Does the Easing of Restriction in Zero-COVID Policy Impact the Pharmaceutical Industrial Index?

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Abstract: After a policy of easing COVID-19 restrictions was issued in China in December 2022, many people were infected by the virus sooner or later, and medical resources became extremely scarce. This paper aims to investigate the relationship between the easing of restrictions in the Zero-COVID policy and the pharmaceutical industry index. The paper predicts that the policy will stimulate an increase in the pharmaceutical industry index. Using the ARIMA model, the paper finds that the predicted value is lower than the actual value, indicating that the policy indeed has a positive effect on the index price. Another discovery is that the index price generally exhibits a decreasing trend. The reason for this is that the index price had already reached a high point when COVID first occurred, and it would continue to decline due to overreacting phenomenon. Based on these results, the paper suggests that investors should not only consider the temporary stimulation but also need to be aware of the long-term price trend.

Keywords: COVID-19, ARIMA, pharmaceutical index

1. Introduction

Since January 2020, China has experienced a massive outbreak of the COVID-19 pandemic. Apart from the harm to public health, almost every industry in China has also suffered damage. To protect people from the virus, the Chinese government implemented a series of policies collectively known as the dynamic zero-COVID policy. However, this policy proved to be a double-edged sword. While it resulted in fewer infections, it also prevented many businesses from operating normally [1]. As a result, China's economy remained depressed during this period. Fortunately, due to the weakened state of the virus and the high vaccination coverage, the government decided to ease the COVID-19 management restrictions. Gradually, China has been recovering its economy, and businesses have resumed normal production. However, even after the government eased restrictions, there are still many people who have been infected by the virus. Consequently, there has been a high demand for various medicines. This paper aims to explore the relationship between the easing policy and the trend of the pharmaceutical industry index in the Chinese stock market. It utilizes the ARIMA model to predict the returns after the Chinese government implemented the easing policy on December 7th, 2022, and compares the fitted returns with the actual returns.

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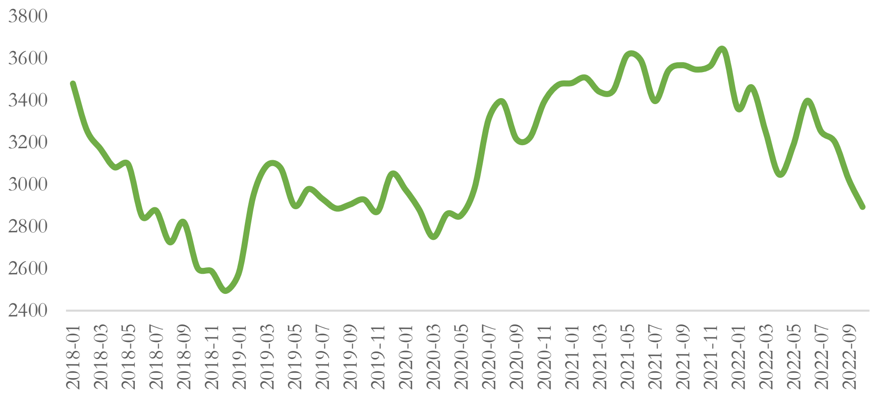

Figure 1: Shanghai stock index from 2018 to 2022.
(Data source: Choice financial terminal; Photo credit: Original)

There is clear evidence that COVID-19 indeed had a depressive impact on China's economy. Prior to 2020, China's GDP was experiencing steady growth, with a growth rate ranging from 6% to 7%. However, since 2020, China's GDP has experienced a significant decline [2]. The GDP in 2020 fell to 2.3%, and in 2021 and 2022, the numbers remained in the range of 2% to 3%. This decline can be attributed to the implementation of the zero-COVID policy. Under this policy, the government imposed strict measures, requiring infected individuals to be isolated in hospitals, while people who had close contact with infected individuals were required to be quarantined in newly established areas or self-isolate at home for daily observation and examination [3]. As a result of this policy, employees were unable to attend work regularly, and factories were instructed to close and cease production if there were infected patients or individuals in close contact in the vicinity. Other industries were also impacted. For example, people started avoiding unnecessary travel, leading to a significant number of flight cancellations and major losses for airline companies [4]. Additionally, the travel industry suffered losses due to a significant decrease in the number of visitors.

In the financial market, recent literature suggests that COVID-19 had a disruptive effect on China's stock market when it initially emerged, causing significant fluctuations [5]. However, the financial market became more stable in 2021 and 2022 compared to other overseas countries [6]. As depicted in Figure 1, even though the index dropped below 3000, which is considered a benchmark in recent years, during the occurrence of COVID-19, it rebounded in 2021 and 2022. Among the existing theories, this paper posits that during the COVID-19 period, there were overreactions [7]. De Bondt suggests that stocks in the loser group (underperforming stocks with lower returns) tend to overreact, resulting in a rebound and excess returns beyond the expected returns. Furthermore, further studies indicate that this overreacting phenomenon may persist for several years [8]. Moreover, research has shown that after the onset of COVID-19, there was a significant increase in the demand for medical resources in the pharmaceutical industry [9]. In response, China and many other countries expanded government budgets to support vaccine research and other healthcare initiatives [10].

Based on these observations, this paper predicts that the easing of restrictions in the zero-COVID policy will act as a stimulant to the stock market. The estimated value of the medical index will be lower than the actual price, as the pharmaceutical industry index will garner more attention following the easing of restrictions. With a large number of people potentially being infected, there will be a dramatic increase in the demand for medicine.

The subsequent sections of this paper are as follows: Section 2 covers the research design, including data and model construction. Section 3 presents the estimation results, along with an analysis of these results. The final section provides the conclusion.

2. Research Design

2.1. Data

All the data mentioned in this paper has been obtained from the Choice Financial terminal. This paper utilizes monthly prices to study the market index and pharmaceutical industry index trends. For the subsequent model, this paper opts to use weekly prices, starting from February 7th, 2020, to May 30th, 2023. Table 1 provides a concise summary of the data.

Table 1: Basic information about the data.

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	171	4329.8	905.1544	2949.988	6548.057

Afterwards, this paper constructs a time series using the data and designates February 7th, 2020, as time point 1. The first 146 observations are extracted as the test period, as the 146th observation represents the index price on December 9th, 2022, the day until which the government in all provinces issued the complete policy of easing restrictions. Figure 2 illustrates the trend of the pharmaceutical industry index. The objective of this paper is to utilize this data to forecast the value of the index after December 9th, 2022, specifically predicting the trend beyond the second dotted line.

Figure 2: Trend of pharmaceutical industry index (Photo credit: Original).

2.2. Stationarity Test

After establishing the time series, the first step is to conduct a unit root test (also known as a smoothness test) on the model. The null hypothesis assumes that the model is not smooth. The procedure involves performing autoregression on the series {x}, where x = ln(1+price). If the p-value of the variable is less than 0.1, the null hypothesis is rejected, indicating that the model is stable and feasible. However, as shown in Table 2, the simple and raw series is not stable. Consequently, a first-order difference series {y} is created. This series represents the natural logarithm of the difference between a variable in the aforementioned raw series and its preceding value, as per equation (1).

$$y_t = \ln\left(x_t - x_{t-1}\right) \tag{1}$$

A second-order difference series can also be generated by applying the same procedure as the first-order difference series. Both the first-order and second-order difference series exhibit smoothness, making them suitable for utilization in the subsequent model.

Table 2: Weak stationarity test: pharmaceutical industry index.

	t	p
Raw	-2.456	0.3502
1st order difference	-8.619	0.0000
2nd order difference	15.845	0.0000

2.3. ARIMA Model

The Autoregressive Integrated Moving Average model (ARIMA) is a statistical model that enables the examination of the relationship between future and present values of a variable. It is primarily employed for the prediction of future values based on current values.

$$x_t = \phi_0 + \sum_{i=1}^{p} \phi_i x_{t-i} + a_i - \sum_{i=1}^{q} \phi_i a_{t-i} \tag{2}$$

In equation (2), a_i represents the residual term, while $\emptyset_0 + \sum_{i=1}^{p} \emptyset_i x_{t-i}$ denotes the autoregressive (AR) component of the model, utilizing historical returns of semiconductor stocks to forecast future values. Conversely, $a_i - \sum_{i=1}^{q} \emptyset_i a_{t-i}$ represents the moving average (MA) component, using past volatility to estimate future values. The letter p and q correspond to the order of the AR and MA models, respectively. It is important to note that the ARIMA model can only predict values within a time span equal to the maximum of {p, q}, as the last p or q variables in the original series can only estimate a maximum of p or q periods. It would be inaccurate to estimate values beyond this range based on fitted values.

Specifically, in this study, x_i represents the second-order difference series, and the ARIMA model (p, d, q) comprises three components. Aside from the p and q, d indicates the order of differencing performed. ARIMA is commonly employed when the raw series exhibits instability and the ARMA model loses effectiveness. Hence, in this case, d is set to 2. Further regression analysis is required to determine the appropriate values of p and q.

3. Empirical Results and Analysis

3.1. Order Determination

In this section of the paper, the primary objective is to determine the specific values of p and q in the ARIMA model. Both components mentioned in the previous section need to be tested, and their respective orders can be established accordingly. The utilization of Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF) plots is a prominent method for determining these orders. The results obtained from these plots are presented below.

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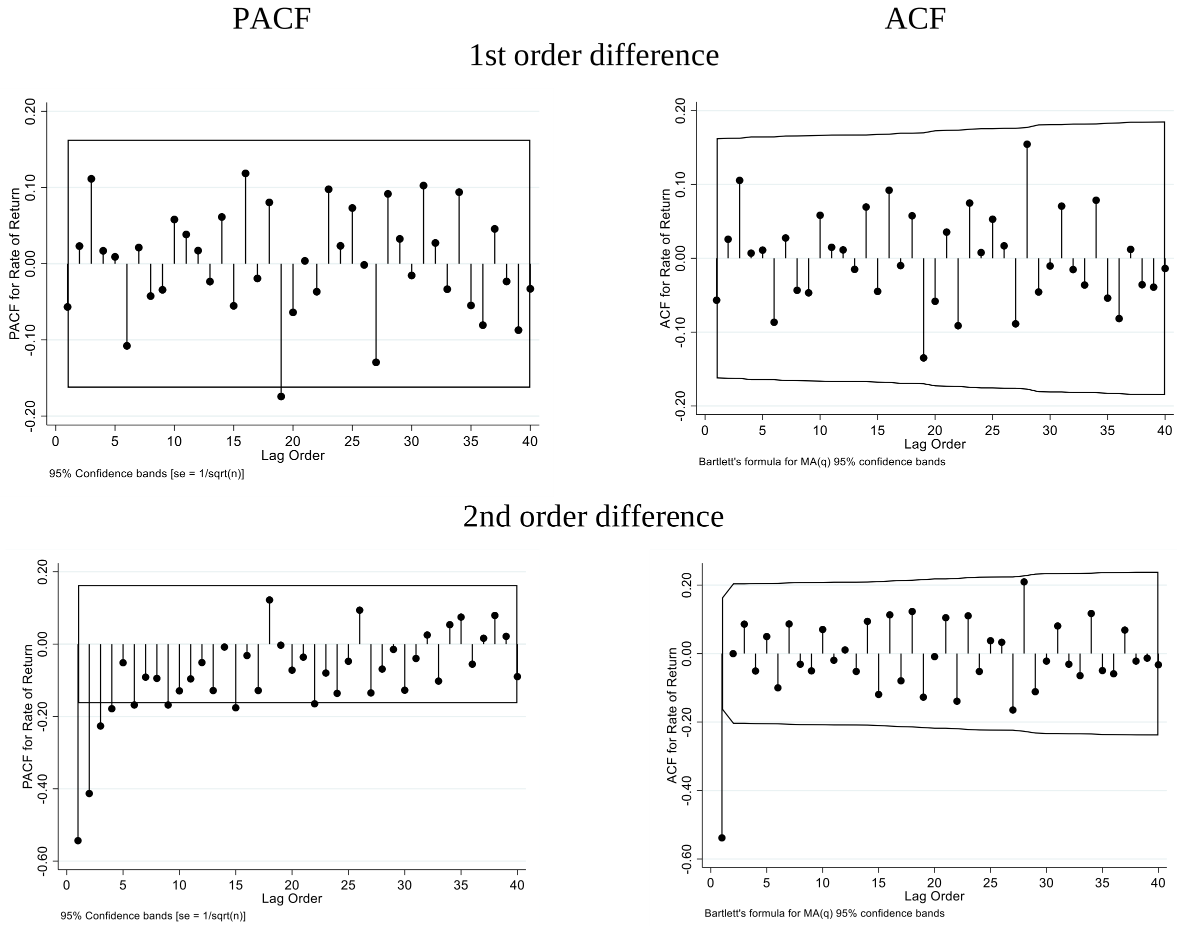

Figure 3: ARMA (p, q) identification.
Photo credit: Original

Note: The Y-axis represents the dependent variable, which includes the PACF and ACF values of the variable, while the X-axis corresponds to the time lag order. The region enclosed by the upper and lower bounds, defined by plus and minus two standard deviations, represents the 95% confidence interval for the autoregressive (AR) component with order p and the moving average (MA) component with order q.

As depicted in Figure 3, when d is set to 1 in the first-order difference mode, the PACF graph displays a line extending beyond the confidence interval at a lag of 19. Thus, the order of the autoregressive (AR) component is determined as 19. Similarly, the order of the moving average (MA) component can be determined by examining the ACF graph and identifying the first line that surpasses the confidence interval. However, in the present range from 0 to 40, none of the lines extend beyond the area, indicating that we cannot determine the order of the MA model within this range. It suggests that the MA model has an order greater than 40. However, using either 19 (the value of p) or a number exceeding 40 (the value of q) as the order would result in extensive computations in the subsequent ARIMA model, which is not desirable. Ideally, the order of both the AR and MA models should be less than 10.

This is why, in section 2.2, this paper examined the stability of both the first and second-order difference series. Since the first-order difference series proved to be uninformative, the focus shifts to the other two graphs in Figure 2. The PACF graph shows that the first line entirely falls within the confidence interval at an x-coordinate of 5, indicating an order of AR of 4. Simultaneously, there is only one line extending beyond the confidence interval in the ACF graph, leading to a determination of an order of MA equal to 1. With these findings, the ARIMA model can be implemented using the parameters (4, 2, 1) when utilizing the second-order difference series.

3.2. Estimation Results

As discussed in section 2.3, the ARIMA model can only estimate the variable's value for the next 4 periods, given that p equals 4. The estimation results are subsequently visualized in Figure 4, which features two curves.

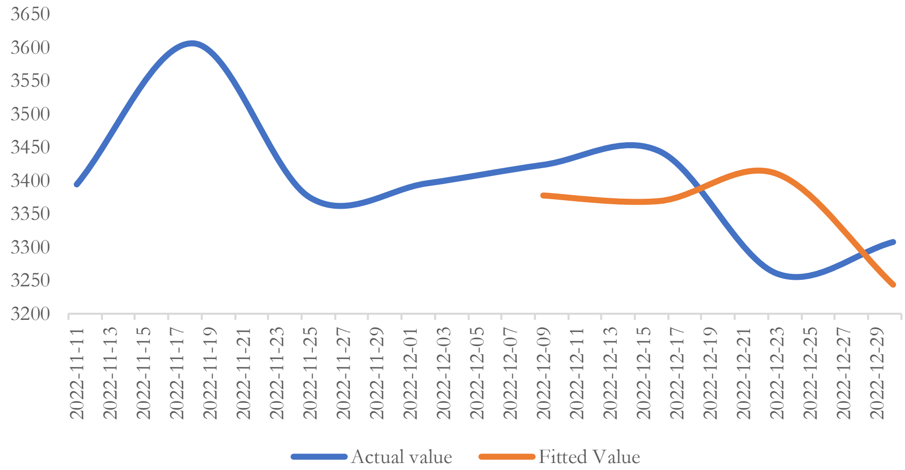

Figure 4: Actual value and fitted value (Photo credit: Original).

The orange line in the graph represents the fitted values, which start from December 9th, 2022, and end on December 30th, 2022. The actual values are represented by the connected blue line. As depicted in the graph, the fitted values are lower than the actual values, and the actual values exhibit a notable increase during the first period following December 9th. In the second period, the actual values experience a significant decline. However, the fitted values show a slight increase in the second period before sharply decreasing thereafter. In summary, both the fitted values and actual values demonstrate a declining trend.

3.3. Analysis

The most likely reason for the existence of an excess value in the actual data, exceeding the predictions made in this paper, is the phased implementation of the easing restrictions in the zero-COVID-19 policy across different provinces before December 9th. During this period, citizens began to be infected by the virus, leading to a significant increase in the number of infected individuals. Consequently, there was a substantial rise in the demand for medicine and other medical resources, which could have served as stimulating information for the stock market. This, in turn, may have directed investors' attention towards stocks in the pharmaceutical sector. However, it is important to note that the reaction in the pharmaceutical industry index, driven by the policy, is influenced by factors external to the stocks themselves. As a result, the index may exhibit an excess value that cannot be accurately predicted by the model, as demonstrated in Table 3.

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Table 3: The actual value, fitted value and the index.

	Actual Value	Fitted Value	Difference	Index	ROI
2022-12-09	3423.73	3377.7156	46.0144	3,167.86	-1.22%
2022-12-16	3443.9	3369.4428	74.4572	3,045.87	-3.85%
2022-12-23	3260.61	3410.498	-149.888	3,089.26	1.42%
2022-12-30	3307.77	3243.648	64.122	3,157.64	2.21%

It is inappropriate to solely rely on the difference between actual and fitted values to measure the effect of the easing policy. Therefore, this paper opts to calculate the average difference divided by the fitted value to assess the policy's impact. However, this ratio, which is approximately 0.26%, does not take into account the market factor. A more comprehensive approach involves subtracting the average return on investment (ROI), which is approximately -0.36%, from the aforementioned ratio, thereby considering the market effect. Ultimately, the overall effect of the policy amounts to approximately 0.62%, indicating a positive impact.

Another question arises: why do both the actual and fitted values exhibit a pronounced decreasing trend over the four periods? It may appear unreasonable when solely focusing on the data surrounding December 9th, the day of easing. However, when examining the overall trend over the three-year period during which China faced the virus, certain explanations can be identified for the observed abnormal phenomenon. Figure 2 illustrates the price trend of the pharmaceutical industry index from the onset of the COVID-19 pandemic in China. The price reached a peak around 6400 and subsequently experienced a rapid decline, failing to reach the previous high in subsequent periods. As explained by DeBont, portfolios that perform well often face an overreacting phenomenon, leading to a subsequent fall in prices due to overvaluation. Furthermore, further studies have demonstrated that this phenomenon can persist for years.

In 2020, a large number of individuals in China were infected by the virus, resulting in numerous casualties. Medical resources were scarce during this crisis, prompting the government to provide subsidies to companies in the medical industry to meet the overwhelming demand for medical supplies. During this time, the stock market experienced significant stimulation and garnered attention from both domestic and international investors. Even during the economic downturn, the price of the pharmaceutical industry index continued to rise, reaching a historical high that was approximately twice the pre-COVID-19 price.

However, with the implementation of the dynamic zero-COVID policy and the improvement of the social healthcare system, the demand for medical resources decreased. The time series analyzed in this paper begins from August 7th, coinciding with the start of the index's decline. Therefore, the reason for the index value dropping after the implementation of the easing policy is that while the policy may have a temporary positive effect on the pharmaceutical industry, the index remains overpriced due to the lingering impact of the previous overreacting phenomenon.

Regarding the fitted value, its trend can also be predicted based on a decreasing series of current data. If the present series exhibits a descending trend, the fitted value should likewise decrease, albeit with some volatility.

4. Conclusion

This paper investigates the impact of easing the restrictions of the zero-COVID policy on the price of the pharmaceutical industrial index. The results indicate a positive effect of the newly implemented policy, as the actual value significantly exceeds the fitted value predicted by the ARIMA model, taking into account the adverse market conditions. Furthermore, the paper provides an explanation for the subsequent decrease in price after an initial period of about two weeks of increase. This

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phenomenon can be attributed to the overreacting effect, which causes the initially overestimated price of the index to decline. Given that the price of the pharmaceutical industrial index had already reached a high point, a continuous decrease is expected.

In conclusion, the stimulating effect of easing the restrictions to mitigate the impact of COVID-19 is temporary, and the pharmaceutical industrial index is anticipated to experience a long-term decline. The virus has had a profound impact on people's lives and mindsets and has even caused devastation. Although China is gradually recovering from the pandemic, not only in economic aspects but also in other domains, the three-year period under study remains significant and should not be forgotten. It is challenging to assess whether the easing of restrictions is a favorable policy in the financial market, as it was not the sole determining factor in the market's recovery from the depression.

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