Summary

The stock price of companies is influenced by random factors and trend factors. In order to solve the problem of stock market prediction, the K graph, fuzzy comprehensive evaluation method, Lyapunov index, time series prediction method and index analysis were used to carry out the analysis.

In task 1, according to the abnormal volatility of stock trading regulations, we screened abnormal data. The monthly K line, weekly K line and 20-day moving average (stock lifeline) and daily K line were selected for qualitative analysis. After consulting the data, the three stocks belong to the outstanding shares, supporting the correctness of qualitative analysis.Secondly, we established the stock price evaluation system by fuzzy comprehensive evaluation method to realize quantitative analysis, The weight coefficient of each index was determined by entropy weight method, resulting in the formula of stock price trend of three stocks. The results are consistent with the qualitative analysis. Chaotic characteristics were clarified by chart, and then we calculated the Lyapunov index by Matlab programming to prove them.

In task 2, due to the randomness and trend of the data, we used the SPSS to prove the feasibility of time series prediction.Secondly, using this method to predict the results of the five quantitative indexes of the three stocks in the last 20 days, the corresponding goodness of fit, significance level and prediction value can be obtained: the goodness of fit tends to be 1, the significance level is lower than 0.05, and the absolute value of relative error is lower than 5.

In task 3, the stock price reversal point was defined. Six of them were selected as waiting indicators: MACD 、KDJ、RSI、CCI 、BIAS and ARit. due to the sensitive response. According to the recall rate and accuracy rate, the judgment vector of the inversion point is selected :{ BIAS,CCI,MACD,ARit}. Secondly, the LIBSVM regression is carried out in Zhou, and the inversion judgment parameters are obtained to determine whether it is the inversion point.

The models and methods are established in this paper, which is feasible and accurate. This method has high universality and provides a way to analyze and predict the stock market with chaotic characteristics.

Key word :fuzzy comprehensive evaluation method; entropy weight method; time series prediction; technical index analysis; LIBSVM regression

Content

1 Introduction

1.1 Background

The change of stock price of listed company can directly reflect the operating condition and market recognition of listed company. The stock price itself is influenced by trend factor and random factor, and its short-term rise and fall is affected by supply and demand. At the same time, stock price model and trend prediction need to be explored based on nonlinear characteristics of complex stock price change.

The emergence of chaos theory provides a scientific solution for solving the unified problems of order and disorder, certainty and randomness. Chaos theory is well-organized and can be used to interpret the behavior of dynamic systems which must be explained and predicted by whole, continuous rather than single data relation.

1.2 Work

Based on the above problem background, the idea and method of chaos theory can be used to solve the practical problem for the nonlinear complex characteristic system of stock price. Therefore, based on the idea of chaos theory, this paper carries out scientific analysis and theoretical prediction to solve the following problems:

1. Analyze the daily, weekly and monthly trends of the three stocks, and carry out qualitative or quantitative analysis of the stock trend (including the test of chaotic characteristics), and give the relevant analysis results;

2. According to the trend and characteristics of different stock prices, the mathematical model of stock prices is established, and the prediction results of the model are evaluated by using the data of the last 20 days;

3. There is a reverse phenomenon in the trend of stock prices, that is, if they rise too much, they will fall; if they fall too much, they will rise and show certain cyclical changes. Using the research results of Question 2 to establish the reverse judgment of stock price model is broken and tested with data.

2 Problem Analysis

2.1 Data analysis

This paper first determines whether there is abnormal data according to the abnormal fluctuation regulation of stock trading in stock exchange, and then processes abnormal data according to the actual situation.

2.2 Analysis of question one

Firstly, this paper draws the daily, weekly and monthly K chart of stock to analyze the stock trend qualitatively.Because the 20-day moving average is the transition average between the short-term moving average and the long-term moving average, and the change of stock trend depends to a large extent on the changing trend of the 20-day moving average, Therefore, this paper introduces the 20-day moving

average to further qualitatively analyze the weekly K chart trend. Finally, according to the data, the issuing enterprises and fundamental analysis of the three stocks are obtained, and it is judged that the three stocks belong to the outstanding shares, which is consistent with the qualitative analysis results.

Because the stock trend is influenced by the trend factor and the random factor, this paper establishes the stock price trend evaluation system based on the fuzzy mathematics thought, and determines the weight coefficient of each index through the entropy weight method. The trend formula of stock price with index is obtained, and then quantitative analysis is realized. In view of the chaos characteristic test, the stock trend chart in the qualitative analysis can roughly display the chaos characteristic. On this basis, with the help of Matlab programming, the Lyapunov index is calculated by using the parameters of the Logistic map, and the quantitative chaos characteristic test is carried out. The results are consistent with each other and the correctness of the conclusion is verified.

2.3 Analysis of question two

Taking stock price as an example from 2016 to 2020, this paper takes all the data of stock 000400. SH as an example, through SPSS time series prediction, and then using the data of the last 20 days to test the prediction results of the model. The R square, significance level and relative error of the prediction model are observed.

2.4 Analysis of question three

Based on the reverse of stock prices, In this paper, the inversion phenomenon is judged by relevant technical indexes. Because the overbought oversold index is more sensitive, Can react quickly to the rise and fall of the stock price, Therefore, six of them are selected: smoothing similarity and difference mean line index (MACD), random index (KDJ), relative strength index (RSI), homeopathy index (CCI), deviation rate index (BIAS) and excess rate of return (AR it), According to the recall rate and accuracy rate, the four indexes are selected to form the judgment vector {BIAS、CCI、MACD、ARit.} of the inversion point Using support vector machine to mine the vector of inversion point judgment, In weeks, Stock 000400. SZ 2020 43 weeks of LIBSVM return, Analysis of the parameters, According to the positive and negative judgment parameters to determine whether the reversal point. Finally, the parameters are t tested, Test whether the reversal effect is obvious.

3 Symbol and Assumptions

3.1 Symbol Description

Symbol	Meaning
d	Deviation from the price of the closing price
Z	Share price
Y_1	Enterprise vitality
Y_2	Profitability
X_1	Stock amplitude
X_2	Turnover
X_3	Volume
X_4	Closing price
X_5	Number of shares
M_{ij}	Standardized data for the j indicators for the i week of 2016

3.2 Fundamental assumptions

1. This paper assumes that the data given by the title is true and effective, and has research value;

2. This paper assumes that market information is true and effective;

3. This paper assumes that the change of stock market has certain regularity, and the law of market evolves by trend;

4. This paper assumes that history will repeat itself.

4 Model

4.1 Model of question one

4.1.1 Exception Data Screening

According to the trading regulations of stock exchanges, when the closing price of three consecutive trading days deviates from the value of more than 20, it is called abnormal fluctuation of stock trading[1]Therefore, it is necessary to filter out the relevant abnormal data. By using the Excel, to establish the deviation formula of closing price increase, this paper calculates the deviation value of each trading day, and selects the abnormal data accordingly.

In this paper, we define the deviation of closing price d ，One trading cycle per three consecutive trading days t ，The closing price on the first day of the cycle is t, and the closing price on the third day is C_{m1} C_{m3}

$$d_m = \frac{C_{m3} - C_{m1}}{C_{m1}} \cdot 100\%$$

（1）

According to the above formula, all deviations are lower than 20, so there is no abnormal floating phenomenon of stock trading. The data given are normal data, so the next step can be studied and analyzed.

4.1.2 Qualitative Analysis Model of Stock Trend

As can be seen from the title: the stock market is a very typical nonlinear complex system. This paper selects the analysis tool K line commonly used in the stock market to describe the trend. On the basis of the data, this paper selects three stocks in 2016 related data to draw monthly K line, weekly K line, daily K line, and analyze its trend.When using the K line combination to predict the stock market, the analysis effect of the daily line with the weekly line and the monthly line is better[2]。

4.1.3 Stock Trend Quantitative Analysis Model

4.1.3.1 Stock Price Evaluation System

Because the stock itself is influenced by the trend factor and the random factor, the stock market is a complex nonlinear system. Because the result of fuzzy comprehensive evaluation method is clear and systematic, it can solve the fuzzy and difficult to quantify problems well, and is suitable for solving various non-deterministic problems, this paper uses the idea of fuzzy comprehensive evaluation method to establish the stock price evaluation system[3]In this paper, quantitative analysis of the impact of specific indicators affecting the stock market trend, and then describe its trend development.

Considering the scope of data analysis and the universality of conclusions, this

paper defines the comprehensive index of stock price based on the most reasonable weekly K chart of data amount Z. Taking the enterprise vitality and profitability which affect the stock price as the second level index of the evaluation system, the stock amplitude X_1, turnover rate X_2 and turnover volume X_3 are selected as the indicators that affect the enterprise vitality, and the closing price X_3, turnover volume X_3 and the number of shares X_4 are used as the indicators that affect the profitability. The structure is shown below. X_1 X_2 X_3 Y_1 X_4 X_3 X_5 Y_2
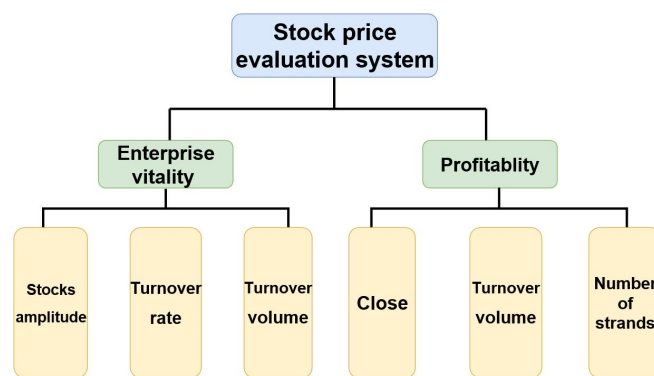
Figure 1 Structure Chart of Stock Price Evaluation

According to the fuzzy mathematics theory, this paper uses the entropy weight method to determine the weight of each index, and then determines the degree of influence of each index on the stock price, and further realizes the quantitative analysis of the stock market[4]. Taking stock 000400. SZ as an example, quantitative analysis is carried out. The relationship between the indicators is as follows:

$$Y_1 = f_1(X_1, X_2, X_3) \tag{2}$$

$$Y_2 = f_2(X_3, X_4, X_5) \tag{3}$$

$$Z = f(Y_1, Y_2) \tag{4}$$

In this paper, the weight coefficients corresponding to five secondary indexes are defined as w_1、w_2、w_3、w_4、w_5

$$Z = w_1 X_1 + w_2 X_2 + w_3 X_3 + w_4 X_4 + w_5 X_5 \tag{5}$$

Data were standardized and obtained: M_{ij}

$$M_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \quad (i = 1, 2, \cdots 50; j = 1, 2, \cdots 5) \tag{6}$$

Define the contribution of the first scheme under the first attribute: P_{ij}

$$P_{ij} = \frac{x_{ij}}{\sum\limits_{i=1}^{50} x_{ij}} (i = 1, 2, \cdots 50; j = 1, 2, \cdots 5)$$

（7）

The total contribution of all programmes to attributes is: X_j E_j

$$E_j = -\frac{1}{\ln(50)} \sum\limits_{i=1}^{50} P_{ij} \ln(P_{ij}) \ E_j \in [0,1](i = 1, 2, \cdots 50; j = 1, 2, \cdots 5)$$

（8）

According to formula (9), the data results are obtained. w_j

$$w_j = \frac{1 - E_j}{\sum\limits_{j=1}^{5} 1 - E_j} (j = 1, 2, \cdots 5)$$

（9）

4.1.4 Chaos Feature Test Model

I. Chaos characteristics

Because of strong speculation, China's stock market is prone to frequent ups and downs of the "chaos" phenomenon. When the stock price rises above a small critical level, speculators in the stock market will collectively buy the stock, and hot money from other capital markets will continue to pour into the stock price. When the stock price rises to a certain extent, the stock price is seriously higher than its own value, the system reaches the most unstable state, the stock is constantly thrown out to realize, the price will stop rising at a certain point and start to fall, thus causing the price to plummet. Tumbling to a certain extent will be bought into the market and later out of profit, later will appear a new round of sharp decline. Therefore, the stock market itself has significant chaotic characteristics.[5]

The basic feature of chaotic characteristics is that variable changes are highly sensitive to initial conditions. The asymmetric supply demand of stock market, the time delay in the iteration of capital variables, the "finite rationality" of human behavior and the flow of hot money will all cause the chaotic characteristics of stock price[6]. The formation process of chaotic features can be represented by Figure 2.
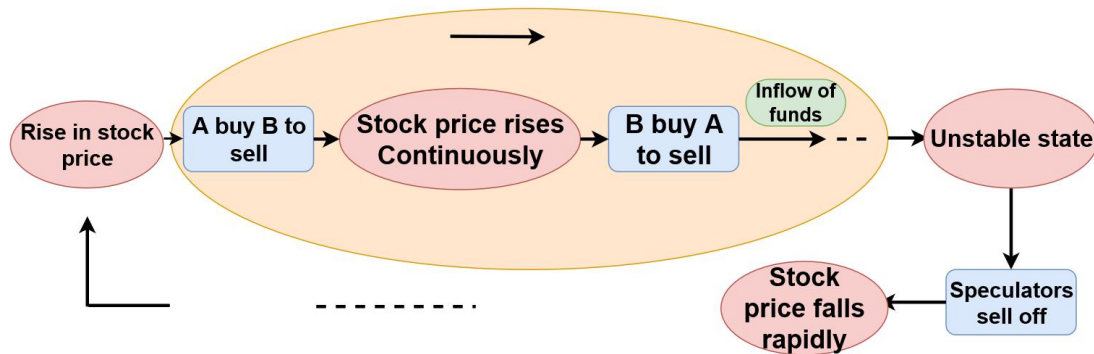
Fig .2 Formation of Chaos Characteristics in Stock Market

II. Chaos Feature Test

The chaotic characteristics of China's stock market can be preliminarily observed from the above qualitative analysis of the trends of the K line, the weekly K line and the daily K line. Then the chaos characteristic test is carried out with the help of power spectrum. If the power spectrum has a single peak (or several peaks), it corresponds to a periodic sequence, and if there is no obvious peak or peak connection in the diagram, it corresponds to a chaotic sequence.Based on the initial sensitivity of chaotic feature itself, this paper uses Lyapunov exponential method to improve the existing power spectrum observation method, which can effectively solve the problem of chaotic feature test in nonlinear complex systems, and the physical meaning is clear. The error is smaller. The Lyapunov index of the above three stocks is calculated by Matlab programming to test the chaotic characteristics.

. Calculation of Lyapunov III index

1）The mapping of stock price Z obtained from Log istic quantitative analysis is

$$Z_{i+1} = aZ_i(1-Z_i)(i=1,2,\cdots 50) \qquad （10）$$

Calculation formula of 2)Lyapunov index:

$$\lambda = \lim_{n\to\infty}\sum_{k=0}^{n-1}\log\left|\frac{df}{dx}\right|_{x_k} \qquad （11）$$

$$\left.\frac{df}{dx}\right|_{x_k} = a-2ax_k \qquad （12）$$

4.2 Model of question one

4.2.1 Time Series Prediction Model

Considering the periodicity, trend and randomness of stock price, this paper uses time series to predict the data of the last 20 days. Time series prediction is to study the statistical law of random data sequence by arranging each value of each statistical index in stock market in different time order and forming sequence according to time order[7]Based on the data of three stocks in 2016, an expert model SPSS time series prediction is used to obtain the prediction value and optimal model of each index. R^2 By the evaluation of the prediction results, such as significance test and relative error, the R value is good and the significance level is small, so the prediction model is more accurate.

4.2.1.1 Establishment of SZ time series model

The optimal time series model of the five indexes in the SZ is as follows.

Table 1 Stock 000400 SZ time series model description table for each indicator

			Model Description
			Type of model
	x1	Model _1	Simple season
	X2	Model _2	Simple season
Model ID	X3	Model _3	Simple season
	X4	Model _4	Simple season
	x5	Model _5	ARIMA(0,0,0)(0,0,0)

Therefore, the best time series model types of the five indexes SZ are: simple seasonality, simple seasonality, simple seasonality, simple seasonality, ARIMA(0,0,0).

4.2.1.2 Stock 002281. SZ time series model establishment

According to the time series method, stock 002281. The optimal time series model corresponding to the five indexes of the SZ is as follows.

Table 2 Stock 002281 SZ time series model description table for each index

			Model Description
			Type of model
	X1	Model _1	Simple season
	X2	Model _2	Simple season
Model ID	X3	Model _3	Simple season
	X4	Model _4	Wintersga
	X5	Model _5	ARIMA(0,0,0)(0,0,0)

Therefore, the best time series model types of the five indexes SZ are: simple seasonality, simple seasonality, simple seasonality, simple seasonality, ARIMA(0,0,0).

4.2.1.3 Stock 600519. Establishment of SH Time Series Model

According to the time series method, stock 600519. The optimal time series model corresponding to the five indexes of the SH is as follows.

Table 3 Stock 600519 SH time series model description table

|			Model Description
			Type of model
Model ID	X1	Model _1	Wintersga
	X2	Model _2	Wintersga
	X3	Model _3	Wintersga
	X4	Model _4	Simple season
	X5	Model _5	ARIMA(0,0,0)(0,0,0)

The best time series model types of the five indexes SH by using the SPSS are: winters additive, winters additive, winters additive, ARIMA(0,0,0)(0,0,0).

4.3 Model of question three

4.3.1 inversion model

The inversion model is a kind of price form which uses the column chart to express the opposite trend of price market[8] m、 $m+1$、 $m+2$ J_m、 J_{m+1}、 J_{m+2} $m+1$.

For a given stock closing price sequence, suppose there are three points in the time series that correspond to the combined stock price, respectively. If the combined stock price slope of (m,m+1)<0, and the combined stock price slope of (mm,m+1, mm,m+2)>0, then the point is called the upward reversal point.
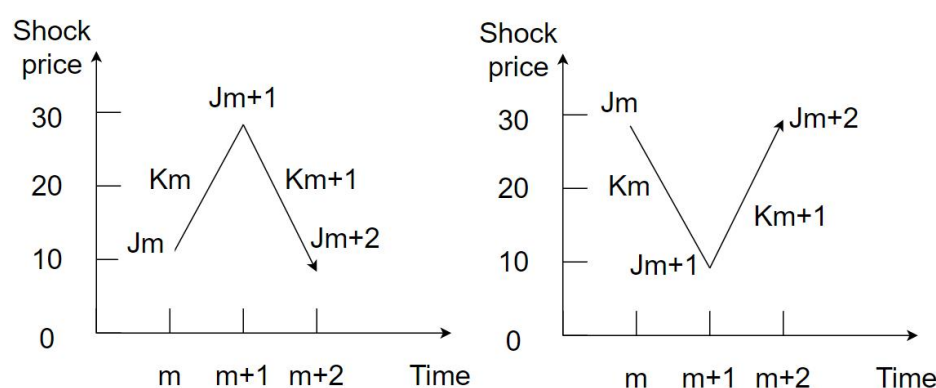
Figure 3 Stock Market Reversal Point Map

Taking the 2020 data of three stocks as an example, this paper establishes the inversion model and replaces the data to test the reversal phenomenon of stock price.

Establishment of 4.3.2 Stock Price Inversion Judgment Model

Ⅰ. Technical indicators analysis

Technical index analysis is the main quantitative analysis method to judge stock price reversal. By summing up the historical change law of the stock market, it numericalizes all kinds of changes of the stock market, which is more intuitive and accurate and easy to be accepted than other analytical methods.The index of overbought oversold is sensitive and can react quickly to the rise and fall of stock price. Therefore, this paper selects six indexes of overbought oversold as the basis for judging the reversal point: smooth similarities and differences average line index (MACD), random index (KDJ), relative strength index (RSI), homeopathy index (CCI), good departure rate index (BIAS) and excess yield (AR it)[11]。

1. Average index of smoothing similarities and differences (MACD)

MACD technical index consists of DIF line, DEA line and MACD column. The DIF line is the difference between the short-term and long-term exponential smooth moving average of the closing price; the DEA line is the DIF line M 8 the exponential smooth moving average; and the MACD is the difference between the two.

2.Random indicators (KDJ)

three graph lines one K line, D line and J line are used in the random index. The K is a fast index and the D is a slow index. The main inversion signal is sent out by

the J line.The above three lines all swing between vertical scales from 0 to 100.

3. Indicators of relative strength (RSI)

The RSI index consists of a RSI line, and we draw the RSI on a chart with a vertical scale from 0 to 100.

When its reading is in the range of 70-100, it enters the overbuying state, and when its reading is in the range of 0-30,

Then enter the oversold state. But in bull and bear markets, RSI drift, so ,80-100

It is usually called the oversold range in a bull market, while 0-20 is the oversold range in a bear market.

4. Homeopathy indicators (CCI)

CCI index consists of a CCI line whose values change between positive and negative infinity without the limitation of the operating region. however, unlike other indicators with no operational area limits, it has a relative technical reference area :[-100,+100].Therefore, the value of CCI index is divided into three intervals :[+100,+∞] is overbought area ,[-100,+100] is oscillating area ,[-100] is oversold area.

5 Behavioural indicators (BIAS)

Good departure rate (BIAS) is divided into two types: positive and negative. When the stock price is above the moving average, its deviation rate is positive and vice versa. When the stock price coincides with the moving average, the deviation rate is zero. With the strength and rise and fall of the stock price trend, the deviation rate shuttles around the top and bottom of zero point, and its value has certain prediction function to the future trend.

6 Excess rate of return (ARit)

1) Define the real return rate of stock according to the market model and the earnings per share Rit EPS , b weekly turnover for 2020 $X_{b2}(b=1,2,\cdots43)$,

Volume $X_{b3}(b=1,2,\cdots43)$

$$Rit = EPS = \frac{X_{b3}}{X_{b2}}(b=1,2,\cdots43)$$

（13）

2) parameter estimates

Access to information to the 2020 corresponding stock market returns Rim ,

Regression of the lower formula using the least square estimation method[9]estimated using parameter estimates α_i、 β_i、 ε_i

$$Rit = \alpha_i + \beta_i Rim + \varepsilon_i t$$

（14）

3) Calculation of excess returns $ARit$

$$ARit = Rit - \alpha_i - \beta_i Rim$$

（15）

II. Screening indicators

According to the recall rate and accuracy rate, four indexes are selected to form the judgment vector of inversion point: BIAS、CCI、MACD、ARit. The recall rate represents the ratio of the predicted accurate reverse trading day to the total reverse trading day, and the accuracy rate represents the ratio of the predicted accurate reverse trading day to the number of days marked as the reverse trading day. Their formulas are as follows:

$$recall = \frac{a}{a+c} \tag{16}$$

$$precision = \frac{a}{a+b} \tag{17}$$

Recall rate and accuracy can not be the best, recall rate is high when the accuracy is low; when the accuracy is high, call
Because the return rate is low, the two metrics are often fused into a measure, which is recorded as a F-Measure： value

$$F - Measure = \frac{2 * precision * recall}{precision + recall} \tag{18}$$

III. LIBSVM regression

Using support vector machine (SVM) to mine the vector of inversion point judgment, the vector {0.2236,0.2618,0.3026,0.2120)

$$J_m = 0.2236Z_{BIAS} + 0.2618Z_{CCI} + 0.3026Z_{MACD} + 0.2120Z_{ARit} \tag{19}$$

LIBSVM regression was carried out for 43 weeks of SZ in 2020, and the inversion judgment parameters were analyzed $(m+1, J_{m+1})$ a_{m+1}

$$a_{m+1} = k_m * k_{m+1} \tag{20}$$

Determine whether the point is a reversal point according to the positive or negative of the parameter, if $(m+1, J_{m+1})$

$$a_{m+1} < 0 \tag{21}$$

$(m+1, J_{m+1})$ It is a reversal point. Finally, the t test of the parameters can test whether the inversion effect is obvious.

5 Test the models

5.1 Test the model of question one

5.1.1 Analysis of Stock Trend Qualitative Analysis Model

This article takes 000400. SZ stock as an example, according to the monthly K line, the weekly K line, the daily K line and the 20 day line and so on carries on the stock trend qualitative analysis.

5.1.1.1 Month chart —— monthly K line

A monthly K line is drawn from the opening price of the first trading day of a month, the closing price of the last trading day, the highest price in the month and the lowest price in the month. During stock analysis, the shock trend, pressure level and position change of the box in the monthly K line are used to express the trend of a stock directly.

The following figure shows the 2016 stock 000400. SZ month K chart:
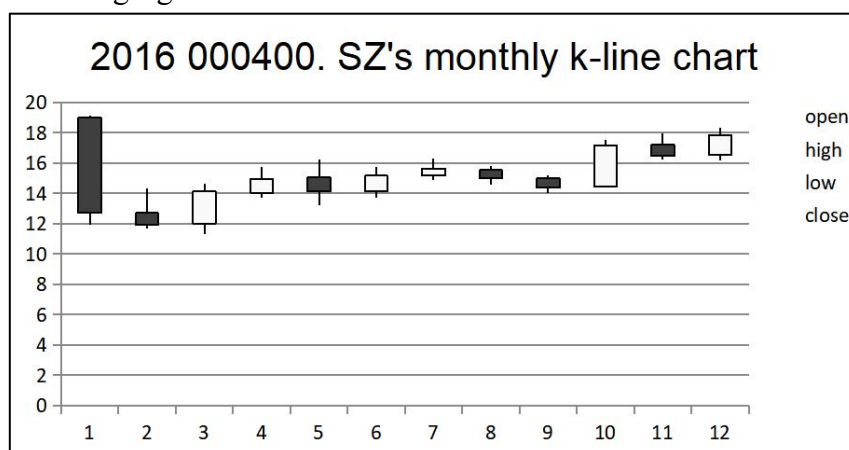
Figure 1 Monthly K chart

From the above chart, the stock 000400. SZ in 2016, the overall performance of the box vibration upward trend. According to the conventional representation method of the stock market analysis chart, the box body is 1-12 points from left to right ,2 points and 9 points are the support position and 7 points are the pressure position.Therefore, the monthly trend of the stock can be obtained as follows: in the 10-20 trend overall upward, there are two local fluctuations :1 point-2 point ,7 point-9 point there is a slight downward trend.

5.1.1.2 Week chart —— weekly K line

The middle week K line refers to the opening price on Monday, the closi ng price on Friday, and the highest and lowest price of the whole week.At the same time, due to the number of weeks in a year, in order to show the stoc k trend intuitively, this paper introduces the 20-day moving average as another certain analysis index.

The stock market defaults to five days a week, four weeks a month, so t he 20-day moving average can be regarded as a monthly line. The 20-day mo

ving average is called stock lifeline, which is the transition moving average be
tween short-term moving average and long-term moving average.

The following figure shows the K chart for the SZ week of the 2016 stoc
k 000400:
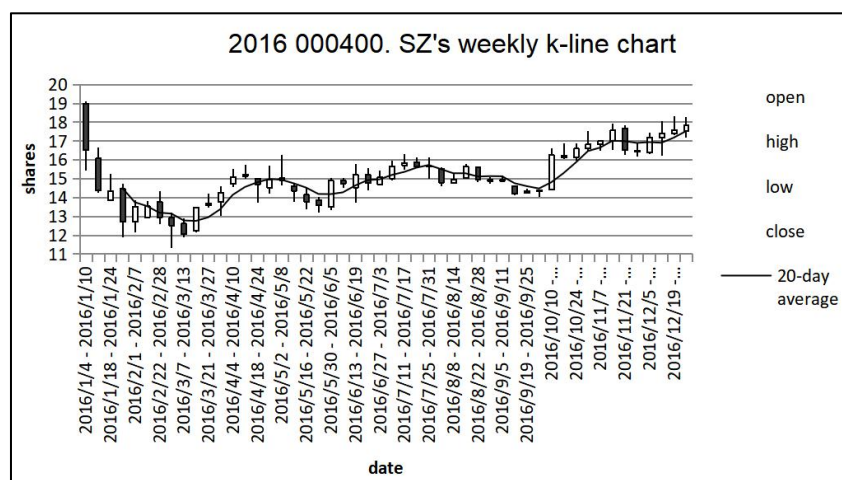
Figure 4   Weekly K chart

According to the above chart, the stock is 000400. SZ in 2016, the overal
l trend of box vibration upward. At the same time, based on the trend analysis
 of the 20-day line, we can get that the weekly trend of the stock is: in the
1200000000-1900000000 trend overall showed a downward-shock-uptrend, box
vibration upward trend.

5.1.1.3 Daily chart —— daily K line

Daily K line in chronological order in this paper can get a year's stock trend. The
daily K chart can further describe the trend of the stock in one year on the basis of
monthly K and weekly K charts.
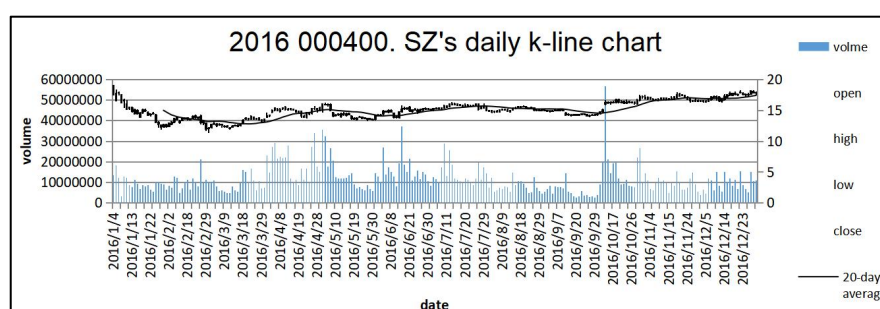
Figure 5 Daily K chart

As can be seen from the above chart, the stock 000400. SZ in 2016 as a
whole showed a downward-shock-up trend, the daily trend of the stock in the
 27000000-45000000 trend overall showed a downward-shock-up trend, the vol
atility is small.

The monthly, weekly and daily movements of the stock 000400. SZ are d
escribed in detail according to the K chart. After the analysis, the monthly, we
ekly and daily trends are generally down-shock-rise, and the box continues to
shock rise. The comprehensive analysis stock 002281. SZ、stock 600519. after
the SH (see appendix 1 for details), its monthly, weekly and daily trends have

reached the same conclusion, the difference is that the stock 000400. SZ box shock range is larger than the other two stocks, and the stock 600519. SH growth rate has slowed since 2019.

5.1.1.4 Qualitative empirical analysis of stock movements

The monthly, weekly and daily movements of the SZ and the stock 600519. SH are generally down-shock-uptrend, and the box body continues to shock upward. The stock can be found according to the literature 000400. SZ issued by Gui zhou Mao tai Liquor Co., Ltd., stock 002281. SZ issued by Wuhan G uang xun Technology Co., Ltd., stock 600519. SH issued by He nan Xu chang Xuji Electric Co., Ltd.

The fundamental general comments of the above three stocks are in good operating condition and high investment value: at the same time, profitability and growth ability are higher than the industry average. Its cash flow ability, operation ability are strong. The difference is that Xu Ji's cash flow capacity fluctuates greatly, and Gui zhou Mao tai's operating capacity has weakened since 2019. Comprehensive know, three stocks can be regarded as outstanding shares. The stock trend of the outstanding stock is usually continuous upward, and considering that the stock itself is influenced by the trend factor and the random factor, the correctness of the qualitative analysis conclusion is verified.

5.1.2 Stock Trend Quantitative Analysis Model

I. Standardized data normalized M_{ij}

Using entropy weight method to determine the weight according to the above formula, calculate the stock 000400. The SZ five secondary indicators were standardized weekly for 50 weeks in 2016, and the following table shows the stock 000400. SZ2016 years ago 25 weeks of standardized data, three stocks standardized data detailed in Appendix II.

Table 4 Data sheets after standardization of five secondary indicators

2016	M1	M2	M3	M4	M5
2016/1/4 - 2016/1/10	0.74578377	0.35302171	0.35302330	0.77349591	1.00000000
2016/1/11 - 2016/1/17	0.70067664	0.26161450	0.26161632	0.40451974	1.00000000
2016/1/18 - 2016/1/24	0.44332552	0.18172240	0.18172441	0.39436444	1.00000000
2016/1/25 - 2016/1/31	1.00000000	0.22309268	0.22309460	0.11340093	1.00000000
2016/2/1 - 2016/2/7	0.64122312	0.24733536	0.24733721	0.25219013	1.00000000
2016/2/15 - 2016/2/21	0.25615480	0.18657307	0.18657508	0.26065289	1.00000000
2016/2/22 - 2016/2/28	0.61044039	0.36061183	0.36061341	0.15232961	1.00000000
2016/2/29 - 2016/3/6	0.70869563	0.27479782	0.27479960	0.07785736	1.00000000

II. Define the contribution of the first scheme under the first attribute P_{ij}

According to the above formula, the contribution of the five secondary indicators of the SZ in the week of 10 weeks in 2016 is detailed in Appendix 2

Table 5 Statistical tables on the contribution of five secondary indicators

2016	P1	P2	P3	P4	P5
2016/1/4 - 2016/1/10	0.04534399	0.02060465	0.02060488	0.02942182	0.04051295
2016/1/11 - 2016/1/17	0.04260146	0.01526953	0.01526973	0.01538690	0.04051295
2016/1/18 - 2016/1/24	0.02695439	0.01060650	0.01060669	0.01500062	0.04051295
2016/1/25 - 2016/1/31	0.06080046	0.01302114	0.01302134	0.00431348	0.04051295
2016/2/1 - 2016/2/7	0.03898666	0.01443610	0.01443631	0.00959267	0.04051295
2016/2/15 - 2016/2/21	0.01557433	0.01088962	0.01088981	0.00991457	0.04051295

III. Define the total contribution of all schemes to attributes X_j E_j

IV. Define attribute weights w_j

Finally, the impact of the stock 000400. The weight coefficients of each index of SZ stock price are:

$$w_1 = 0.1775、\ w_2 = 0.2334、\ w_3 = 0.2334、\ w_4 = 0.2425、\ w_5 = 0.1133$$

then:

$$Z_1 = 0.1775X_1 + 0.2334X_2 + 0.2334X_3 + 0.2425X_4 + 0.1133X_5 \quad (22)$$

Similarly, according to the above steps to the stock 002281. SZ、 stock 600519. SH quantitative analysis, the standardized data and the contribution of each index are detailed in Appendix II. Get the relationship between the stock price Z and the five secondary indicators as follows:

$$Z_2 = 0.1994X_1 + 0.2X_2 + 0.2X_3 + 0.1998X_4 + 0.2008X_5 \quad (23)$$

$$Z_3 = 0.0606X_1 + 0.0361X_2 + 0.0375X_3 + 0.0498X_4 + 0.8160X_5 \quad (24)$$

On the basis of the above relations, the indexes affecting the stock price are: closing price, trading volume, turnover rate, stock amplitude, stock number, SZ(Guangxun Technology), and the indexes affecting the stock price are: stock number, trading volume, turnover rate, closing price, stock amplitude, SH(Guizhou Maotai). The indexes affecting the stock price are: stock number, stock amplitude, closing price, turnover rate, turnover rate.

5.1.3 Stock Market Chaos Characteristic Model

I. Chaos Feature Test

On the basis of the above qualitative analysis, the trend of the mid-month K line, the weekly K line and the daily K line can prove that China's stock market has chaotic characteristics.Based on the initial sensitivity of chaotic features, this paper improves the existing power spectrum observation method reasonably, and uses the Lyapunov index method to effectively solve the problem of chaotic feature testing in nonlinear complex systems, and the physical meaning is clear. The error is small. This paper uses Matlab programming to calculate the Lyapunov index of the above three stocks, so as to test the chaotic characteristics.

II. Lyapunov Index Calculation Method

Taking stock 000400. SZ(Xu Ji Electric) as an example, the parameters a=0.35 and the initial value of iteration Z(0)a=0.35.Matlab program to calculate the Lyapunov index of the Logistic map (see directory 3 for details), get figure 6-Figure 8.

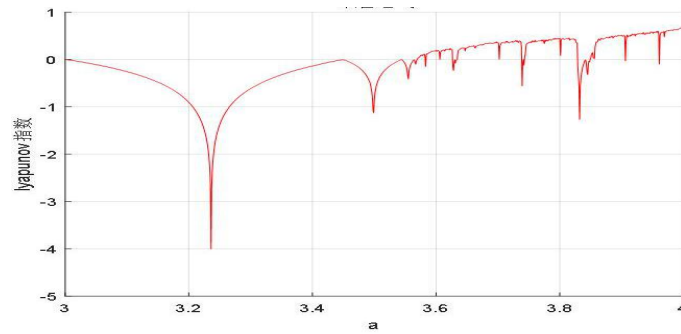**Figure 6 Stock 000400 SZ Lyapunov Index**
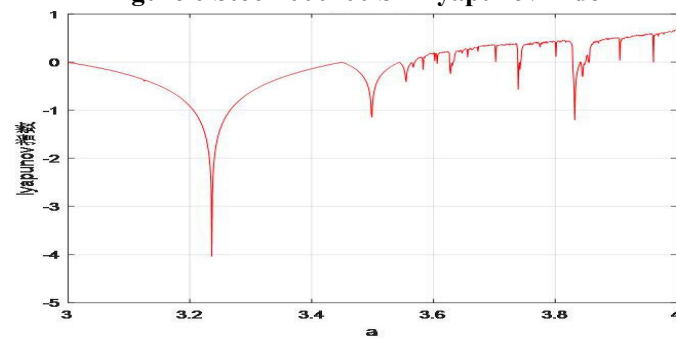
Figure 7 Stock SZ Lyapunov Index
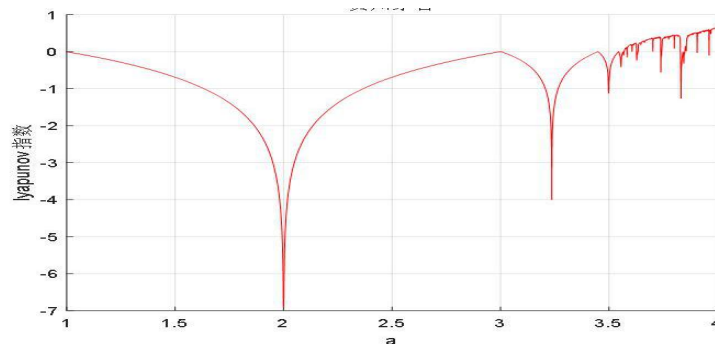
Figure 8 Stocks 600519 SH Lyapunov Index

According to the above figure, the L yapunov index is less than 0, and the stock price fluctuation in the stock market has a general chaotic behavior, which proves that the stock market has chaotic characteristics, and further proves the authenticity of the above chaotic feature test.

5.2 Test the model of question two

5.2.1 time series model of SZ stock 000400

Table 6 Statistical tables of SZ models

		Model fit statistics		Q(18) Yang-Box			
Model	Number of predicted variables	R smooth	R party	Statistics	DF	Significant significance	Number of outliers
x1- model _1	0	.864	.629	46.369	16	.000	0
X2- model _2	0	.763	.590	24.363	16	.082	0
X3- model _3	0	.763	.590	24.363	16	.082	0
X4- model _4	0	.720	.724	24.560	16	.078	0
x5- model _5	0	.	.	.	0	.	0

By using the SPSS model statistics, the correlation coefficients of the five indexes of the stock are all greater than 0.59, which meet the model fitting conditions. $\alpha \leq 0.082$ The absolute value of correlation error is less than 5.It is proved that the prediction reliability under this model is high.The forecast results are shown in Table 7.

Table 7 Stocks 000400 SZ forecast for the last 20 days

Date	Predicted ValueX1	Predicted ValueX2	Predicted ValueX3	Predicted ValueX4	Predicted ValueX5
2020/9/25	0.018139474	0.857770051	8648639	13.76	10082701.4
2020/9/28	0.021985668	0.51624628	5205157	13.59	10082701.4
2020/9/29	0.024150141	0.531905869	5363048	13.68	10082701.4
2020/9/30	0.032746854	0.75896955	7652463	13.95	10082701.4
2020/10/9	0.031842529	0.931133494	9388341	14.13	10082701.4
2020/10/12	0.034669505	1.629471062	16429470	14.75	10082701.4
2020/10/13	0.040010513	2.148716686	21664869	15	10082701.4
2020/10/14	0.03085259	1.728188318	17424807	14.77	10082701.4
2020/10/15	0.023099137	1.291056141	13017334	15.23	10082701.4
2020/10/16	0.022040385	0.978244226	9863344	14.84	10082701.4
2020/10/19	0.022920669	1.041355828	10499680	14.76	10082701.4
2020/10/20	0.016812697	0.737117186	7432132	14.81	10082701.4
2020/10/21	0.038369964	0.969512433	9775304	14.03	10082701.4
2020/10/22	0.021306966	0.764269652	7705903	14.08	10082701.4
2020/10/23	0.023023059	0.73262744	7386864	14.2	10082701.4
2020/10/26	0.032002726	0.7233221	7293041	14.2	10082701.4
2020/10/27	0.0332907	1.026284968	10347725	14.63	10082701.4
2020/10/28	0.035054191	1.331507023	13425188	14.76	10082701.4
2020/10/29	0.039014402	1.049168378	10578451	14.47	10082701.4
2020/10/30	0.030567812	0.914525784	9220890	14.33	10082701.4

Table 8 SZ relative error table for the last twenty days

Date	Relative ErrorX1	Relative ErrorX2	Relative ErrorX3	Relative ErrorX4	Relative ErrorX5
2020/9/25	0.03441284	0.0489174	0.02649882	0.001455604	0
2020/9/28	0.017464204	0.03495849	0.009094671	-0.001469508	0
2020/9/29	0.049462561	0.002730035	0.007861538	-0.014409222	0
2020/9/30	0.01647823	0.002151449	0.030071379	0.01233672	0
2020/10/9	0.010393755	0.046439971	0.046523432	-0.024171271	-3.32526E-15
2020/10/12	0.007601744	0.042343491	0.044399591	-0.025759577	-2.0321E-15
2020/10/13	0.018541175	0.031089863	0.022730304	0.004688547	-2.0321E-15
2020/10/14	0.006066506	0.02131855	0.034456204	-0.01598934	-1.47789E-15
2020/10/15	-0.009377013	0.046466032	0.026058016	0.026280323	4.24894E-15
2020/10/16	-0.008850588	0.022008178	0.039752248	0.008152174	0
2020/10/19	-0.007669875	0.035664119	0.035664132	0.00203666	1.66263E-15
2020/10/20	-0.009395893	0.019845114	0.019845047	0.000675676	0
2020/10/21	-0.003727252	0.010527821	0.046724031	-0.020251397	3.69473E-15
2020/10/22	0.008992685	0.025997323	0.025997364	-0.004243281	0
2020/10/23	0.059326209	0.027000724	0.02016835	0.012838802	0
2020/10/26	0.046817696	0.01202237	0.057286135	-0.012517385	0
2020/10/27	0.016007296	0.006155814	0.021361783	0.024509804	0
2020/10/28	0.018418246	0.012699806	0.027546017	0.027139875	-9.23684E-16
2020/10/29	0.019219788	0.027768382	0.005149617	-0.004814305	0
2020/10/30	0.004210979	0.02265719	0.023151879	0.017033357	2.77105E-15

5.2.2 Stock 002281. SZ Time Series Model Solution

Table 9 Statistical tables of SZ models

		Model statistics					
	Number of	Model fit statistics		Q(18) Yang-Box			Number of
Model	predicted variables	R smooth	R party	Statistics	DF	Significant significance	outliers
X1- model 1	0	.918	.692	44.096	16	.000	0
X2- model 2	0	.625	.908	18.369	16	.303	0
X3- model _3	0	.625	.908	18.369	16	.303	0
X4- model 4	0	.798	.902	26.101	15	.037	0
X5- model _5	0	1.000	1.000	.	0	.	0

By using the SPSS model statistics, the correlation coefficients of the five indexes of the stock are larger, indicating that the fitting degree of the model is higher. $\alpha \leq 0.303$ The significance level shows that the prediction reliability of the model is high.

5.2.3 Stock 002281. SZ Time Series Model Solution

Table 10 Statistical tables of SZ models

Model	Number of predicted variables	Model fit statistics		Q(18) Yang-Box			Number of outliers
		R smooth	R party	Statistics	DF	Significant significance	
X1- model _1	0	.876	.705	23.829	15	.068	0
X2- model _2	0	.878	.700	25.674	15	.042	0
X3- model _3	0	.878	.700	25.674	15	.042	0
X4- model _4	0	.636	.700	26.828	16	.043	0
X5- model _5	0	.	.	.	0	.	0

By using the SPSS model statistics, the correlation coefficient of the five indexes of the stock is obtained, $R^2 \geq 0.700$ which indicates that the model fits well. $\alpha \leq 0.068$ The significance level of the five indexes proves that the prediction reliability of the model is high.

5.3 Test the model of question three

5.3.1 Stock price inversion judgment model

Take the stock 000400. SZ excess return as an example, the results are detailed in the table in appendix five.

Ⅱ. Screening indicators

Table 11 SZ excess return table

DATE	RIT	RIM	ARit
2020/1/2-2020/1/8	0.49881413	0.50992705	-0.6550
2020/1/9-2020/1/15	0.51544127	0.53799802	-0.6468
2020/1/16-2020/1/22	0.54038198	0.54069690	-0.6227
2020/1/23-2020/1/29	0.35471227	0.47914384	-0.7898
2020/1/30-2020/2/5	0.17458495	0.05942869	-0.8433
2020/2/6-2020/2/12	0.59303458	0.27247949	-0.4891
2020/2/13-2020/2/19	0.53761079	0.36510969	-0.5725

According to the size of recall and accuracy (see Table 12), four indexes are selected to form the judgment vector of inversion point :{ BIAS、CCI、MACD、ARit}.

Table 12 Statistical tables of recall, return and composite indicators of candidate indicators

Index	Recall	Precision	F-Measure
MACD	0.5106	0.5517	0.5304
KDJ	0.4042	0.5547	0.4676
RSI	0.3882	0.5328	0.4492
CCI	0.75	0.53	0.6211
BIAS	0.7447	0.6931	0.7179
AR it	0.4636	0.5498	0.503033906

As can be seen from the results, BIAS index has the highest reliability, Its recall rate and accuracy rate have great advantage over other technical indexes; CCI indicators are second in reliability, Yet its recall rate and accuracy rate also have great advantages over the remaining three technical indicators: the reliability of MACD and ARit indicators is general, Its recall rate and accuracy rate are more than 50; The accuracy and MACD、KDJ and CCI of KDJ and RSI indicators are comparable, But their recall rates are low, As a result, their F-Measure is also lower than other indicators. The selected data on the four indicators are shown in the table below.

Table 13 Statistical tables of recall, return and composite indicators of selected indicators

Index	Recall	Precision	F-Measure	SVM
MACD	51.06%	55.17%	53.04%	0.2236
CCI	75.00%	53.00%	62.11%	0.2618
BIAS	74.47%	69.31%	71.79%	0.3026
ARIT	46.36%	54.98%	50.30%	0.2120

Ⅲ. LIBSVM regression analysis

- Take the week as the unit, carries on the LIBSVM regression to the stock 000400. SZ 2020 year 43 weeks, analyzes obtains the judgment parameter, as shown in the following table according to the judgment parameter positive and negative to judge whether is the reversal point. If the reverse point output 1, otherwise output 0. $a_{m+1} = k_m * k_{m+1}$ Additional data are available in the appendix.

Table 14 Statistical tables of inversion parameters

DATE	Km	Km+1	Am+1	Inverse point=1
2020/1/2-2020/1/8				
2020/1/9-2020/1/15	-0.0082			
2020/1/16-2020/1/22	-0.0241	-0.0082	0.0002	0
2020/1/23-2020/1/29	0.1671	-0.0241	-0.0040	1
2020/1/30-2020/2/5	0.0535	0.1671	0.0089	0
2020/2/6-2020/2/12	-0.3542	0.0535	-0.0190	1

6 Sensitivity Analysis

This paper uses time series to predict the stock price in the last twenty days for the stock market with chaotic characteristics. SPSS is used to select the optimal time series type for different indexes to realize the prediction.The stability of the optimal solution can be obtained by using sensitivity analysis in the optimization model. R^2 $\alpha \leq 0.1$ In this paper, the indexes of the three stocks meet the conditions of model fitting, and the significance level of each index is less than 5, which proves that the prediction reliability of the three stocks under the model is high.

7 Strengths and Weakness

7.1 Strengths

1. Fuzzy comprehensive evaluation method can make a general evaluation of things restricted by many factors, the results are clear and systematic. In this paper, because the stock market is affected by random factors and trend factors, the fuzzy comprehensive evaluation method can effectively solve the fuzzy and difficult to quantify, and is suitable for solving all kinds of non-deterministic problems.

2. Time series prediction method mainly analyzes and predicts the data with strong randomness. In this paper, the time series prediction method can effectively predict the stock market which is influenced by random factors and has high credibility[12]。

7.2 Weakness

1. The fuzzy comprehensive evaluation method, the calculation is relatively complex, and the determination of the weight vector of the index is more subjective. At the same time, there may be a super-fuzzy phenomenon: when the number of index sets is large, under the constraint of weight vector and 1, the weight coefficient of membership degree of box gauge is small, which makes the resolution poor and the result error large[13]。

2. Premise of time series prediction is to assume that the past development trend of things will extend to the future, and the causality between market development is not within the scope of analysis, and the analysis of actual situation is more general.

8 Conclusion

8.1 Conclusion of question one

Qualitative analysis, according to the K line chart respectively elaborated the stock 000400. SZ month, week, day trend, after analysis obtained its month, week, day trend is roughly down-shock-rise, and the box body continues to shock rise. The comprehensive analysis stock 002281. SZ、 stock 600519. after the SH (see appendix 1 for details), its monthly, weekly and daily trends have reached the same conclusion, the difference is that the stock 000400. SZ box shock range is larger than the other two stocks, stocks 600519. SH growth slowed since 2019.

In quantitative analysis, the relationship between three stocks and quantitati ve indexes is obtained by using fuzzy comprehensive evaluation method as foll ows:

$$Z_1 = 0.1775X_1 + 0.2334X_2 + 0.2334X_3 + 0.2425X_4 + 0.1133X_5 \qquad (22)$$

$$Z_2 = 0.1994X_1 + 0.2X_2 + 0.2X_3 + 0.1998X_4 + 0.2008X_5 \qquad (23)$$

$$Z_3 = 0.0606X_1 + 0.0361X_2 + 0.0375X_3 + 0.0498X_4 + 0.8160X_5 \qquad (24)$$

8.2 Conclusion of question two

This paper first takes stock 000400. SZ all the data as an example to carry on the SPSS fitting, the fitting precision is high, proves that the time series can be used as the prediction method. Taking the data of three stocks in 2016 as an example, the optimal time series model of the corresponding index is obtained by using the SPSS time series model. The relative error between the predicted value and the last twenty days is calculated, and the absolute value of the relative error is less than 5.

8.3 Conclusion of question three

Four indexes are selected to form the judgment vector of inversion point: BIAS、 CCI、 MACD、 ARit. Using support vector machine to mine the vector of inversion point judgment, In weeks, Stock 000400.43 weeks SZ 2020 year LIBSVM regression analysis to determine the parameters, According to the relative relationship between the judgment parameter and 0, it is judged whether it is a reversal point.Take stock 000400. SZ as an example, the results are detailed in Table 14.

Reference

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Appendix I

2016 002281. SZ's daily k-line chart
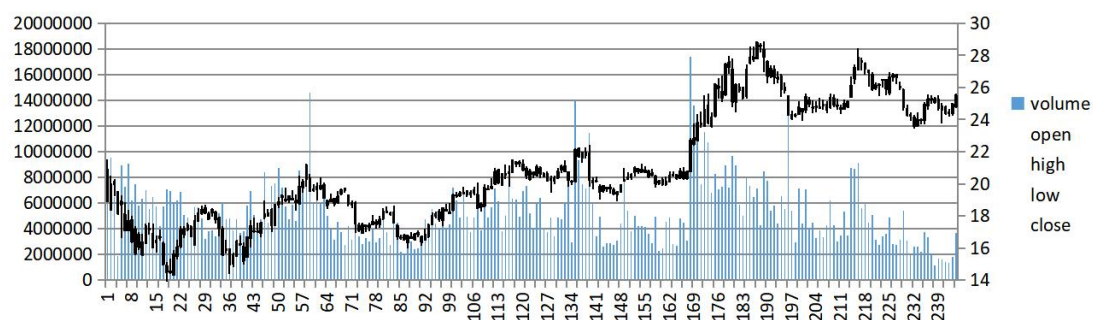
2016 002281. SZ's monthly k-line chart
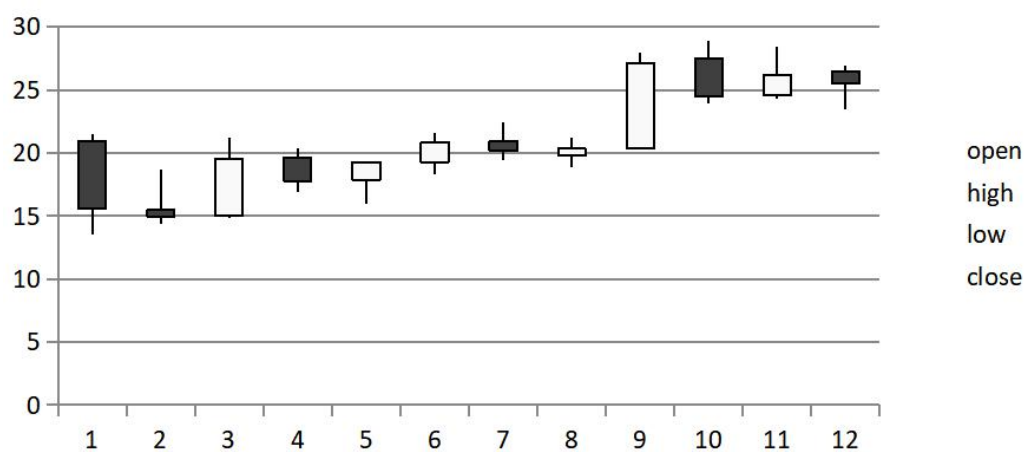
2016 002281. SZ's weekly k-line chart

Monthly k-line chart of 600519.SH in 2016

open
high
low
close

600519.SH daily k line chart in 2016

600519.SH weekly k line chart in 2016

open   close   high   low —— 20-day average...

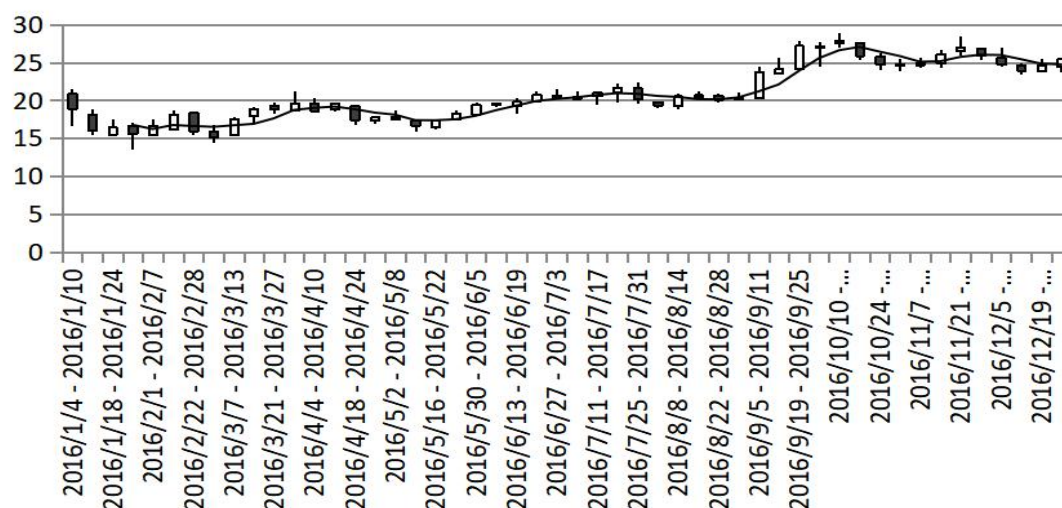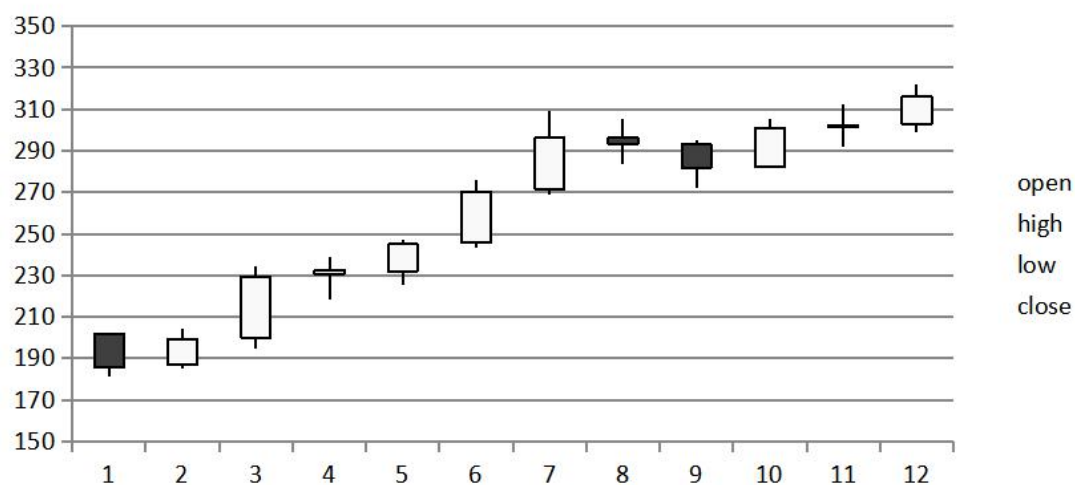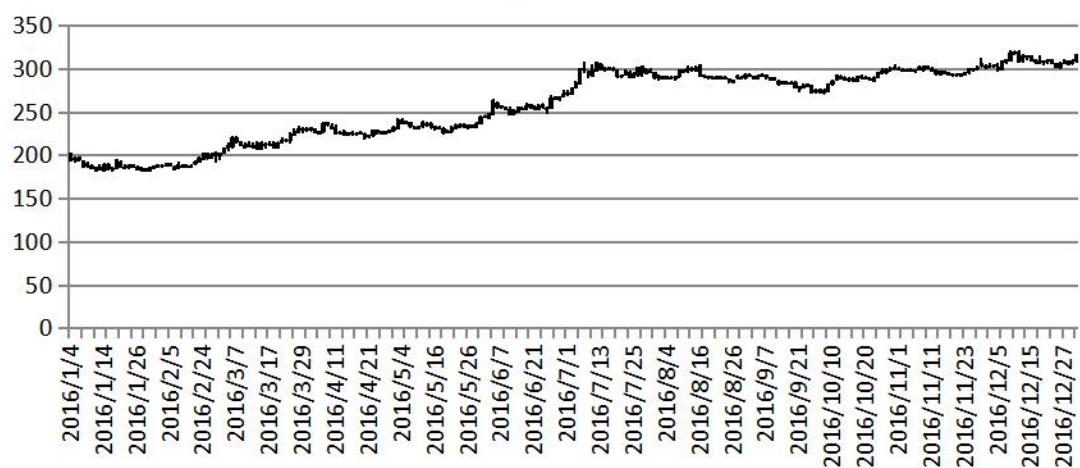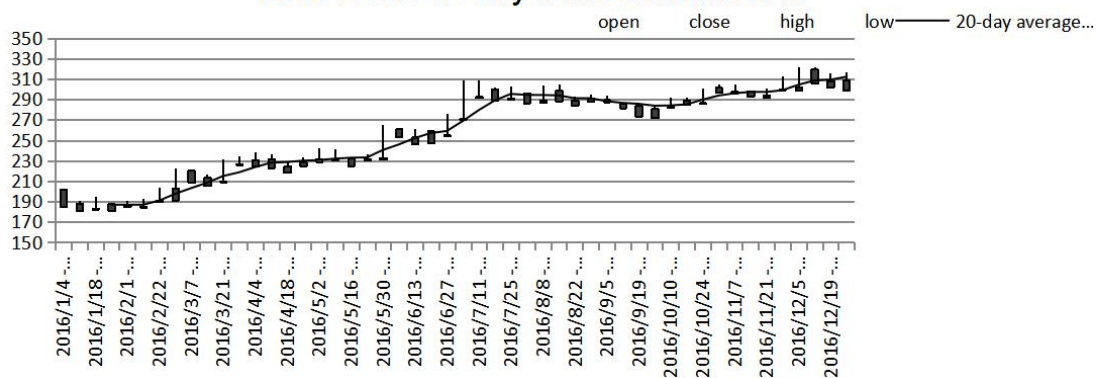# Appendix II

Stock 002281.SZ, stock 600519.SH standardized data and contribution degree

Stock 002281.SZ standardized data

2016	M1	M2	M3	M4	M5
2016/1/4 - 2016/1/10	0.74154065	0.63743497	0.53810973	0.29364686	0.00000000
2016/1/11 - 2016/1/17	0.75452958	0.71182711	0.60396548	0.06733626	0.00000000
2016/1/18 - 2016/1/24	0.51071058	0.58487124	0.49157762	0.10176383	0.00000000
2016/1/25 - 2016/1/31	1.00000000	0.56058712	0.47008006	0.03392128	0.00000000
2016/2/1 - 2016/2/7	0.58800348	0.39074095	0.39074095	0.12277476	1.00000000
2016/2/15 - 2016/2/21	0.64659489	0.30926349	0.30926349	0.23086719	1.00000000
2016/2/22 - 2016/2/28	0.68570913	0.31135922	0.31135922	0.06075452	1.00000000
2016/2/29 - 2016/3/6	0.61278977	0.25631881	0.25631881	0.00000000	1.00000000
2016/3/7 - 2016/3/13	0.68837630	0.38646135	0.38646135	0.18783273	1.00000000
2016/3/14 - 2016/3/20	0.48787361	0.61909129	0.61909129	0.29136857	1.00000000
2016/3/21 - 2016/3/27	0.21596396	0.42612866	0.42612866	0.28782455	1.00000000
2016/3/28 - 2016/4/3	0.52600470	0.79084145	0.79084145	0.34756650	1.00000000
2016/4/4 - 2016/4/10	0.35931690	0.48732001	0.48732001	0.27314221	1.00000000
2016/4/11 - 2016/4/17	0.16031431	0.19154867	0.19154867	0.34579449	1.00000000
2016/4/18 - 2016/4/24	0.47214991	0.23107061	0.23107061	0.17998527	1.00000000
2016/4/25 - 2016/5/1	0.13346718	0.15680744	0.15680744	0.20555280	1.00000000
2016/5/2 - 2016/5/8	0.14021481	0.25831704	0.25831704	0.18757959	1.00000000
2016/5/9 - 2016/5/15	0.25275880	0.11615738	0.11615738	0.11771189	1.00000000
2016/5/16 - 2016/5/22	0.24731490	0.15079711	0.15079711	0.17644126	1.00000000
2016/5/23 - 2016/5/29	0.24338638	0.30255417	0.30255417	0.24554953	1.00000000
2016/5/30 - 2016/6/5	0.29094456	0.45330316	0.45330316	0.33339044	1.00000000
2016/6/6 - 2016/6/12	0.00000000	0.29530988	0.29530988	0.34756650	1.00000000
2016/6/13 - 2016/6/19	0.37710520	0.42022091	0.42022091	0.36655229	1.00000000
2016/6/20 - 2016/6/26	0.18521174	0.45230820	0.45230820	0.43750234	1.00000000
2016/6/27 - 2016/7/3	0.13227322	0.51052203	0.51052203	0.41963717	1.00000000
2016/7/4 - 2016/7/10	0.05108654	0.37044551	0.37044551	0.41555370	1.00000000
2016/7/11 - 2016/7/17	0.27241280	0.27283130	0.27283130	0.46481053	1.00000000
2016/7/18 - 2016/7/24	0.42936104	0.70730503	0.70730503	0.50921824	1.00000000
2016/7/25 - 2016/7/31	0.49991854	0.59479517	0.59479517	0.39309463	1.00000000
2016/8/1 - 2016/8/7	0.06738251	0.14309806	0.14309806	0.32801437	1.00000000
2016/8/8 - 2016/8/14	0.38555397	0.35542916	0.35542916	0.42499672	1.00000000
2016/8/15 - 2016/8/21	0.04600566	0.26017488	0.26017488	0.41402240	1.00000000
2016/8/22 - 2016/8/28	0.11555271	0.16893909	0.16893909	0.38799030	1.00000000
2016/8/29 - 2016/9/4	0.06298420	0.22731225	0.22731225	0.40636590	1.00000000
2016/9/5 - 2016/9/11	0.92373755	1.00000000	1.00000000	0.67204651	1.00000000
2016/9/12 - 2016/9/18	0.28452224	0.89863744	0.89863744	0.70445903	1.00000000
2016/9/19 - 2016/9/25	0.65414124	0.67291004	0.67291004	0.94819101	1.00000000
2016/9/26 - 2016/10/2	0.46789618	0.64020309	0.64020309	0.93645104	1.00000000

2016				
2016/10/10 - 2016/10/16	0.19654765	0.55335126	0.55335126	1.00000000	1.00000000
2016/10/17 - 2016/10/23	0.24379640	0.46626834	0.46626834	0.84074476	1.00000000
2016/10/24 - 2016/10/30	0.29438993	0.58521127	0.58521127	0.75295021	1.00000000
2016/10/31 - 2016/11/6	0.17376741	0.31204379	0.31204379	0.75371586	1.00000000
2016/11/7 - 2016/11/13	0.08138746	0.28046574	0.28046574	0.76417975	1.00000000
2016/11/14 - 2016/11/20	0.32056061	0.32762379	0.32762379	0.86116210	1.00000000
2016/11/21 - 2016/11/27	0.30298112	0.56226256	0.56226256	0.93287800	1.00000000
2016/11/28 - 2016/12/4	0.10949831	0.18893587	0.18893587	0.84227606	1.00000000
2016/12/5 - 2016/12/11	0.31370207	0.21102822	0.21102822	0.75295021	1.00000000
2016/12/12 - 2016/12/18	0.12266316	0.06342747	0.06342747	0.68914603	1.00000000
2016/12/19 - 2016/12/25	0.22806904	0.04749921	0.04749921	0.74784588	1.00000000
2016/12/26 - 2016/12/31	0.20533586	0.00000000	0.00000000	0.81165006	1.00000000

Standardized data for stock 600519.SH

2016	M1	M2	M3	M4	M5
2016/1/4 - 2016/1/10	0.33342376	0.26202148	0.26202148	0.03854764	0.00000320
2016/1/11 - 2016/1/17	0.24572124	0.46052160	0.46052160	0.00000000	0.00000130
2016/1/18 - 2016/1/24	0.34834295	0.52504174	0.52504174	0.02560714	0.00000284
2016/1/25 - 2016/1/31	0.18274862	0.15523423	0.15523423	0.01129727	0.00000415
2016/2/1 - 2016/2/7	0.08040888	0.01993977	0.01993977	0.03334405	0.00000118
2016/2/15 - 2016/2/21	0.16458391	0.07184246	0.07184246	0.02814046	0.00000166
2016/2/22 - 2016/2/28	0.38773566	0.49182052	0.49182052	0.12214741	0.00000320
2016/2/29 - 2016/3/6	1.00000000	1.00000000	1.00000000	0.20684267	0.00000107
2016/3/7 - 2016/3/13	0.32817662	0.25217128	0.25217128	0.19890035	0.00000201
2016/3/14 - 2016/3/20	0.25543903	0.71382635	0.71382635	0.18486436	0.00000107
2016/3/21 - 2016/3/27	0.61837262	0.73241740	0.73241740	0.31481715	0.00000154
2016/3/28 - 2016/4/3	0.12965266	0.44214595	0.44214595	0.31557030	0.00000249
2016/4/4 - 2016/4/10	0.30080377	0.41543823	0.41543823	0.34822967	0.00000332
2016/4/11 - 2016/4/17	0.27990291	0.93699432	0.93699432	0.31426940	0.00000272
2016/4/18 - 2016/4/24	0.22483180	0.29603055	0.29603055	0.33138647	0.00000190
2016/4/25 - 2016/5/1	0.14169433	0.21445419	0.21445419	0.35740442	0.00000059
2016/5/2 - 2016/5/8	0.20857119	0.44124722	0.44124722	0.36438818	0.00000154
2016/5/9 - 2016/5/15	0.19627774	0.44333914	0.44333914	0.35576118	0.00000201
2016/5/16 - 2016/5/22	0.13384244	0.16598910	0.16598910	0.35781523	0.00000000
2016/5/23 - 2016/5/29	0.03640306	0.00000000	0.00000000	0.36589449	0.00000201
2016/5/30 - 2016/6/5	0.93839424	0.65659424	0.65659424	0.58122723	0.00000190
2016/6/6 - 2016/6/12	0.10718744	0.30450118	0.30450118	0.51542921	1.00000000
2016/6/13 - 2016/6/19	0.29813103	0.31512116	0.31512116	0.54267958	0.00000272
2016/6/20 - 2016/6/26	0.19936417	0.06385961	0.06385961	0.51193733	0.00000403
2016/6/27 - 2016/7/3	0.48749639	0.57098462	0.57098462	0.63914512	0.00000201
2016/7/4 - 2016/7/10	0.91639010	0.76797635	0.76797635	0.80519852	0.00000130
2016/7/11 - 2016/7/17	0.27947350	0.79792588	0.79792588	0.85842794	0.00000166
2016/7/18 - 2016/7/24	0.18484206	0.36828544	0.36828544	0.79127913	0.00000107

2016/7/25 - 2016/7/31	0.18657069	0.49690348	0.49690348	0.82786124	0.00000213
2016/8/1 - 2016/8/7	0.12189132	0.25467759	0.25467759	0.77735975	0.00000166
2016/8/8 - 2016/8/14	0.30773142	0.32931852	0.32931852	0.85458087	0.00000213
2016/8/15 - 2016/8/21	0.27268202	0.77691564	0.77691564	0.78120681	0.00000190
2016/8/22 - 2016/8/28	0.08913643	0.17476248	0.17476248	0.74602364	0.00000000
2016/8/29 - 2016/9/4	0.03934265	0.31712275	0.31712275	0.77631055	0.00000000
2016/9/5 - 2016/9/11	0.01326235	0.12953792	0.12953792	0.76826668	0.00000071
2016/9/12 - 2016/9/18	0.01067971	0.23946227	0.23946227	0.73287366	0.00000296
2016/9/19 - 2016/9/25	0.16747797	0.28121676	0.28121676	0.71965374	0.00000000
2016/9/26 - 2016/10/2	0.15971997	0.29087250	0.29087250	0.72126252	0.00000201
2016/10/10 - 2016/10/16	0.12015372	0.17848537	0.17848537	0.77505151	0.00000391
2016/10/17 - 2016/10/23	0.03495217	0.05401582	0.05401582	0.76518903	0.00000178
2016/10/24 - 2016/10/30	0.24495697	0.51309368	0.51309368	0.85514044	0.00000261
2016/10/31 - 2016/11/6	0.07234125	0.24713129	0.24713129	0.83954234	0.00000403
2016/11/7 - 2016/11/13	0.07055432	0.30899442	0.30899442	0.84136095	0.00000332
2016/11/14 - 2016/11/20	0.00000000	0.20428363	0.20428363	0.80582804	0.00000190
2016/11/21 - 2016/11/27	0.08939422	0.38856181	0.38856181	0.85402130	0.00000095
2016/11/28 - 2016/12/4	0.18314948	0.64645660	0.64645660	0.88815527	0.00000284
2016/12/5 - 2016/12/11	0.41632925	0.65679211	0.65679211	1.00000000	0.00000130
2016/12/12 - 2016/12/18	0.21955231	0.61801512	0.61801512	0.92879429	0.00000095
2016/12/19 - 2016/12/25	0.20404144	0.29670352	0.29670352	0.87598455	0.00000190
2016/12/26 - 2016/12/31	0.30140236	0.22896544	0.22896544	0.97474925	0.00000355

Contribution degree of stock 002281.SH

2016	P1	P2	P3	P4	P5
2016/1/4 - 2016/1/10	0.04284923	0.03199756	0.02755245	0.01309942	0.00000000
2016/1/11 - 2016/1/17	0.04359979	0.03573185	0.03092442	0.00300383	0.00000000
2016/1/18 - 2016/1/24	0.02951093	0.02935900	0.02516990	0.00453963	0.00000000
2016/1/25 - 2016/1/31	0.05778407	0.02814000	0.02406918	0.00151321	0.00000000
2016/2/1 - 2016/2/7	0.03397723	0.01961417	0.02000683	0.00547691	0.02173913
2016/2/15 - 2016/2/21	0.03736288	0.01552422	0.01583500	0.01029886	0.02173913
2016/2/22 - 2016/2/28	0.03962306	0.01562941	0.01594231	0.00271023	0.02173913
2016/2/29 - 2016/3/6	0.03540948	0.01286653	0.01312411	0.00000000	0.02173913
2016/3/7 - 2016/3/13	0.03977718	0.01939934	0.01978771	0.00837911	0.02173913
2016/3/14 - 2016/3/20	0.02819132	0.03107676	0.03169890	0.01299779	0.02173913
2016/3/21 - 2016/3/27	0.01247928	0.02139054	0.02181877	0.01283969	0.02173913
2016/3/28 - 2016/4/3	0.03039469	0.03969816	0.04049290	0.01550475	0.02173913
2016/4/4 - 2016/4/10	0.02076279	0.02446219	0.02495190	0.01218472	0.02173913
2016/4/11 - 2016/4/17	0.00926361	0.00961524	0.00980773	0.01542570	0.02173913
2016/4/18 - 2016/4/24	0.02728274	0.01159914	0.01183135	0.00802904	0.02173913
2016/4/25 - 2016/5/1	0.00771228	0.00787132	0.00802890	0.00916960	0.02173913
2016/5/2 - 2016/5/8	0.00810218	0.01296684	0.01322643	0.00836782	0.02173913
2016/5/9 - 2016/5/15	0.01460543	0.00583080	0.00594752	0.00525106	0.02173913

2016/5/16 - 2016/5/22	0.01429086	0.00756962	0.00772116	0.00787095	0.02173913
2016/5/23 - 2016/5/29	0.01406385	0.01518742	0.01549147	0.01095383	0.02173913
2016/5/30 - 2016/6/5	0.01681196	0.02275463	0.02321016	0.01487236	0.02173913
2016/6/6 - 2016/6/12	0.00000000	0.01482378	0.01512054	0.01550475	0.02173913
2016/6/13 - 2016/6/19	0.02179067	0.02109399	0.02151628	0.01635170	0.02173913
2016/6/20 - 2016/6/26	0.01070229	0.02270468	0.02315922	0.01951674	0.02173913
2016/6/27 - 2016/7/3	0.00764328	0.02562687	0.02613990	0.01871978	0.02173913
2016/7/4 - 2016/7/10	0.00295199	0.01859539	0.01896766	0.01853762	0.02173913
2016/7/11 - 2016/7/17	0.01574112	0.01369542	0.01396959	0.02073494	0.02173913
2016/7/18 - 2016/7/24	0.02481023	0.03550486	0.03621564	0.02271594	0.02173913
2016/7/25 - 2016/7/31	0.02888733	0.02985716	0.03045488	0.01753573	0.02173913
2016/8/1 - 2016/8/7	0.00389364	0.00718315	0.00732695	0.01463254	0.02173913
2016/8/8 - 2016/8/14	0.02227888	0.01784161	0.01819879	0.01895887	0.02173913
2016/8/15 - 2016/8/21	0.00265839	0.01306010	0.01332155	0.01846931	0.02173913
2016/8/22 - 2016/8/28	0.00667711	0.00848030	0.00865007	0.01730803	0.02173913
2016/8/29 - 2016/9/4	0.00363948	0.01141048	0.01163891	0.01812776	0.02173913
2016/9/5 - 2016/9/11	0.05337731	0.05019737	0.05120230	0.02997962	0.02173913
2016/9/12 - 2016/9/18	0.01644085	0.04510924	0.04601230	0.03142553	0.02173913
2016/9/19 - 2016/9/25	0.03779894	0.03377832	0.03445454	0.04229828	0.02173913
2016/9/26 - 2016/10/2	0.02703694	0.03213651	0.03277987	0.04177456	0.02173913
2016/10/10 - 2016/10/16	0.01135732	0.02777678	0.02833286	0.04460945	0.02173913
2016/10/17 - 2016/10/23	0.01408755	0.02340545	0.02387401	0.03750516	0.02173913
2016/10/24 - 2016/10/30	0.01701105	0.02937607	0.02996416	0.03358869	0.02173913
2016/10/31 - 2016/11/6	0.01004099	0.01566378	0.01597736	0.03362285	0.02173913
2016/11/7 - 2016/11/13	0.00470290	0.01407864	0.01436049	0.03408964	0.02173913
2016/11/14 - 2016/11/20	0.01852330	0.01644585	0.01677509	0.03841597	0.02173913
2016/11/21 - 2016/11/27	0.01750748	0.02822410	0.02878914	0.04161517	0.02173913
2016/11/28 - 2016/12/4	0.00632726	0.00948408	0.00967395	0.03757347	0.02173913
2016/12/5 - 2016/12/11	0.01812698	0.01059306	0.01080513	0.03358869	0.02173913
2016/12/12 - 2016/12/18	0.00708798	0.00318389	0.00324763	0.03074242	0.02173913
2016/12/19 - 2016/12/25	0.01317876	0.00238434	0.00243207	0.03336099	0.02173913
2016/12/26 - 2016/12/31	0.01186514	0.00000000	0.00000000	0.03620726	0.02173913

Contribution degree of stock 600519.SH

	P1	P2	P3	P4	P5
2016/1/4 - 2016/1/10	0.02703392	0.01342460	0.01342460	0.00139515	0.00000320
2016/1/11 - 2016/1/17	0.01992302	0.02359470	0.02359470	0.00000000	0.00000130
2016/1/18 - 2016/1/24	0.02824356	0.02690037	0.02690037	0.00092680	0.00000284
2016/1/25 - 2016/1/31	0.01481721	0.00795338	0.00795338	0.00040888	0.00000415
2016/2/1 - 2016/2/7	0.00651953	0.00102161	0.00102161	0.00120682	0.00000118
2016/2/15 - 2016/2/21	0.01334442	0.00368083	0.00368083	0.00101848	0.00000166
2016/2/22 - 2016/2/28	0.03143751	0.02519829	0.02519829	0.00442086	0.00000320
2016/2/29 - 2016/3/6	0.08107976	0.05123472	0.05123472	0.00748623	0.00000107

2016/3/7 - 2016/3/13	0.02660848	0.01291993	0.01291993	0.00719877	0.00000201
2016/3/14 - 2016/3/20	0.02071094	0.03657270	0.03657270	0.00669077	0.00000107
2016/3/21 - 2016/3/27	0.05013750	0.03752520	0.03752520	0.01139413	0.00000154
2016/3/28 - 2016/4/3	0.01051221	0.02265323	0.02265323	0.01142139	0.00000249
2016/4/4 - 2016/4/10	0.02438910	0.02128486	0.02128486	0.01260342	0.00000332
2016/4/11 - 2016/4/17	0.02269446	0.04800665	0.04800665	0.01137430	0.00000272
2016/4/18 - 2016/4/24	0.01822931	0.01516704	0.01516704	0.01199382	0.00000190
2016/4/25 - 2016/5/1	0.01148854	0.01098750	0.01098750	0.01293548	0.00000059
2016/5/2 - 2016/5/8	0.01691090	0.02260718	0.02260718	0.01318825	0.00000154
2016/5/9 - 2016/5/15	0.01591415	0.02271436	0.02271436	0.01287601	0.00000201
2016/5/16 - 2016/5/22	0.01085191	0.00850441	0.00850441	0.01295035	0.00000000
2016/5/23 - 2016/5/29	0.00295155	0.00000000	0.00000000	0.01324276	0.00000201
2016/5/30 - 2016/6/5	0.07608478	0.03364042	0.03364042	0.02103627	0.00000190
2016/6/6 - 2016/6/12	0.00869073	0.01560103	0.01560103	0.01865485	0.99990298
2016/6/13 - 2016/6/19	0.02417239	0.01614515	0.01614515	0.01964112	0.00000272
2016/6/20 - 2016/6/26	0.01616440	0.00327183	0.00327183	0.01852847	0.00000403
2016/6/27 - 2016/7/3	0.03952609	0.02925424	0.02925424	0.02313248	0.00000201
2016/7/4 - 2016/7/10	0.07430069	0.03934706	0.03934706	0.02914243	0.00000130
2016/7/11 - 2016/7/17	0.02265964	0.04088151	0.04088151	0.03106895	0.00000166
2016/7/18 - 2016/7/24	0.01498695	0.01886900	0.01886900	0.02863865	0.00000107
2016/7/25 - 2016/7/31	0.01512711	0.02545871	0.02545871	0.02996266	0.00000213
2016/8/1 - 2016/8/7	0.00988292	0.01304834	0.01304834	0.02813486	0.00000166
2016/8/8 - 2016/8/14	0.02495079	0.01687254	0.01687254	0.03092972	0.00000213
2016/8/15 - 2016/8/21	0.02210899	0.03980506	0.03980506	0.02827410	0.00000190
2016/8/22 - 2016/8/28	0.00722716	0.00895391	0.00895391	0.02700072	0.00000000
2016/8/29 - 2016/9/4	0.00318989	0.01624770	0.01624770	0.02809689	0.00000000
2016/9/5 - 2016/9/11	0.00107531	0.00663684	0.00663684	0.02780576	0.00000071
2016/9/12 - 2016/9/18	0.00086591	0.01226878	0.01226878	0.02652478	0.00000296
2016/9/19 - 2016/9/25	0.01357907	0.01440806	0.01440806	0.02604632	0.00000000
2016/9/26 - 2016/10/2	0.01295006	0.01490277	0.01490277	0.02610454	0.00000201
2016/10/10 - 2016/10/16	0.00974203	0.00914465	0.00914465	0.02805132	0.00000391
2016/10/17 - 2016/10/23	0.00283391	0.00276749	0.00276749	0.02769437	0.00000178
2016/10/24 - 2016/10/30	0.01986105	0.02628821	0.02628821	0.03094997	0.00000261
2016/10/31 - 2016/11/6	0.00586541	0.01266170	0.01266170	0.03038543	0.00000403
2016/11/7 - 2016/11/13	0.00572053	0.01583124	0.01583124	0.03045125	0.00000332
2016/11/14 - 2016/11/20	0.00000000	0.01046642	0.01046642	0.02916521	0.00000190
2016/11/21 - 2016/11/27	0.00724806	0.01990786	0.01990786	0.03090946	0.00000095
2016/11/28 - 2016/12/4	0.01484972	0.03312103	0.03312103	0.03214487	0.00000284
2016/12/5 - 2016/12/11	0.03375588	0.03365056	0.03365056	0.03619285	0.00000130
2016/12/12 - 2016/12/18	0.01780125	0.03166383	0.03166383	0.03361571	0.00000095
2016/12/19 - 2016/12/25	0.01654363	0.01520152	0.01520152	0.03170438	0.00000190
2016/12/26 - 2016/12/31	0.02443763	0.01173098	0.01173098	0.03527895	0.00000355

Appendix III

```
clc
alpha01=3:0.001:4;
n=1000;
for j=1:length(alpha01)
alpha=alpha01(j);
z1=0.35;%初始值
s1=0;
for ii=1:n
df=alpha-2*alpha*z1;
s1=s1+log(abs(df));%lambda 叠加
z1=alpha*z1*(1-z1);%x 迭代
end
ly1(j)=s1/n;% 指数
end
title('许继电气')
plot(alpha01,ly1,'r')
grid on
xlabel('a')
ylabel('lyapunov 指数')

clear
clc
alpha02=3:0.001:4;
n=1000;
for j=1:length(alpha02)
alpha=alpha02(j);
z2=0.8;%初始值
s2=0;
for ii=1:n
df=alpha-2*alpha*z2;
s2=s2+log(abs(df));%lambda 叠加
z2=alpha*z2*(1-z2);%x 迭代
end
ly2(j)=s2/n;% 指数
end
plot(alpha02,ly2,'r')
title('光迅科技')
grid on
xlabel('a')
ylabel('lyapunov 指数')
```

```
clear
clc
alpha03=1:0.001:4;
n=1000;
for j=1:length(alpha03)
alpha=alpha03(j);
z3=0.26;%初始值
s3=0;
for ii=1:n
df=alpha-2*alpha*z3;
s3=s3+log(abs(df));%lambda 叠加
z3=alpha*z3*(1-z3);%初始值迭代
end
ly3(j)=s3/n;% 指数
end
plot(alpha03,ly3,'r')
title('贵州茅台')
grid on
xlabel('a')
ylabel('lyapunov 指数')
```

Appendix IV

反转判断参数统计表

DATE	Km	Km+1	Am+1	Inverse point=1
2020/1/2-2020/1/8				
2020/1/9-2020/1/15	-0.0082			
2020/1/16-2020/1/22	-0.0241	-0.0082	0.0002	0
2020/1/23-2020/1/29	0.1671	-0.0241	-0.0040	1
2020/1/30-2020/2/5	0.0535	0.1671	0.0089	0
2020/2/6-2020/2/12	-0.3542	0.0535	-0.0190	1
2020/2/13-2020/2/19	0.0834	-0.3542	-0.0295	1
2020/2/20-2020/2/26	-0.0351	0.0834	-0.0029	1
2020/2/27-2020/3/4	-0.2024	-0.0351	0.0071	0
2020/3/5-2020/3/11	-0.2378	-0.2024	0.0481	0
2020/3/12-2020/3/18	0.4373	-0.2378	-0.1040	1
2020/3/19-2020/3/25	0.3495	0.4373	0.1529	0
2020/3/26-2020/4/1	-0.2838	0.3495	-0.0992	1
2020/4/2-2020/4/8	-0.1255	-0.2838	0.0356	0
2020/4/9-2020/4/15	-0.2672	-0.1255	0.0335	0
2020/4/16-2020/4/22	0.4097	-0.2672	-0.1095	1
2020/4/23-2020/4/29	0.2820	0.4097	0.1155	0
2020/4/30-2020/5/6	-0.4394	0.2820	-0.1239	1
2020/5/7-2020/5/13	-0.0181	-0.4394	0.0079	0
2020/5/14-2020/5/20	0.2025	-0.0181	-0.0037	1
2020/5/21-2020/5/27	0.4141	0.2025	0.0839	0
2020/5/28-2020/6/3	-0.5122	0.4141	-0.2121	1
2020/6/4-2020/6/10	0.1128	-0.5122	-0.0578	1
2020/6/11-2020/6/17	-0.1471	0.1128	-0.0166	1
2020/6/18-2020/6/24	0.1434	-0.1471	-0.0211	1
2020/6/25-2020/7/1	-0.0542	0.1434	-0.0078	1
2020/7/2-2020/7/8	-0.4444	-0.0542	0.0241	0
2020/7/9-2020/7/15	0.6461	-0.4444	-0.2871	1
2020/7/16-2020/7/22	-0.2011	0.6461	-0.1299	1
2020/7/23-2020/7/29	0.2229	-0.2011	-0.0448	1
2020/7/30-2020/8/5	-0.1570	0.2229	-0.0350	1
2020/8/6-2020/8/12	0.3662	-0.1570	-0.0575	1
2020/8/13-2020/8/19	-0.5961	0.3662	-0.2183	1
2020/8/20-2020/8/26	0.5400	-0.5961	-0.3219	1
2020/8/27-2020/9/2	-0.0709	0.5400	-0.0383	1
2020/9/3-2020/9/9	0.2179	-0.0709	-0.0155	1
2020/9/10-2020/9/16	-0.3306	0.2179	-0.0720	1
2020/9/17-2020/9/23	-0.0184	-0.3306	0.0061	0
2020/9/24-2020/9/30	0.0475	-0.0184	-0.0009	1

2020/10/8-2020/10/14	-0.3764	0.0475	-0.0179	1
2020/10/15-2020/10/21	0.5281	-0.3764	-0.1988	1
2020/10/22-2020/10/28	-0.2285	0.5281	-0.1207	1
2020/10/29-2020/10/31	0.0738	-0.2285	-0.0169	1

Appendix V

DATE	RIT	RIM	ARit
2020/1/2-2020/1/8	0.49881413	0.50992705	-0.6550
2020/1/9-2020/1/15	0.51544127	0.53799802	-0.6468
2020/1/16-2020/1/22	0.54038198	0.54069690	-0.6227
2020/1/23-2020/1/29	0.35471227	0.47914384	-0.7898
2020/1/30-2020/2/5	0.17458495	0.05942869	-0.8433
2020/2/6-2020/2/12	0.59303458	0.27247949	-0.4891
2020/2/13-2020/2/19	0.53761079	0.36510969	-0.5725
2020/2/20-2020/2/26	0.57917863	0.38639339	-0.5374
2020/2/27-2020/3/4	0.78978904	0.41356920	-0.3349
2020/3/5-2020/3/11	0.99208589	0.29575395	-0.0971
2020/3/12-2020/3/18	0.46555986	0.00000000	-0.5344
2020/3/19-2020/3/25	0.14133067	0.08387890	-0.8840
2020/3/26-2020/4/1	0.41290725	0.04327553	-0.6001
2020/4/2-2020/4/8	0.55700912	0.10489539	-0.4746
2020/4/9-2020/4/15	0.84244165	0.16536622	-0.2074
2020/4/16-2020/4/22	0.43784796	0.18218742	-0.6171
2020/4/23-2020/4/29	0.17181376	0.23516287	-0.8991
2020/4/30-2020/5/6	0.61797529	0.25742191	-0.4597
2020/5/7-2020/5/13	0.63737361	0.26176416	-0.4416
2020/5/14-2020/5/20	0.43507677	0.26247228	-0.6441
2020/5/21-2020/5/27	0.00000000	0.19295620	-1.0582
2020/5/28-2020/6/3	0.54315317	0.29559362	-0.5460
2020/6/4-2020/6/10	0.42953439	0.29296155	-0.6588
2020/6/11-2020/6/17	0.59066066	0.33933677	-0.5117
2020/6/18-2020/6/24	0.43745044	0.30678994	-0.6551
2020/6/25-2020/7/1	0.50730155	0.35872325	-0.6009
2020/7/2-2020/7/8	1.00000000	0.51898565	-0.1565
2020/7/9-2020/7/15	0.49895072	1.00000000	-0.8026
2020/7/16-2020/7/22	0.60472779	0.68407129	-0.6016
2020/7/23-2020/7/29	0.42657694	0.83234909	-0.8244
2020/7/30-2020/8/5	0.60472779	0.90242632	-0.6674
2020/8/6-2020/8/12	0.21502280	0.82454640	-1.0336
2020/8/13-2020/8/19	0.84690161	0.94327018	-0.4376
2020/8/20-2020/8/26	0.29296380	0.89710873	-0.9776
2020/8/27-2020/9/2	0.37647201	0.93882105	-0.9067
2020/9/3-2020/9/9	0.09811130	0.73818240	-1.1245
2020/9/10-2020/9/16	0.44049498	0.77731609	-0.7939
2020/9/17-2020/9/23	0.45719662	0.77169121	-0.7755
2020/9/24-2020/9/30	0.38482283	0.68930871	-0.8231

2020/10/8-2020/10/14	0.81071472	0.85328541	-0.4466
2020/10/15-2020/10/21	0.27626216	0.83222884	-0.9747
2020/10/22-2020/10/28	0.48224908	0.75770248	-0.7463
2020/10/29-2020/10/31	0.39039005	0.69796649	-0.8201