Research on Current Situation
of Pharmaceutical Industry in Chinese Stock
Market Through Stock Price Information

Sining Zhu(✉)

Department of Commerce, Mcmaster University, Hamilton, ON L8P 0C4, Canada
zhus65@mcmaster.ca

Abstract. After nearly ten years of development, China's stock market has become mature. During the decade of rapid development of the Chinese stock market, the prices of stocks have been undergoing constant changes. The pharmaceutical industry, a large segment of the Chinese stock market, has seen its stocks go through numerous ups and downs during the decade, which may be caused by external or internal factors. Based on stock price information, this paper focuses on the analysis of the current situation of China's pharmaceutical industry stocks and the prediction of future development trends. Using basic statistical analysis and linear analysis as tools, it is concluded that after two relatively strong increases in the stock price of China's pharmaceutical industry in the past ten years, there will be a rapid upward trend between 2021 and 2022, and a substantial increase in the latter part of 2022. Major emergencies will have a relatively strong impact on China's pharmaceutical industry (including chemical and biophar maceuticals, medical machinery, specialty medical, and pharmacy chains).

Keywords: Stock Price · Pharmaceutical Industry · Statistical Description · Liner Regression

1 Introduction

Along with the emergence and development of the digital and information era, the Internet, big data and artificial intelligence are developing at a high speed. Huge information database makes data and information gradually become trans-parent. There are no secrets among industries in this era, and people can freely access information and analyze it through the database to truly realize the sharing of information. The stock price is a visualization of a company's assets, it reflects the basic information about a company or even an industry, its current situation, earnings expectations, risk premium, etc. Chen, Goldstein and Jiang's study found that personal information in a firm's stock price influences the firm's investment decision [1]. The Covid-19 pandemic, which started in 2019, has a huge impact on the Chinese economy as an unexpected event. Yu uses an empirical design to obtain a negative shock to the stock market after a major unexpected event has occurred [2]. While the stock market as a whole will receive a negative impact,

the sectors within it may have the opposite result from the whole. The pharmaceutical industry, as an industry with a direct link to the Covid-19 pandemic, is more affected. Ren, Wang, and Yan use ARIMA model to back-test and conclude that the epidemic has a positive impact on the stock price of the Chinese pharmaceutical industry [3].

As one of the most important industries affecting people's livelihoods, the current state of the pharmaceutical industry and its future development mark the general direction of the overall market. Ding pointed out that the growth of listed companies in the pharmaceutical industry greatly reflects the degree of national health and social progress by establishing a multiple regression model [4]. Lee concluded that the healthcare industry has been one of the most favored industries by investment institutions since 2017 [5]. The development of the pharmaceutical industry seems to form a paradox with the stock market, so it is very necessary and representative to analyze the current situation of the Chinese pharmaceutical industry in the stock market. The development of the pharmaceutical industry is closely related to its share price. Markovitch, Steckel, and Yeung found empirically that drug companies with good stock realizations tend to focus on long-term research, while underperforming drug companies tend to improve their product orders immediately [6]. Pérez-Rodríguez and Valcarcel find that unexpected scientific findings in the development of new drugs are reflected in stock prices by using the ARMA-GARCH dynamic econometric model [7]. The pharmaceutical industry in the Chinese stock market can be bro-ken down into some of the following segments: chemical and biopharmaceuticals, medical devices, medical services, etc. These sectors will be different and at the same time closely related. Meng proposed that China's spurt of biopharmaceutical development has simultaneously driven the pursuit of medical de-vices [8].

Mean reversion is a theory in finance that represents the idea that historical asset return and price fluctuations eventually converge to the long-term mean of the data. Lan used the P/E ratio and determined that the Chinese stock market in Shanghai and Shenzhen largely conformed to the regularity of mean reversion [9]. Luo and Yang said that the Shanghai and Shenzhen stock markets are the most representative sample of China's securities market [10]. This paper selects the leading stocks in the pharmaceutical industry (including chemical and biopharmaceuticals, medical machinery, specialty medical, and pharmacy chains) in the Chinese stock market and analyzes the current situation of the Chinese pharmaceutical industry stock market and forecasts the subsequent development of the pharmaceutical industry stock market by means of the mean reversion method for the period 2011–2022.

2   Method

2.1   Data Source and Data Processing

The study analyzed stock price data from five top-performing companies in four major pharmaceutical industries in China: chemical and biopharmaceuticals, medical machinery, specialty medical, and pharmacy chains. Specifically, the data set included monthly stock price data points for each company, spanning a period of almost ten years from January 2013 to December 2022. The closing price of the forward adjusted option was

Table 1. Stock list.

Stock code (biopharmaceuticals)	Stock code (medical machinery)	Stock code (specialty medical)	Stock code (pharmacy chains)
600196.SH	600420.SH	300003.SZ	600833.SH
000963.SZ	300238.SZ	600055.SH	600085.SH
000513.SZ	002524.SZ	000710.SZ	000028.SZ
600276.SH	300015.SZ	300298.SZ	600829.SH
002001.SZ	000725.SZ	002551.SZ	000153.SZ

used to calculate each stock price. Table 1 shows the unique stock codes for each company analyzed, and the data was sourced from Choice Financial Terminal, which created by east money.com.

2.2 Research Method

To better compare the performance of leading stocks within the same industry, a basic data processing method was employed. Specifically, the average value of the five stocks in each industry was computed at the same time point, excluding any missing data points from the calculation. This approach was used to obtain the industry's development trends over the past years. A time-series curve was then generated, with time as the horizontal axis and stock price as the vertical axis. Finally, basic descriptive statistics such as mean value, variance, and maximum value were calculated to further analyze the data. This study utilizes the method of mean reversion. Firstly, it analyzes the changes in stock prices over time in four industries and calculates the average prices of five leading stocks, which are presented using charts. Secondly, the data is integrated to draw a chart of the stock prices in the Chinese pharmaceutical industry over time. Finally, the method of mean reversion is used to calculate the portfolio's return rate, sharp ratio, high water mark, and other indicators for supplementary analysis.

3   Results and Discussion

To investigate the correlation and impact of the pharmaceutical industry, this study has selected the pharmaceutical industry and three representative down-stream industries. These industries are chemical and biopharmaceuticals, medical machinery, specialty medical, and pharmacy chains. Within each of these industries, five leading stocks that best represent the industry were chosen, and multi-year monthly price data was used to create charts for analysis.

Figure 1 shows the price changes over time for the five leading stocks in the biopharmaceutical industry. As can be seen from the chart, the stock prices have been steadily increasing since 2013, with more pronounced upward trends in the periods of 2015–2016, 2018–2019, and 2021–2022. After reaching its peak in the second half of 2021, the stock prices have temporarily shown a steady decline. The sudden increases in 2018 and 2021 may have been caused by the outbreak of the novel coronavirus (COVID-19).

Fig. 1. Biopharmaceuticals.

The stock price changes for the medical machinery industry are similar to those of the biopharmaceutical industry. The stock prices have also experienced rapid growth in the years of 201 5–2016, 2018–2019, and 2021–2022. There were two instances of rapid stock price growth in 2015–2016. The growth in 2018–2019 was not as significant as that of the biopharmaceutical industry, only showing a slight increase. The stock prices reached their peak in 2021–2022, as Fig. 2 shows.

Figure 3 shows the price changes of Specialty Medical. There was a significant increase in stock price from 2015 to 2016, while the stock price of Special-ty Medical
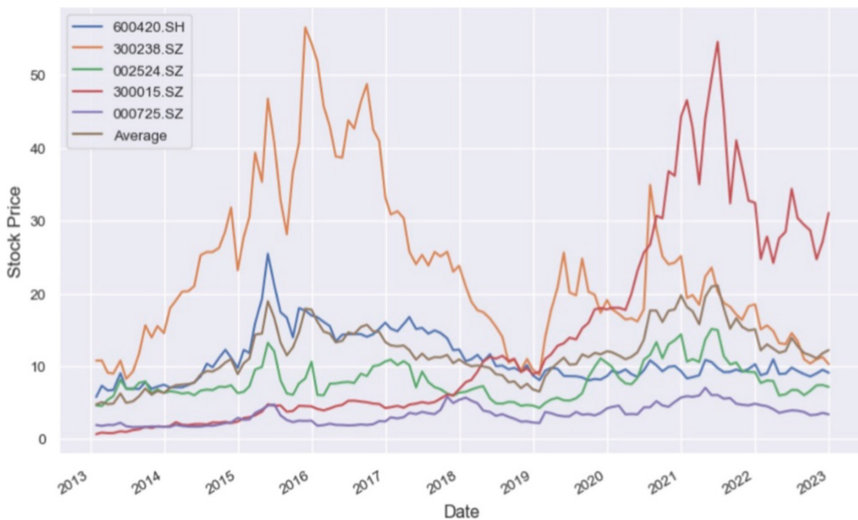
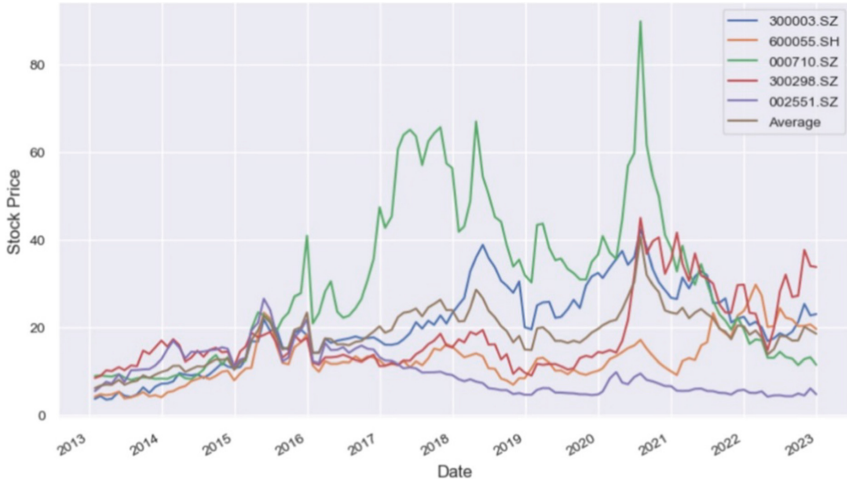**Fig. 2.** Medical machinery.

Fig. 3. Specialty medical.

remained relatively stable with slight fluctuations during other periods. There was a slight downward trend in stock prices from 2018 to 2019. Similarly, after reaching its peak in 2021–2022, the stock price gradually began to decline.

From Fig. 4 the stock price showed an obvious growth trend between 2015 and 2016, then reached a small peak in the middle of 2015. After showing a slight growth from 2017 to 2018, it showed a steady downward trend from 2018 until 2022, when the stock price gradually recovered, showing slight changes with high frequency.
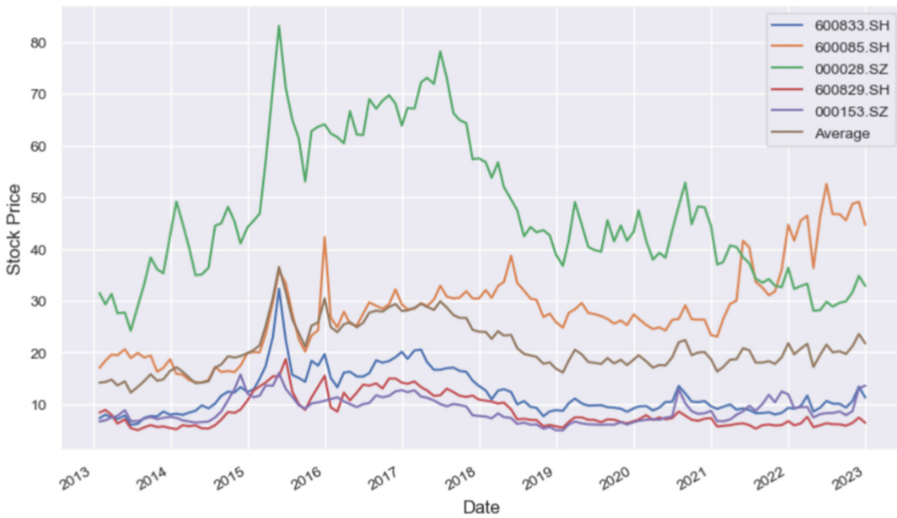

Fig. 4. Pharmacy chains.

Figure 5 is the stock price performance chart of China's pharmaceutical industry from 2013 to 2022. The averages of the four major sub-sectors of the pharmaceutical industry are shown in the figure. The figure shows that during 2015–2016, the stock prices of the four industries all had a very significant increase. Among them, the stock prices of chain drugstores were the highest, and the growth rate was even more dramatic. The growth of biopharmaceutical and specialty medical appears to be the slowest among the four industries. Pharmacy chains, special medical, and medical machinery experienced a second share price increase in early 2016, while biopharmaceutical's share price only changed slightly, almost maintaining the average level during 2015–2016. The overall stock price of the pharmaceutical industry had a very significant in-crease during 2017–2019. Contrary to the general environment, specialty medical showed a steady decline until 2020, when it began to gradually recover. From 2021 to 2022, the entire pharmaceutical industry will see a significant improvement. During this period, the stock price of the pharmaceutical industry reached the highest peak in 10 years. Among them, the biggest and most obvious improvement is the biopharmaceutical industry. Its stock price will rise rapidly in the early stage of 2021, and it will maintain a high price until the middle of 2022 before it begins to decline significantly. Pharmacy chains has been maintained at a similar price from 2021 to 2023, and it can be seen from the picture that its stock price has not increased significantly. The stock price of medical machinery reached its peak in mid-to-late 2020 and began to decline very rapidly until it reached a relatively stable price in mid-2021.

There are many reasons for the phenomenon described above. The growth of the medical industry in 2015–2016 can be explained by the Chinese pharmaceutical policies and the economic development at that time. In 2015, the State Council of China issued the "Opinions on Reforming the Drug and Medical De-vice Review and Approval System," which clearly defined requirements for drug approval and accelerated innovation in

Fig. 5. Pharmaceutical industry performance.

Table 2. Statistical performance.

Name	Mean	Std	Max	Min
pharmacy chains	20.988	4.811	36.536	12.228
biopharmaceuticals	24.063	12.574	53.104	5.584
medical machinery	18.179	18.179	40.706	6.052
specialty medical	11.849	3.799	21.108	4.784

drug production, contributing to the rap-id development and innovation of the Chinese pharmaceutical industry. The GDP also rapidly increased in 2015–2016, which was a peak period of China's economic development, providing the necessary environment for the development of the medical industry (Table 2).

According to the four branches of the pharmaceutical industry, this paper selects five leading stocks in each branch for statistical analysis. From the data analysis in the figure, biopharmaceuticals have the highest mean, and thus its overall stock price is higher than that of the other three branches. The standard deviation of Medical machinery is very high, it has a standard deviation of 18.179, indicating that its stock price changes are very unstable, and the stock is very risky. The most stable stock prices of the four branches are pharmacy chains and specialty medical. They have a standard deviation of 4.81 and 3.799 respectively, and the stock risk is relatively small, but the stock price of special-ty medical is relatively low. Generally speaking, stocks in the pharmaceutical industry have greater risks and higher stock prices.

Figure 6 is a scatterplot of stock price and time changes in the pharmaceutical industry. Time is used as the independent variable, stock price is the dependent variable,
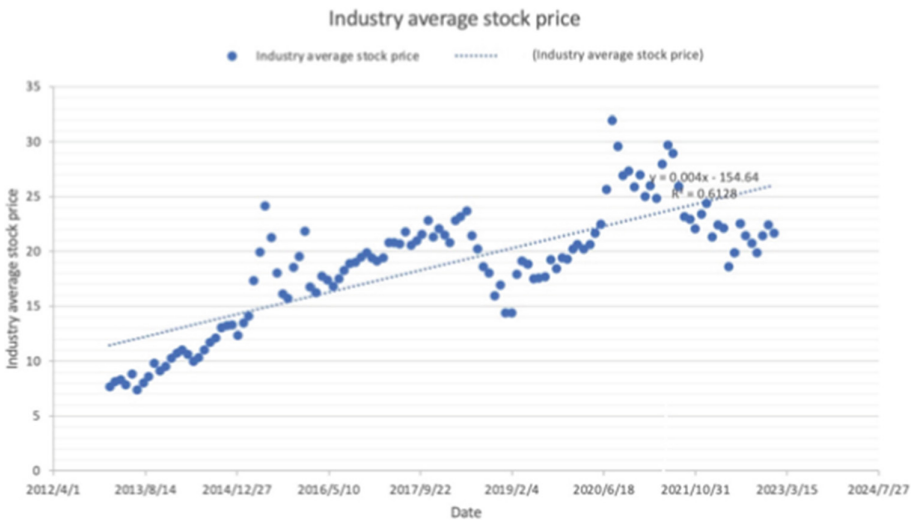

Fig. 6. Regression Line &Scatter plot.

and a linear regression model is constructed to produce Fig. 6. The graph shows the relationship between time and stock price. Through the distribution of scattered points, it can be seen that the stock price and time basically present a linear distribution. From this, it can be concluded that the change of time has a greater impact on the stock price of the pharmaceutical industry, and there is a direct proportional relationship between them, which conforms to the simple linear regression curve. The formula of liner regression is:

$$Y = 0.004X - 154.64 \tag{1}$$

And the coefficient of determination is 0.618, which is close to 1. From this, it can be concluded that most of x can explain y, and the square of R is equal to 0.618.

4   Conclusion

This paper examines the relationship between the average stock prices of the leading stocks in the Chinese pharmaceutical industry and its four branches from 2013 to 2022. Firstly, a comprehensive analysis of the four branches was conducted based on the data, and a line chart of stock prices over time was created, followed by an analysis of the stock price changes in each branch. The conclusion is that the economy and major epidemics have a huge impact on the pharmaceutical industry as a whole, with the chemical and biopharmaceutical branches being greatly affected by major diseases and experiencing significant stock price volatility. The stock price of pharmacy chains is relatively stable, and external factors will not have a significant impact on it. Their stocks are low risk, but the stock price is also low, belonging to the stable development type of stocks. To ensure the effectiveness of the experimental model, a linear regression model analysis was conducted, improving the experimental model and determining the linear relationship between time and the stock price of the pharmaceutical industry, predicting that the Chinese pharmaceutical industry's stock market will continue to develop steadily and show a slight downward trend in the future.

References

1. Chen, Q., Goldstein, I., Jiang, W.: Price Informativeness and Investment Sensitivity to Stock Price. The Review of Financial Studies 2(3), 610-650 (2006).
2. Yu, F.: The Impact of Unexpected Events on China's Stock Market: A Study Based on Industry Classification. Working paper, (2021).
3. Ren, M. Wang, C. Yang, H.: The Impact of the COVID-19 Pandemic on China's Pharmaceutical Industry Stock Prices: An Empirical Analysis Based on the ARIMA Model. Northern Economy and Trade 2, 93-96 (2022).
4. Qian, D.: Analysis of Factors Affecting the Growth of Listed Pharmaceutical Companies. Southwest University, MA thesis, (2011).
5. Li, P. F.: Analysis of the Impact of Financial Information of Listed Companies in the Pharmaceutical Industry on Stock Prices. East China Jiaotong University, (2018).
6. Markovitch, D. et al.: Using Capital Markets as Market Intelligence: Evidence from the Pharmaceutical Industry. Management Science 51(10), 1449-1592 (2005).

7. Jorge, V., et al.: Do product innovation and news about the R&D process produce large price changes and overreaction? The case of pharmaceutical stock prices. Applied Economics 44(17), 2217-2229 (2012).
8. Meng, Y.: The burgeoning biomedical and medical device industry. Admissions Examination Newsletter: Advanced Placement Edition, 48–49 (2016).
9. Lan, Y. Lan, H.: Mean Reversion in the Cyclical Movement of Chinese Stock Market. Emergence and Transfer of Wealth, (2015).
10. Luo, C. Yang, Q.: Research on the Effectiveness of China's Stock Market. Finance 12(2), 195-20 (2022).