a positive impact [13].

Table 5 Actual value and predicted value, weekly model

	Actual value	Predicted value	Difference	Difference (%)
2020-11-15	36.7	36.595174	0.104826	0.29%
2020-11-22	37.23	36.208121	1.021879	2.82%
2020-11-29	40.34	36.086689	4.253311	11.79%
2020-12-06	41.12	37.065534	4.054466	10.94%
2020-12-13	37.68	36.887008	0.792992	2.15%
2020-12-20	37.27	36.02447	1.24553	3.46%

4. Discussion

The study examined the impact of the vaccine announcement on the company's stock price. It was generally positive. Here are some examples of other documents that have studied the impact of Pfizer's COVID-19 vaccine development, such as "COVID-19 and China's Hotel Industry: Impacts, a Disaster Management Framework, and Post-Pandemic Agenda". This paper explores the economic implications of Pfizer's COVID-19 vaccine, discussing its potential to accelerate the global economic recovery by enabling the return of normalcy in economic activities [14]. Additionally, in "Barriers to COVID-19 Health Products in Low-and Middle-Income Countries During the COVID-19 Pandemic: A Rapid Systematic Review and Evidence Synthesis", this article discusses the scientific and social implications of Pfizer's COVID-19 vaccine, examining its role in addressing the pandemic while also highlighting the challenges it poses in terms of access, equity, and vaccine hesitancy [15]. Compared with these studies above, this paper interprets the effect directly from the fluctuation of Pfizer's stock price, which makes the conclusion more direct and obvious.

At the beginning, the successful development and release of the Pfizer vaccine has provided important tools and tools for global outbreak control, which has increased market confidence and recognition of Pfizer. The success of the vaccine demonstrates not only Pfizer's strong research and development capabilities in the pharmaceutical sector, but also its social responsibility in responding to the global public health crisis [16]. Additionally, Pfizer's widespread vaccination and use of the vaccine is expected to bring considerable benefits to the company. Pfizer's growing demand for vaccines as the global vaccination push has led to strong sales and profits for the company. In addition, the success of the vaccine for the company has established a good brand image, increased its competitiveness in the pharmaceutical industry and market share [17]. Finally, the Pfizer launch has raised investor expectations for the company's future. The successful development and deployment of the vaccine demonstrated the company's ability to innovate and market operations, which helped attract more investors to Pfizer and drove the company's share price up.

From the research in this paper, this paper can find that in difficult situation, the message of hope will always push things forward. Although the research impact of this paper is mainly related to stock price finance, it can also give policy makers relevant enlightenment on public opinion, such as timely disclosure of some news that can give people hope, and so on. Investors can also be more secure by giving higher priority to companies with a positive image.

5. Conclusion

The purpose of this study is to explore the stock price fluctuations following Pfizer's announcement of the successful development of COVID-19 vaccine. In this paper, ARIMA model is introduced to estimate the stock price. The study leads to a conclusion by using Stata software to analyze.

Finally, this paper proves that during the epidemic, the vaccine development of publicity for the company brought a short-term impact. This has a significant positive impact compared to the predicted status quo. Despite the extended influence of stock returns and volatility on the long-term outlook, it will eventually dissipate and revert to its usual state. It is undeniable that they have contributed significantly to stock price growth in the short term, which could promote the development of Pfizer.

There are some deficiencies in this article. It is not enough to rely on stock price fluctuations to consider the impact of a vaccine announcement on a company. Second, there are some other factors that are not taken into account when judging the impact of stock price changes, such as stock market fluctuations. Future research could also discuss the impact on companies in terms of market share, sales costs and profits, and the response to the vaccine. If the vaccine has unique advantages, such as higher effectiveness and lower side effects, it may replace other competitors' products and increase the company's market share. After the successful development of a vaccine, if it can be widely accepted by the market, then the company's sales and profits may be significantly increased. This will help the company's long-term development, including the expansion of production scale, more R & D investment. This allows us to extrapolate and study the data more comprehensively.

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