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The Impact of the Epidemic Opening Policy on the Pharmaceutical Industry Index

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Abstract: Starting from December 8, 2019, China began to report the earliest cases of unexplained pneumonia patients. Until January 9, 2020, China officially declared the pathogen as the "coronavirus". From this moment on, "COVID-19" officially appeared in people's vision. After about two years of nationwide ban, on December 7, 2022, China announced that it would officially lift the control of novel coronavirus. The research object of this article is the economic impact of deregulation on the pharmaceutical industry market. Use ARIMA model for prediction. The data in the pharmaceutical industry is divided into daily data and monthly data. Observed the short-term and long-term effects of open policies, and explained the research results based on actual situations. After data analysis and analysis of the actual situation, the conclusion is that the open policy of the epidemic has certain benefits for the pharmaceutical industry in the short and long term. Investors can also pay appropriate attention to the stock market of the pharmaceutical industry and start holding shares in the medium and long term.

Keywords: China, epidemic situation, open policy, pharmaceutical industry, ARIMA model

1. Introduction

On December 8th, 2019, China officially reported the first case of pneumonia of unknown cause, and then in the next month, people were still infected with similar symptoms, so the pathogen was determined as "coronavirus" on January 9th, 2020 [1]. Among them, Wuhan, Hubei Province in China, was the first city to discover the symptoms of the disease and the first city to formulate measures. On January 23rd, 2020, Wuhan announced the closure of the city and restrictions on certain residents' activities [2]. On January 24th, 2020, seven cities in Hubei Province were closed, the business activities of travel agencies across the province were suspended, and the school was postponed; Hubei officially launched the first level response to major public health emergencies. On January 31st, 2020, the United States led the first case of human-to-human transmission, Italy, Thailand, the Philippines, the United Kingdom, Russia, Sweden, and other countries also had cases one after another, and 62 countries began to implement entry control on Chinese citizens. Since then, with China as the prime minister, the world has begun to formulate policies and response plans related to the epidemic. Back to China's perspective, on December 7, 2022, China's nationwide ban was lifted, epidemic prevention policies were cancelled, and the comprehensive nucleic acid itinerary code was taken offline. Until December 26, 2022, the Chinese government officially announced an open policy, which means that all policies restricting residents' activities in China will be relaxed [3].

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This article focuses on the stock market trend of the pharmaceutical industry after China's epidemic opening policy. Through the follow-up data analysis and the real-world response, the pharmaceutical industry has indeed been subject to certain fluctuations after the opening of the epidemic. There will be more detailed analysis and explanation in the follow-up result analysis and the part related to the real world in this paper.

2. Literature Review

Firstly, the historical literature is reviewed to enrich the epidemic background. This paper mainly describes the impact of the epidemic on China's medical industry, especially the supply side of medical equipment.

The Covid-19 epidemic has had a significant impact on the medical industry. The epidemic has changed the consumption habits of medical devices and made people reflect on the minimum storage supply chain strategy, which will greatly reshape the medical device industry [4]. During the epidemic period, the demand for diagnostic tests, personal protective equipment (PPE), respirators and other key medical supplies increased sharply, but may face the problem of insufficient supply [4].

It can be seen from the literature that the impact of the epidemic itself on the pharmaceutical industry is negative to some extent. Although the demand side has increased, due to the sudden outbreak of the epidemic and the limited resource reserves of the pharmaceutical industry, the lag caused by the lack of supply side has brought a certain blow to the pharmaceutical industry [4].

At present, the existing literature mainly describes the impact of the epidemic itself on China's pharmaceutical industry. For this paper, there is a certain research gap. This article will focus on the impact on the pharmaceutical industry after the introduction of the epidemic opening policy in China. However, this literature review still plays a great role in the historical research during the epidemic.

3. Research Design

3.1. Data Source

This paper uses the search engine to obtain the closing price of the SSE pharmaceutical industry on the investing website, which is divided into daily, weekly, and monthly data from January 1st, 2016 to August 1st, 2023. As the data source and basis of empirical analysis, this paper studies the impact of China's pharmaceutical industry market after the epidemic opening policy [11].

3.2. Weak Stationarity Test

After obtaining the data, please clean up the data. Since the data form is time series, it is necessary to complete the stability test of time series. For daily, weekly, and monthly data, first take the closing price of the original data in logarithmic form and observe the percentage change; Then conduct stability test. If p value is greater than 0.1, it is necessary to accept that the original assumption is unstable; It can be seen that in Table 1, the original logarithmic data is unstable, so taking their first-order or second-order difference, the result p value is 0.0000, less than 0.1, so the original assumption is rejected and the data is stable. After obtaining the stationary data, ARIMA model analysis is carried out using the stationary data.

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Table 1: Weak stationarity test.

	t	p
	Daily	
Raw	-1.932	0.6382
1st order difference	-29.101	0.0000
	Weekly	
Raw	-1.747	0.7299
1st order difference	-13.009	0.0000
2nd order difference	-23.180	0.0000
	Monthly	
Raw	-1.931	0.6383
1st order difference	-6.571	0.0000
2nd order difference	-9.732	0.0000

The second-order difference is derived from the weekly data and monthly data because the order of the difference data needs to be determined later, and the first-order difference between the weekly data and monthly data is difficult to determine the order, so the second-order difference result is used.

From equation (1), $\phi_0 + \sum_{i=1}^{p} \phi_i \, x_{t-i}$ represents the AR(p) model, which uses the historical returns of pharmaceutical industry's stocks to forecast the future; while $\alpha_i - \sum_{i=1}^{q} \phi_i \, a_{t-i}$ which uses past volatility to estimate the future and the last part of the model.

Specifically, in this paper, the AR model uses the pharmaceutical closing stock data from January 1, 2016 to December 7, 2022, while the MA model uses an error term to predict the future.

$$P_t = \phi_0 + \sum_{i=1}^{p} \phi_i \, P_{t-i} + \alpha_i - \sum_{i=1}^{q} \phi_i \, a_{t-i} \quad (1)$$

ARIMA model, as its name implies, is a (p, d, q) model composed of ARMA (p, q) model and differential time d. This paper will use the complete ARIMA model for analysis. So next, this article will perform the sequence determination and analysis steps.

3.3. Set Order

First, PACF and ACF are used to determine the order of daily data. PACF is the order of AR, and ACF is the order of MA. In the case of first-order difference, the maximum order within 10 is found, that is, the order beyond the critical value. It can be seen that the order determination results of PACF and ACF are both order 5, so the ARIMA model is (5, 1, 5).

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PACF ACF

Daily

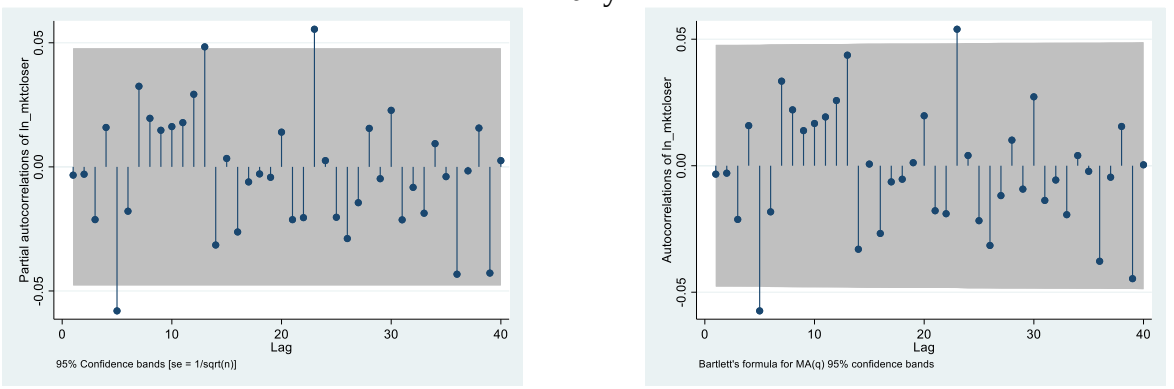

Figure 1: PACF and ACF, daily.

Photo credit: Original

PACF ACF

Weekly

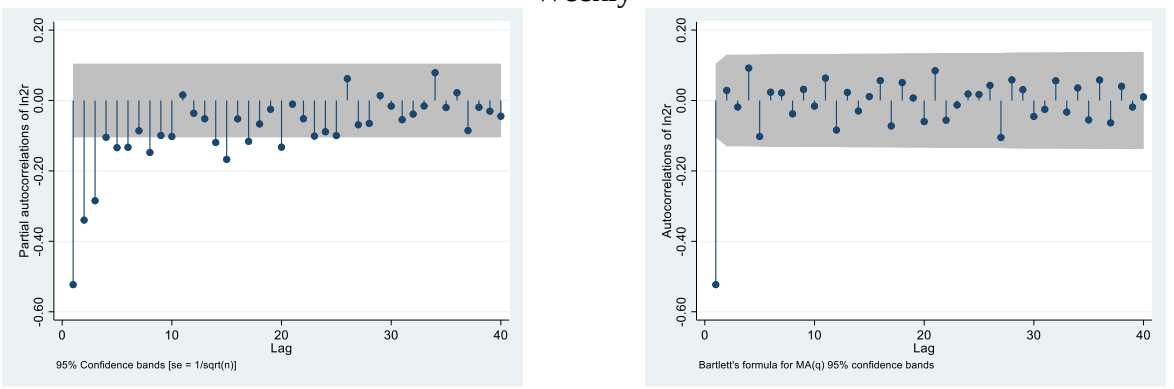

Figure 2: PACF and ACF, weekly.

Photo credit: Original

PACF ACF

Monthly

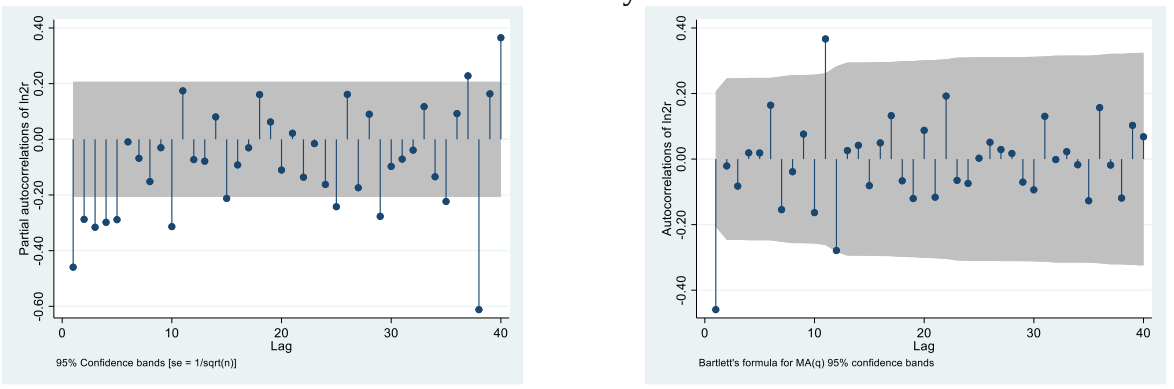

Figure 3: PACF and ACF, monthly.

Note: The Y-axis is the dependent variable, PACF, and ACF of the log of Logarithmic return on the two semiconductor stocks, and the X-axis is the time lag order. The area bounded by y=±2 standard error refers to the 95% confidence interval for AR(p) and MA(q).

Photo credit: Original

Next, the order of the data in cycles is determined. Similarly, under the premise of the first-order difference, the first step is to find the order that exceeds the critical value, but the result is not

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satisfactory, because it is found that the smallest order that exceeds the critical value is also more than 10 orders, which is not friendly to the subsequent model analysis; Therefore, the data of second-order difference is selected, and it is found from figure 1 that the order of ARIMA is (8, 2, 1).

The monthly data is the same as figure 2. It is still difficult to find an order within ten orders by the first-order difference, so the second-order difference is selected. Figure 3 shows that the ARIMA order is (5, 2, 1).

On the whole, the result of ranking by week is not ideal, so this paper mainly uses the daily and monthly data for subsequent prediction and analysis. The daily data will be presented as the result of short-term data analysis, and the monthly data will be analyzed as the result of long-term policy analysis.

3.4. White-Noise Test

Next, white noise is detected for ARIMA model analysis results. The original assumption is white noise data. According to the ARIMA data analysis results, it can be found that p values are all greater than 0.1, so the original assumption is accepted, and the daily and monthly model residuals are all white noise sequences.

Table 2: Residual test.

Model	Portmanteau (Q) statistic	Prob > chi2
Daily-ARIMA(5,1,5)	26.1985	0.9546
Weekly-ARIMA(8,2,1)	25.4686	0.9641
Monthly-ARIMA(5,2,1)	39.4973	0.4927

4. Result interpretation

After a series of tests, ARIMA model is used to predict the closing price of subsequent medical stocks. First, focus on the short-term, that is, daily data. The following table 2 shows the prediction results.

Table 3: Actual value and fitted value, daily-data-based model.

	Actual value	Fitted value	Difference	Average
2022-11-30	7262.26			
2022-12-01	7316.41			
2022-12-02	7289.18			
2022-12-05	7320.65			
2022-12-06	7227.86			
2022-12-07	7315.82	7232.099	83.721	
2022-12-08	7283.81	7240.4653	43.3447	
2022-12-09	7316.07	7231.4235	84.6465	
2022-12-12	7425.01	7231.9881	193.0219	
2022-12-13	7330.6	7238.6076	91.9924	1.37%

Table 3 shows the actual value and the fitted value. The predicted value starts from December 7th, 2022 to December 13th, 2022. The following figure shows the curve of the two. The blue line is the data value and the yellow line is the predicted value. It is worth noting that figure 4 is interpreted as: when there is no epidemic opening policy, the blue line is before December 7, 2022, followed by the yellow line, and the open policy is shown as the blue line after December 7, 2022.

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After the difference between the data value and the predicted value is made, the difference is divided by the data value and averaged, and the average percentage difference is obtained, 1.37%, which means that in theory, the implementation of the open policy will increase the stock market of the pharmaceutical industry by an average of 1.37% in the short term.

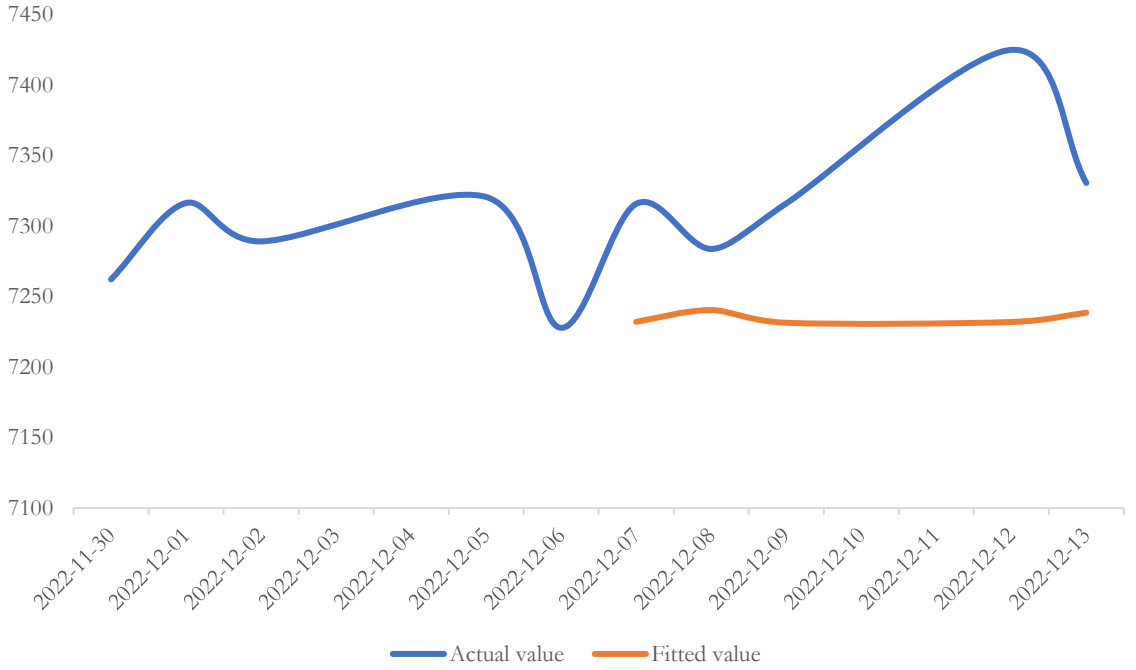

Figure 4: Actual value and fitted value, daily.

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Table 4 shows the closing price of the stock market for each week from October 16, 2022 to February 5, 2023, which is also divided into data values and forecast values. From the week of December 7, 2022, ARIMA model began to predict. Make a difference between the data value and the predicted value, and then take the average percentage difference. The results and the two groups of data are shown in Figure 5.

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Table 4: Actual value and fitted value, weekly-data-based model.

	Actual value	Fitted value	Difference	Average
2022-10-16	7026.73			
2022-10-23	6931.64			
2022-10-30	7416.5			
2022-11-06	7247.04			
2022-11-13	7612.94			
2022-11-20	7227.97			
2022-11-27	7289.18			
2022-12-04	7316.07			
2022-12-11	7343.68	7319.836	23.844	
2022-12-18	6979.63	7265.3892	-285.759	
2022-12-25	7181.17	7256.6425	-75.4725	
2023-01-01	7375.79	7261.7177	114.0723	
2023-01-08	7562.15	7236.1092	326.0408	
2023-01-15	7881.14	7243.3431	637.7969	
2023-01-29	7668.31	7234.7158	433.5942	
2023-02-05	7599.58	7228.809	370.771	2.66%

Figure 5 shows that in the week around December 16, 2022, the blue line has a significant decline compared with the yellow line. It can be seen from Figure 4 that there is a significant downward trend around December 12, 2022, and there is no recovery trend until December 16, 2022. It exceeded the yellow line around the end of December and has been above the yellow line since then. It means that the open epidemic policy makes the medical industry fluctuate in the short term (Figure 4 shows a certain increase in the ultra short term, but figure 5 shows a decrease in the short term), but it has a positive effect in the medium and long term. In terms of data, the implementation of the epidemic opening policy made the medical industry stock market rise by an average of 2.66%.

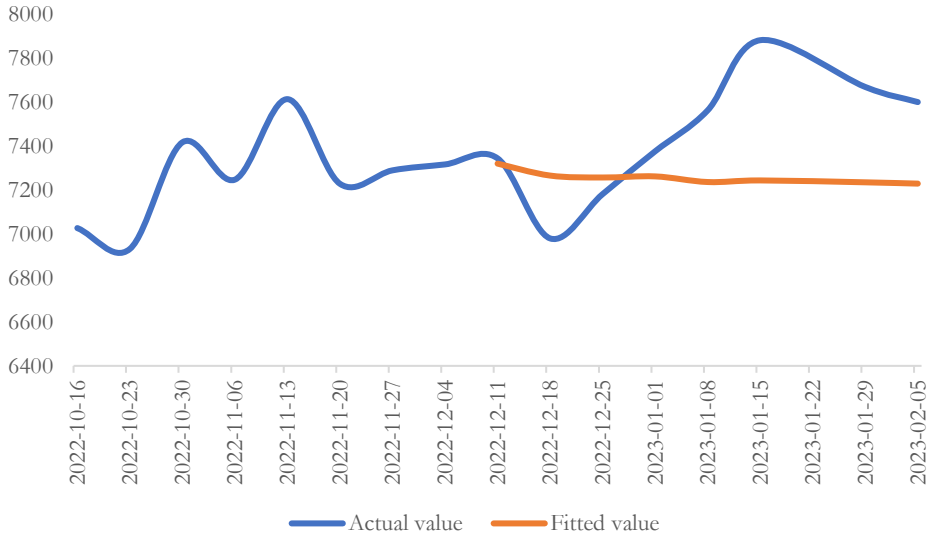

Figure 5: Actual value and fitted value, weekly.

Photo credit: Original

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Table 5 shows the monthly data from July 2022 to April 2023, and the forecast value starts from December 2022. Similarly, for the difference between the data value and the predicted value and the average percentage difference, 1.32%, which means that in the long run, the implementation of the opening policy will pull up the stock market of the pharmaceutical industry by an average of 1.32%.

Table 5: Actual value and fitted value, weekly-data-based model.

	Actual value	Fitted value	Difference	Average
Jul-22	7186.52			
Aug-22	6952.11			
Sep-22	6410.71			
Oct-22	6967.17			
Nov-22	7262.26			
Dec-22	7181.17	7163.7499	17.4201	
Jan-23	7626.99	6984.1941	642.7959	
Feb-23	7513.43	7498.1068	15.3232	
Mar-23	7247.48	7530.4787	-282.999	
Apr-23	7254.52	7167.2562	87.2638	1.32%

Figure 6 shows the data visualization results. From a long-term chart, around September 2022, the medical stock market suffered a certain blow and fell to the bottom in the past two years, perhaps because people's demand and expectation for the medical industry have been greatly reduced [5].

From December 2022 to February 2023, the blue line has been higher than the yellow line, and it is the largest gap in several months. This gap can also be seen in figure 5, the gap between blue and yellow lines will reach its peak around January 16, 2023. In addition, it is worth noting that the blue line and the yellow line in the chart intersect around February 2023, and the yellow line that had been lower than the blue line now exceeded the blue line, until around April 2023, the yellow line intersected with the blue line again, and the yellow line was lower than the blue line. That is to say, in theory, if there is no open policy, the medical shares will also have a certain growth during the period from February to April 2023, and can exceed the stock market price under the open policy.

But according to the data, the implementation of the open policy still has a long-term benefit for the medical industry, because this policy has brought a long-term growth of 1.32%.

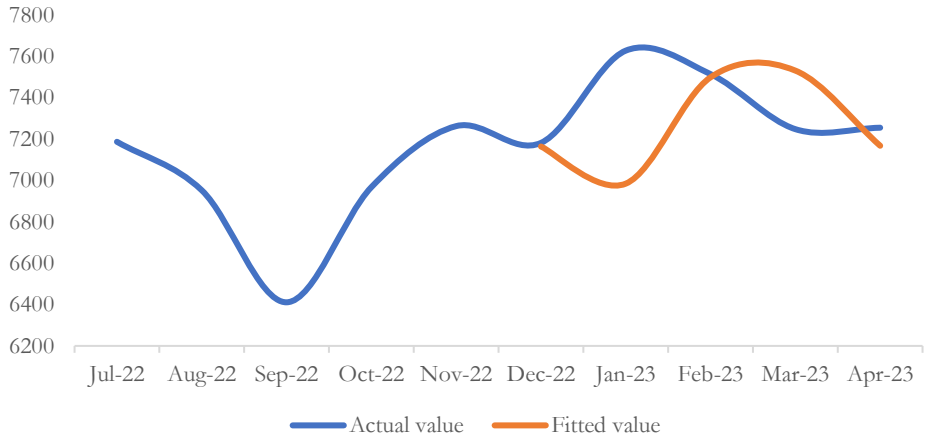

Figure 6: Actual value and fitted value, monthly.

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In conclusion, the implementation of the open policy can bring certain benefits to the medical industry in both the short and long term. From the reaction of the medical stock market, people's expectations for the medical industry have also changed due to the open policy. The long-term and short-term forecast results are not much different, implying that the market change of medical stocks should be relatively stable.

5. Current Situation (Real World)

After the outbreak, there is no doubt that many commercial activities have been greatly affected. Among them, the pharmaceutical industry is the most special, because during the outbreak, the pharmaceutical industry is indispensable [6]. During the epidemic period, the study found that in February 2020, the sales of prescription drugs decreased by 27% year-on-year, and the outpatient volume of hospitals nationwide decreased by 60% [7]. At the same time, marketing and sales activities are most affected, because it is impossible to conduct field visits or promote medical treatment and drugs to medical staff [5]. This can be seen from the monthly chart. Before the opening-up policy, the medical stock market has been at a low position, and once fell to the "bottom" in September 2022.

However, the restrictions on sales representatives visiting hospitals are gradually tightened, which has given birth to the urgent need for transformation of pharmaceutical enterprises [8]. More importantly, the epidemic has accelerated the penetration of Internet healthcare [9] and helped form new consumption habits, "Internet healthcare" has become the focus of the new transformation of the medical industry [10]. This also explains why after falling to the bottom in September 2022, there began to be a recovery in October.

Until the announcement of the opening-up policy in December 2022, the medical shares have increased significantly. In the short term, it can be seen that except for a small decrease around December 13, 2022, it has been increasing since then, in the long term, it will rise to the peak of the range between January and February 2023.

6. Conclusion

This paper summarizes the short-term and long-term changes of the medical stock market under the implementation of the epidemic opening policy. Through the prediction and analysis of ARIMA model, the result is that in theory, it can indeed bring certain benefits to the medical industry. Whether it is short-term or long-term, it can be seen that the medical stocks have a certain amount of rise.

However, there are still some deficiencies in this paper. First of all, the influencing factors of the medical stock market after the opening policy may not only be this policy, but also include but not limited to the state funding support; Secondly, because the time of the outbreak opening policy is not long from the time of this study and there are not many relevant studies, there are certain restrictions on the reliable arguments and data access. In addition, there are some ultra long-term practical results that can not be obtained now, and future fluctuations may contradict this conclusion.

Looking forward to the future, the pharmaceutical industry has been hit to a certain extent due to the epidemic, but it has also brought a certain Turnaround: Internet medicine may be the focus of future development. Under the opening-up policy, people's expectations for the pharmaceutical industry have also improved to some extent. This is illustrated by the medical stock market. The improvement of the stock market has also brought a certain amount of capital accumulation to the pharmaceutical industry. At the same time, with the support of the national government, the pharmaceutical industry may complete its transformation in the future to better respond to various diseases, plagues, or emergencies.

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