The Impact Caused by COVID-19 Pandemic on Pfizer Inc. Stock Price: Based on a Counterfactual Framework

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Abstract: As the coronavirus pandemic spreads worldwide, many nations have implemented social distance regulations and quarantine measures to stop the spread of the COVID-19 epidemic. During this period, people's consumption levels dropped all over the world, resulting in a decrease in the capacity of the entire society to produce goods and services. As a result, thousands of workers lost their jobs and numerous manufacturing plants, entertainment companies struggled financially until going out of business. However, the value of some biopharmaceutical firms' shares has climbed rather than fallen due to some of these businesses made great contribution on preventing the spread of the pandemic by developing vaccines and useful medications. In this article, an American multinational pharmaceutical and biotechnology corporation, Pfizer Inc. was selected and daily stock data from February 2009 to December 2022 was extracted. The ARIMA model was applied to forecast the stock price of Pfizer Inc. without the Covid-19 pandemic. This study focuses on comparing the forecasted stock price with actual stock price and explores the possible reasons for this difference.

Keywords: COVID-19 pandemic; forecast stock price; ARIMA model; Pfizer

1. Introduction

Coronavirus disease 2019 (COVID-19) is an infectious illness brought on by coronavirus 2 that causes severe acute respiratory syndrome (SARS-CoV-2). In Wuhan, the first instance of the mysterious pneumonia was found. Epidemiological evidence connected Huanan Seafood Wholesale Market to cases of pneumonia [1]. This pandemic is a pathogenic viral infection with extremely high transmissibility. The clinical features of COVID-19 range from an asymptomatic condition to severe acute respiratory distress syndrome and multi-organ failure [2]. Since January 2020, the COVID-19 disease has caused more than 98 million confirmed cases and 2.2 million deaths, which has caused unprecedented widespread impacts and dramatically changed people's lives.

In addition to endangering physical health, the breakup of COVID-19 also threatens global public health and social institutions. In certain nations, intensive care units are fully overcrowded. Extremely stringent pandemic protection measures, including the forced closure of schools and the suspension of all commercial and production operations, jeopardize economic organizations and negatively impact people's daily lives and job activities [2]. First, the widespread contagion and lockdown will inevitably have a psychological effect on people's mental health. Around the globe, during COVID-19, people are asked to keep social distance and stay at home. As humans are social beings, being

alone might be detrimental. People develop maladaptive behaviors, emotional discomfort, and defensive responses to pandemics. Findings showed that Chinese respondents reported psychological distress such as anxiety, insomnia, worries about families' health, sensitivity to social risks, and so on during the outbreak of COVID-19 in a range of 7% to 53.8%. Thus, the COVID-19 epidemic has severely pressured people's mental health worldwide.

Moreover, the COVID-19 epidemic had a major effect on tourism worldwide. Because COVID-19 spreads through human-to-human transmission, many people are forced to quarantine or stay home. As a result, many well-known brands in many industries went bankrupt. A lot of well-known U.S. businesses are struggling financially, including JCPenney, Hertz, and J. Crew and so on. Asmelash and Cooper claim that the travel industry has been negatively impacted: 2020 is expected to be a loss-making year for travel destinations, with 80% of hotel rooms unoccupied and 90% fewer airline employees.[3]. Many individuals are experiencing layoffs and unemployment due to the slump in the service and tourist industries, and many families are experiencing financial hardship. Additionally, the lockdown measures and economic crisis slowed the growth of the entire society, increasing social pressure and resulting in a vicious loop.

What is more, global economics and the stock market also had a powerful impact during the COVID-19 epidemic. The serious worldwide epidemic has caused an unheard-of decrease in activities all around the world. The pandemic's escalating effects caused severe lockdowns and significant economic activity disruptions in industrialized and developing countries at an incredibly rapid and massive scale. For instance, the global GDP declined by over 4.9% due to economic disruption, and in the second quarter of 2020, international commerce decreased by 3.5%. The fact that this fall in goods and service sales was higher than what was observed during the financial crisis of 2007–2008 is shocking. Due to the severe income loss and declined consumer confidence, there is a noticeable fall in the consumption of luxury and technological goods and traditional services like hotels. Thus, businesses everywhere had to reduce their investment in order to save expenses. The COVID-19 epidemic has also increased financial risks globally, hurting global financial markets. COVID-19 had a detrimental impact on the stock market by decreasing stock returns internationally and fostering uncertainty, which reduced capital flows. A decline in investment, project finance, and liquidity availability due to stock market volatility finally led to these challenges in the global financial system [4]. For instance, one of the worst stock price crashes happened in March 2020. The Dow Jones Industrial Average (DJIA) fell 6,400 points, or about 26%, in just four trading days, due to U.S. government reactions to the COVID-19 pandemic. Among all the companies, stocks in crude petroleum, hospitality, real estate, and entertainment sectors are the biggest victims [5].

However, even though most of the companies' stock prices fell significantly during the COVID-19 pandemic, the healthcare and medical devices industries performed best. For instance, Pfizer Inc., one of the pharmaceutical and biotechnology corporations in the U.S., performed extremely well during the pandemic. Pfizer Inc. was a privately held firm before it offered 240,000 shares of common stock to the public on June 22, 1942, and was added to Dow Jones Industrial Average in 2004. This famous biotech company has created numerous well-known drugs, including Bextra, Diflucan, Lyrica, and Viagra [6].

This paper mainly focuses on using the ARIMA model to predict the stock price of Pfizer Inc. during the COVID-19 pandemic period and comparing the forecasting graph with the actual stock trend. Then, several possible explanations for the difference between the forecasting and actual stock price will be provided.

The remaining of the paper is structured as follows: information about the data source, a brief introduction, and an explanation of the design of the ARIMA model based on the collected stock price data of Pfizer Inc. in Section 2. Section 3 shows the ARIMA model's results and some analysis of the tables and lists possible reasons for the difference. In Section 4, there is a discussion on the study's

importance and how investors apply research findings. Finally, Section 5 reiterates the conclusion briefly.

2. Research Design

2.1. Data Source

As one of the most well-known pharmaceutical and biotechnology companies in the US, Pfizer Inc. could not be a better example to investigate the effect of the COVID-19 pandemic on the stock prices of biotech companies. In order to make sure the data is not affected by the 2008 economic crisis, this study extracts Pfizer's monthly closing stock prices from February 2009 to December 2022. The stock price forecasting is predicted using the ARIMA model from February 2009 to January 2020, the date that COVID-19 became widespread worldwide. The data source is collected from the organization "Investing," a professional website including the stock price of various companies, providing high accuracy. The software STATE was used to construct models and generate graphs for analysis.

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

Testing whether the data is stationary or not is an essential step before processing. Table 1 shows the ADF test results in State. Based on Table 1, the close price is not stable, but the p-value of return equals 0, which means that the variable has no unit root and is considered statically significant. Due to the ADF test, the data are considered stationary and suitable for model building.

Table 1: ADF test.

Variables	t-statistic	p-value
Close price	-2.710	0.2320
Return	-7.889	0.0000***

2.3. Autoregressive Integrated Moving Average (ARIMA)

A statistical model called an ARIMA uses historical time series data to estimate future trends or to better understand the current data set [7]. In this study, the ARIMA model is used to predict the stock prices of Pfizer after the breakout of the COVID-19 pandemic. The general formula for ARIMA (p, d, q) model is:

$$F_t = L_t + \Omega_1 D`_{t-1} + \cdots + \Omega_p D`_{t-p} + \mathcal{B}_1 E_{t-1} + \cdots + \mathcal{B}_q E_{t-q} \tag{1}$$

Where Ft is the forecast point at time t, Lt represents the level when time t. is the previous differenced observed data point. Et-p means the error in prediction on previous data points and are two smoothing constants [8]. In addition, "p" stands for the lag order, commonly known as the number of lag observations. The terms "d" and "q" refer to the size of the moving average window and the degree of differencing, respectively, of the number of times the raw data are differenced.

3. Empirical Results and Analysis

3.1. Lag Order

The autoregressive model is a statistical model. By using past values, the Autoregressive model can forecast future values. The PACF graph in Figure 1 shows that when lag equals 12 and 22, the values of partial autocorrelations of DNP are beyond the gray shadow area, confidence bands. Thus, the A.R. is (12,22). P is set to be the lag value when the PACF plot first crosses the confidence bands [9]. Thus,

in this research, p = 12. P value means the order of this autoregressive model is 12 and this model only considers 12 previous time intervals for prediction. This can be represented by the formula:

$$F_t = L_t + \Omega_1 D`_{t-1} + \Omega_2 D`_{t-2} + \cdots + \Omega_{12} D`_{t-12} \tag{2}$$

The moving average (M.A.) process is a process where the present value of a series is defined as a linear combination of past errors. From the ACF graph in Figure 1, no lag value crosses the confidence bands. It means the ACF graph lag value is not statistically significant. Thus, MA has no order, and the model should be the A.R. model.
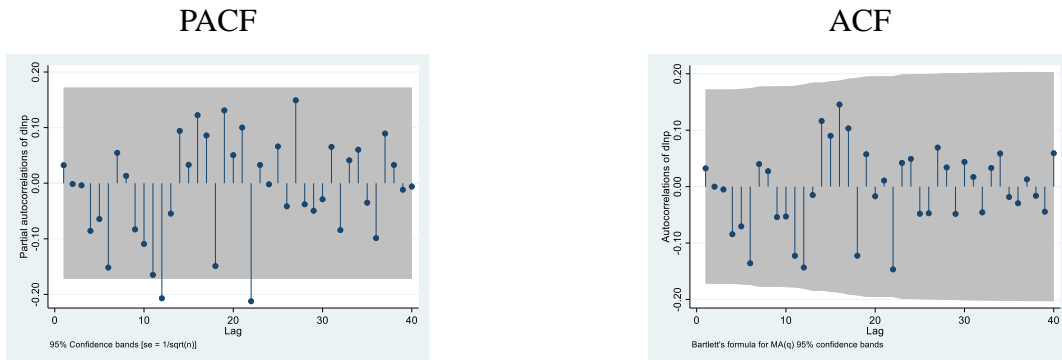

Figure 1: PACF and ACF (Photo credit: Original).

From the ADF test result in Table 1, d equals 1 in this study because, after one time differencing, the p-value becomes 0. Thus, first-order differencing makes the data stationary. So, the formula should be

$$D'_t = D_t - D_{t-1} \tag{3}$$

Thus, the ARIMA model is (12,1).

3.2. Model Estimation Results

From the result of residual test in Table 2, the value of Prob > chi2 is 0.942, which is less than 1. It indicates the data is white noise. Thus, the ARIMA model can be applied.

Table 2: Residual test.

Portmanteau (Q) statistic	Prob > chi2
27.0072	0.9420

Figure 2 and 3 display the actual value of the stock price of Pfizer from February 2009 to December 2020 and compares the actual and fitted value of the stock price of Pfizer from January 2020 to October 2021.
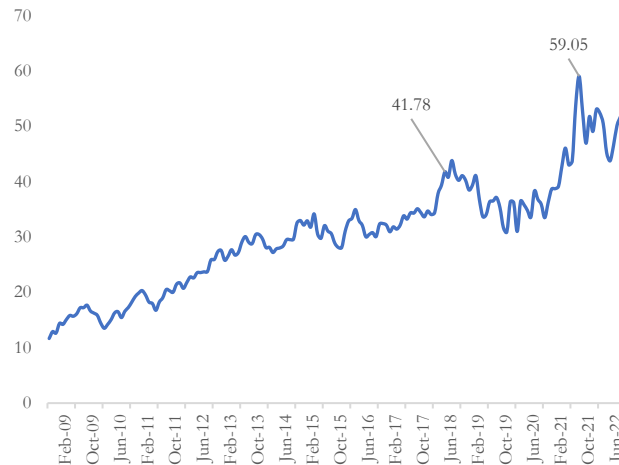
Figure 2: Actual value (Photo credit: Original).

The data of Pfizer stock prices with the COVID-19 pandemic outbreak implicated is shown by the real value. The predicted value by the ARIMA model (12,1) does not consider the breakout of the COVID-19 pandemic. By using the previous data, the ARIMA model predicts that after October 2021, the stock price of Pfizer will only reach $43.95 in January 2022. However, the actual stock price reached $53.73. Thus, it is clear that the anticipated value and the actual value diverge greatly.

3.3. Possible Explanations

In Figure 3, there is a significant surge in the actual stock prices of Pfizer Inc. in May 2021. In comparison to what our ARIMA model projected, the actual rise in the stock price in November was stunningly greater. In order to understand the cause of these two increases, it is crucial to understand what Pfizer did over these two time periods. Since December 11, 2020, the Pfizer-BioNTech COVID-19 Vaccine has been authorized for use in individuals 16 years of age and older under the EUA. On May 10, 2021, the authorization was extended to include those aged 12 to 15 as well. The clinical trial's results showed that the vaccination was 91% effective at preventing COVID-19 illness. [10]. Moreover, in December 2021, Pfizer's Paxlovid received an emergency use authorization from the U.S. Food and Drug Administration for the treatment of mild-to-moderate coronavirus illness (COVID-19) in adults and children who have tested positive for SARS-CoV-2 directly. This medicine is the first oral medication for COVID-19. It is available as a pill. It is an essential step forward in to fight against the COVID-19 epidemic [11]. The market is now quite confident in the ability to combat the pandemic thanks to the COVID-19 vaccine and potent medicine -- Paxlovid. This is the main reason for the rise in stock prices in May 2021 and November 2021.

4. Discussion

Compared with other studies, this article mainly focuses on the positive effect of the COVID-19 epidemic on the stock prices of biotech companies and takes Pfizer Inc. as an instance. Then, some possible explanations for the stock price fluctuation are listed, while other articles mainly talk about the economic negative impact of the COVID-19 epidemic on the tourism, education, retail, and global trade sectors. Although some articles investigate stock market performance during the pandemic, their topics are more about industries like communication services, technology, energy, and so on. The VAR model and TGARCH model are applied in some articles to predict the stock price. However, this article chooses a more common model -- ARIMA model for prediction.

Through this article, investors should understand that technology is driving the future. Thus, finding high-qualities technology companies, such as Zoom Video Communications, Inc., Apple Inc, and Pfizer Inc., and holding on to them for as long as possible is a more reliable choice, especially when there is an emergency. Moreover, Investors must be aware of latent crises, sensitive to big events, and able to sell stocks at the appropriate time in order to minimize losses.

5.   Conclusion

During the widespread COVID-19 epidemic, the severe lockdown and significant economic activity disruptions had an enormous economic impact on numerous companies all over the world. However, unlike most companies, the stock prices of biotech companies, like Pfizer Inc., increased during the serious pandemic. Thus, as one of the world-famous multinational pharmaceutical and biotechnology companies, Pfizer Inc. is chosen in this study for analysis. The monthly closing stock prices data is collected from the organization "Investing," and the ARIMA model is applied to forecast the future stock price of Pfizer Inc. By comparing the predicted value from the ARIMA model with the actual value, the result shows that in November 2021, the predicted stock price is much lower than the actual one, which means the investors and market had more confidence on the Pfizer Inc. than usual in November 2021. The reason behind this is the coming out of the Pfizer-BioNTech COVID-19 Vaccine and the first potent medicine--Paxlovid in the world made the public confident to combat the COVID-19 epidemic. The significance of this article is that the technology companies like Apple Inc. and Zoom Video Communications Inc. are always better choices for investors because technology is driving the whole of society.

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