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Research on the trend of Chinese stock market based on Monte Carlo simulation method

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Abstract: *The quantitative trading strategy of stock market in developed countries has been very mature, but the quantitative trading strategy of China's stock market has only begun to develop in recent years. In this paper, the closing levels of CSI 300 Index from 2002 to 2022 were selected as the research objects. Monte Carlo simulation method was used to simulate the closing levels of the next 30 trading days, and the simulation results of the last trading day were counted and analyzed. It is found that most of the results of Monte Carlo simulation are in the reasonable range, and the occasional extreme case has similar cases in history. Therefore, the use of Monte Carlo simulation can roughly simulate the future period of income and risk situation, to provide a certain degree of help for investors to make decisions.*

Keywords: *Quantitative trading; CSI 300 Index; Monte Carlo simulation method; Trend prediction; China Stock market*

1. Introduction

In the development process of Chinese stock market for more than 30 years, the stock market has experienced many ups and downs of bull and bear market conversion, which brings profit opportunities to investors but also brings great risks. Especially in recent years, the sluggish international economic situation, slow domestic economic growth, repeated global epidemics and geopolitical conflicts have all contributed to the poor performance of the stock market. For most institutional and individual investors, it is difficult to grasp the future trends and investment opportunities of China ' s A-shares, and many investors are in a state of loss. In such an environment, the many advantages of quantitative investment, such as the discipline and systematization brought by programmatic exchanges, have allowed it to rise as an important tool for investment institutions such as private equity and public offering.

Tracing the history of quantitative investment, it began to rise gradually in the 1970s. It has been developed for more than 40 years in overseas countries with developed securities markets such as the United States, while quantitative trading is still in its infancy in China. However, due to its advantages such as system, accuracy and efficiency, it is developing rapidly. By promoting the continuous integration of computer technology and financial field, quantitative trading provides the power for the intelligent development of the capital market. For some insuperable human weaknesses in investment, such as greed, fear and fluke, quantitative investment, as a way of combining the application of information technology and investment behavior, can directly use computers to execute investment decisions so as to avoid the negative impact of human emotion and cognition on investment. It can judge and analyze investment objects more quickly and accurately based on big data, and balance risk and return. This kind of investment decision means is obviously more advantageous in the imperfect Chinese stock market, and its application prospect is very broad.

2. Review of research literature

The stock markets of developed countries have experienced a long history of development. Many scholars focus on stock market research, and the research on the effectiveness of technical indicators or the trend of stocks has been in the forefront. Grundy(2002) studied the technical analysis strategy and found that the strategy could obtain certain excess returns in the stock market[1]. Tharavanij Piyapas(2015) used technology to analyze Asian stock markets and found that he had better performance in some markets and obtained better returns[2]. Ratner M and Leal RPC(2015) conducted technical analysis on stock indexes in Europe and Asia and found that the smooth movement index had very good effect on the indexes of many countries, especially for some Asian stock market indexes, which further indicated the effectiveness of MACD index[3].

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Compared with foreign countries, Chinese stock market started relatively late, but Chinese scholars have more and more research in the field of stock trend. Since the early stock market in China is extremely immature, the research results at that time are very effective for the market investment. Fang Kuangnan and other scholars used a variety of indicators to study and analyze the CSI 300 index, and the results showed that technical indicators were similar in stock prediction[4]. Bao Yi (2015) demonstrated the effectiveness of the current moving average in China's stock market by analyzing and verifying blue chip stocks in China[5]. In terms of research on stock trend, Huayu (2019) also used quantitative investment mean-average regression strategy to analyze stock return rate and proved the effectiveness of the mean-average quantitative strategy[6]. Yu Tongtong (2020) also constructed a stock quantitative trading strategy based on artificial intelligence and visualization technology, believing that only by minimizing manual intervention can investors obtain greater returns[7].

To sum up, there are many domestic and foreign studies on the trend of stocks, and all of them have verified that the stock market has trend, and investors can obtain excess returns by adopting trend strategies. However, most of the studies focus on the effectiveness of a certain technical indicator, and do not consider the overall trend research. This paper will use the Monte Carlo simulation method to further explore the quantitative trading strategy based on trend theory, build a model through historical data, and simulate the overall trend of the stock market in the future.

3. Research methods and data sources

3.1. Monte Carlo Simulation

Li Yanzi and Wang Hanmo (2016) pointed out that "Monte Carlo simulation is a method to repeatedly generate time series by setting stochastic processes, calculate parameter estimators and statistics, and then study their distribution characteristics"[8]. The main idea of this method is that, for a random system, the change of output with input is random, then the specific distribution of output can be obtained by repeated sampling point method, and then the distribution of output can be analyzed.

3.2. Law of large Numbers

The law of large numbers refers to the probability that the frequency of random events approximates the frequency of repeated trials with the remaining conditions unchanged. Combining the law of large numbers and Monte Carlo simulation, this paper can use the existing data for modeling, and on this basis run multiple data simulations to predict what will happen in the future. The more simulation times, the closer the results will be to the real situation. Of course, each model has its own assumptions and conditions. The following assumptions will be made in the simulation and prediction process in this paper:

(1) Assume that the closing points of the index conform to the normal distribution.

(2) Assume that the mean and variance of historical data are approximately unchanged in the forecast period.

According to these assumptions, this paper can calculate from the data, and get the forecast data through Monte Carlo simulation.

3.3. The data source

In this simulation, 5000 historical closing prices of CSI 300 index from January 4, 2002 to August 4, 2022 were selected from NetEase Finance. The historical trend is shown in Figure 1.

Since the price of the index changes every day on the basis of the price of the previous day, the data of the closing price cannot be well used in the model of this paper. However, the value of the rise and fall will not change according to the rise and fall of the previous day, so the rise and fall data can reflect the change of the index more directly. Therefore, this paper can use the existing data to calculate the rise and fall of the index in each trading day. This simulation also selected the closing index point on August 4, 2022, because this paper simulated the subsequent rise and fall based on August 4, and speculated the changes of the CSI 300 index in the next 30 trading days.

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Figure 1: Chart of the CSI 300 Index's historical closing trend over the past 5000 trading days.

3.4. The data simulation

In this paper, the current known data is brought into the model and simple simulation is carried out by Excel software. The simulation process can be divided into the following steps:

(1) Calculate the mean value and standard deviation of the data;

(2) Put the calculated average and standard deviation into the parameters of the model, and run a simulation of the normal distribution function, so as to get the random rise and fall of one trading day;

(3) Repeat step (2) 5000 times, then 5000 results will be obtained;

(4) Continue the simulation on the basis of (3) for a total of 30 trading days, so as to get a new 5000 results;

(5) Distribution probability of closing points in statistical results.

Through calculation, this paper obtained that the average daily rise and fall of CSI 300 index was 0.036%, and the standard deviation was 0.01625. They were used as the mean and standard deviation of normal distribution in Monte Carlo simulation to simulate, and finally 5000 data were obtained. In this paper, due to the limitation of Excel on the data of charting tools, we can only draw data from them 250 times at random and show their closing price paths over the 30 trading days.

4. The results of the research

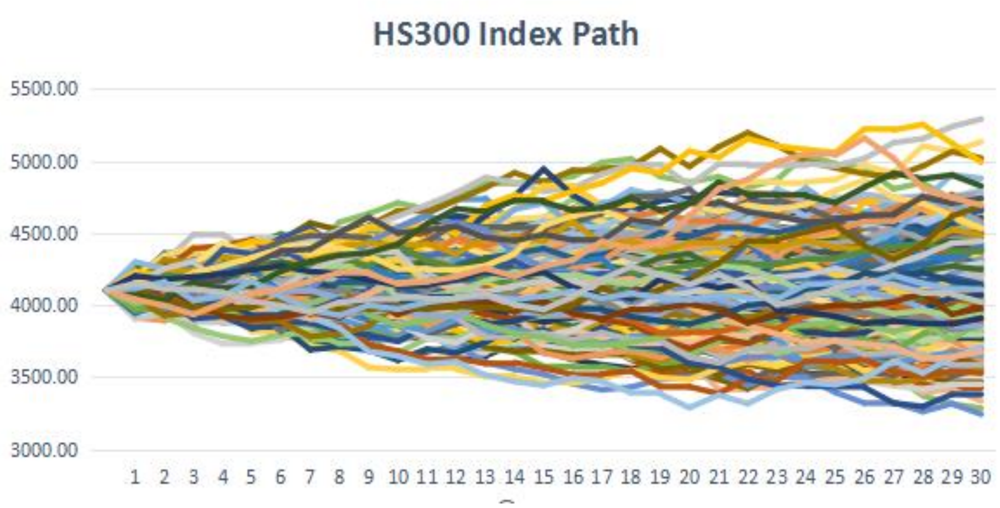

Figure 2: Chart of 250 Monte Carlo simulations of CSI 300 index

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It should be noted here that on August 4, 2022, the CSI 300 index closed at 4101.54, against which all simulations were conducted. By figure 2, can see the trend of each line is not the same, after the 30 trading days to simulate the closing also have bigger difference, in order to better show the 30 trading days after the closing of the distribution, this article will save 29 days in front of the path, because this is not the simulation the biggest concern.

Fortunately, the most concerned issues in this paper can be intuitively demonstrated by Excel. After 5000 Monte Carlo simulations, the distribution of these 5000 different closing points is shown in Figure 3:

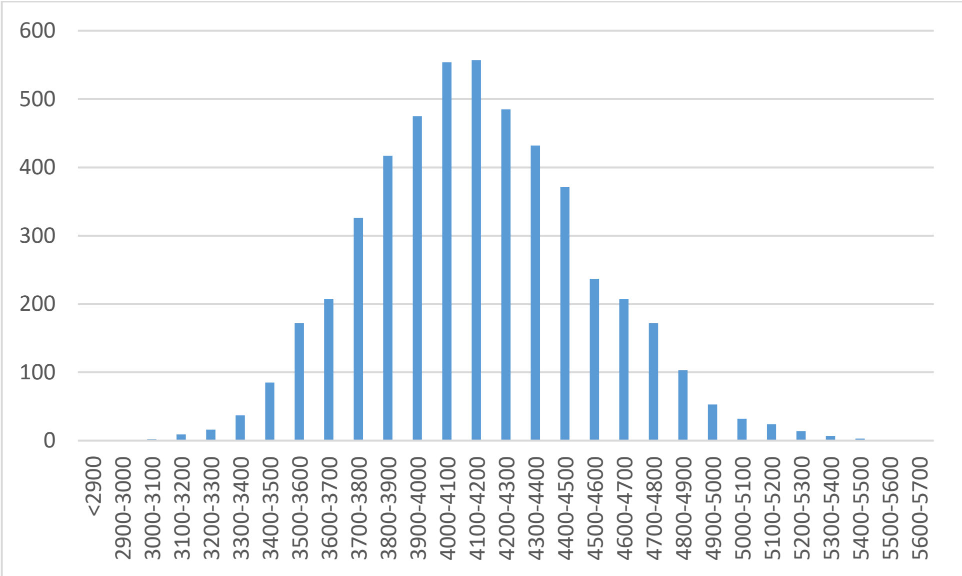

Figure 3: Simulated closing level distribution of CSI 300 index after 30 trading days

In Figure 3, the abscissa represents the closing level of CSI 300 index after 30 trading days, and the ordinate represents the number of results in the actual simulation process. It can be seen from Figure 3 that after 30 trading days, the CSI 300 index closed between 4000 and 4100 for nearly 600 times, and there were also close between 4100 and 4200 for nearly 600 times. It should be pointed out once again that on August 4, 2022, the CSI 300 index closed at 4101.54. This means that after 30 trading days, the CSI 300 index is most likely to close between 4,000 and 4,200 points, which also means that the 30 trading days do not seem to have much impact on the CSI 300 index. For further research, this paper calculates that the simulated average closing level is 4147.08, which is 1.11% higher than the closing level on August 4, 2022.

In the previous paper, the average historical rise and fall of CSI 300 index was calculated to be 0.036%. Assuming that the rise and fall of CSI 300 index in every trading day simulated in this paper were 0.036%, then the closing point after 30 trading days was 4146.08, which was very close to the average value simulated by Monte Carlo. Based on this, 5000 simulations is probably enough for this study.

Although this paper uses Monte Carlo simulation to make corresponding predictions for the future, there are some points in this experiment that are worthy of further discussion. For example, the Monte Carlo simulation itself assumes that the closing prices of stocks and indices are normally distributed. This may not be the case in real life, there are many factors that can affect the stock market. GDP is a typical example. Generally speaking, the growth rate of GDP is positively correlated with the economic development of a country. The higher the GDP growth rate, the better the economic development of the country, which will play a positive role in promoting the stock market. For this reason, GDP data seems to be an effective reference factor for the model. However, GDP data is generally published once every quarter, and only 4 data are published in a year. However, the stock market trades for about 255 days in a year, so 255 data are obtained, which is not matched in the total amount of data. Furthermore, GDP is a relatively lagging indicator. For example, the annual GDP growth data released by China's National Bureau of Statistics is usually released on a certain day between January and March of the following year, but the closing level of the CSI 300 index is real-time, and the market gets its closing level immediately after the end of each trading day. Therefore, although there is a certain relationship between GDP growth and the rise or fall of the stock market, this paper does not include it as a variable in the model due to data and lag.

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In addition to GDP, some unexpected events will also have a big impact on the stock market. For example, the public health emergencies discovered at the end of 2019 and broke out in 2020 had a great impact on China's stock market. On February 3, 2020, when news of a public health emergency spread across China, the CSI 300 index fell 7.88 percent that day, a rare drop in the history of China's stock market. In March 2022, public health emergencies once again spread in China. Combined with the impact of the war between Russia and Ukraine, the CSI 300 index began to fall from 4,619.69 points on March 1, 2022 to 3,784.12 points on April 26, 2022, a cumulative decline of 18.09% in nearly two months. These are not fully reflected in the model in this paper, but there is randomness in Monte Carlo simulation itself, which can represent the impact of sudden events on the stock market to a certain extent.

In addition to the assumptions of Monte Carlo simulations, extreme values are also worth discussing. The lowest close out of 5000 simulations is 2,918.55, while the highest is 5,608.62, which represents a -28.84% gain or 36.74% fall from the initial level of 4101.54. This seems to have a bigger impact than previous emergencies. The possible reason for this is that for each trading day, Monte Carlo method is simulated separately, and when the number of simulations gradually increases, it is possible that there will be a big rise or fall in several consecutive trading days. While this is rarely the case in practice, it is possible in theory, and it makes more sense to choose a 95% range of simulation results that would result in a 30-day closing range from 3466.68 to 4927.49.

5. Conclusions

After more than 30 years of development, China's stock market has gradually become mature. In the process of development, there are many events and policy changes that lead to the volatility of China's stock market, but there are often many opportunities in the volatility. Quantitative trading can use historical data to try to find potential rules, and use the discipline and systematics brought by programmatic trading to grasp the future trends and investment opportunities of China A shares. In this paper, the CSI 300 index, which can relatively represent the large-cap enterprises in China's A-share market, is selected as the benchmark, and Monte Carlo simulation is used to forecast the trend of the next 30 trading days for 5000 times, and the distribution of the final closing points is counted. In the simulation, the CSI 300 index closed at an average of 4147.08 after 30 trading days, representing a gain of 1.11 percent from the benchmark of 4101.54. Through further calculation and analysis, this paper finds that there are some situations in the simulation results with large fluctuations, but most of the forecasts make the index run in a more reasonable range. For those results with large deviations, this paper proposes several possible reasons, including public health events, war, etc. Of course, the model itself is a random prediction based on historical data, and it is reasonable to have individual situations in the process of 5000 random predictions. To sum up, this paper believes that using Monte Carlo simulation to predict the trend of China A shares CSI 300 index is effective.

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