Research on Extreme Points of RSI Expert System Based on Nonlinear Regression Analysis of Data

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Abstract. In this paper, four kinds of statistical regression functions are used as the management objective to analyze the data of Shenzhen stock-market for past 192 month. 24 regression functions are obtained by analysis and the method of extreme values from mathematical function theory is obtained in the state of waveform increasing function: the average number of maximal points of the first regression function is 31.30; the average number of the maximal points of the second regression function is 50.00; the average number of the maximal point of the third regression function is 51.23; the average number of the maximal point of the fourth regression function is 57.14 or monotone increasing function without extreme value. The first three types of statistical regression functions have no maximal point but only minimum point in the state of waveform decreasing function, and the average number of the minimum points are 40.20, 46.69, 47.78.

Keywords: Regression analysis; regression function; function extreme point; RSI expert system.

1. Introduction

Introduction Regression analysis is the use of mathematical statistics to establish the regression relationship between dependent variables and independent variables function expression based on a large number of observed data (known as regression equation). In regression analysis, when the causal relationship of research only involves dependent variables and one independent variable, it is called unitary regression analysis; while when the causal relationship of research involves dependent variables and two or more independent variables, it is called multiple regression analysis. In addition, regression analysis is divided into linear regression analysis and nonlinear regression analysis based on whether the function expression of causality between independent variable and dependent variable linear or nonlinear in regression analysis. If the dependent variable of the regression model is a linear function of the independent variable and above, the regression law is shown as various curves with different shapes on the graph, which is called nonlinear regression. The regression function is often a more complex nonlinear function in many practices.

Liu Ying (2019) [1] fitted the growth model of Catharanthus roseus morphological indexes by multiple nonlinear regression and BP neural network. By comparing the fitting effect and prediction ability of the two models, the regression estimation standard error of multiple nonlinear regression fitting
is 0.456-12.090, and BP neural network is 0.0331-1.4857. So BP neural network has a better fitting effect and higher prediction accuracy.

Li Ming (2020) [2] established a regression mathematical model between coating bond and three-dimensional roughness parameters by using regression analysis method and MATLAB software. The results show that there are many irregular shapes of convex peaks and pits on the sandblasting pretreatment surface, with different directions and no fixed orientation, and the average surface roughness Sa is 4.84 μm and the average coating bond is 32.82 MPa. There is a nonlinear relationship between the bond strength of the coating and the three-dimensional roughness parameters, and the influence of Sa, Sdr, Sdq, Sq on the coating bond is significant and there is a nonlinear regression relationship.

Luo Qi (2020) [3] used a nonlinear autoregressive distributed NARDL lag model to test the efficiency of interest rate transmission of China, the US and the Eurozone. The results show that the transmission efficiency of immediate inter-bank interest rate to market interest rate spectrum depends on the transmission efficiency of future interbank interest rate expectation; The transmission efficiency of China inter-bank interest rates to short-term loans and treasury bill rates is similar to that of the US and Eurozone, but the transmission efficiency of medium and long-term loans and treasury bill rates is relatively low, and some interest rate transmission has a short-term positive asymmetry.

Based on 192 months' historical data of A-share in Shenzhen stock market, this paper analyzes the effectiveness of RSI expert trading system in China stock market by using statistical regression with the management objectives of winning rate, annual return rate and net profit rate, so as to find the best buying and selling with maximize goal.

2. RSI Empirical analysis

2.1. Experiments and results

Mathematical formula:

\[ RSI = \frac{100 \times RS}{1 + RS} \text{ or } RSI = 100 - \frac{100}{1 + RS} \]

The average of the sum of the closing price increases in RS=N days / the average value of the sum of the closing price decreases in n days.

Welles Wilder takes N = 14, and Wang Zhaojun’s research also obtains the same result [4].

(1) Experimental platform: great wisdom securities information platform V5.99
(2) Experimental procedure: N = 14
   LC: =REF(CLOSE,1);
   WRSI: =SMA(MAX(CLOSE-LC,0), N,1)/SMA(ABS(CLOSE-LC), N,1) *100;
   ENTERLONG: CROSS (WRSI, LL);
   EXITLONG: CROSS (LH, WRSI);
(3) Experimental parameters: meet the buying conditions of all the funds to buy stocks, meet the conditions to sell all, the transaction cost is 0.5%, LL takes 20, LH = 80 with 5 step size.
(4) Experimental sample: daily data of all a shares in Shenzhen stock market (1996.3-2012.9)
(5) Experimental process, time and results: see attached table 1

Taking the Shenzhen stock market test from March 1, 1996 to June 30, 2001 as an example, the test results are shown in table 1-3 by the detection system of great wisdom securities information platform V5.99 version.
Table 1. System detection settings.

Detection method: technology trading index - rsi14
Testing time: March 1, 1996 to June 30, 2001, Not included in strength selling detect stocks
Detect stocks: 1512 in total; initial investment: 10000.00 yuan
Purchase conditions:
One of the following conditions:
1. The following conditions are valid at the same time
1.1 Technology trading index: RSI14 (14) trading indicator line RSI over 20.00 [daily line]
When all conditions are met: buy with all funds at closing price
When the signal appears again: no more buying
Selling conditions: no conditions for selling shares
Closing conditions: (closing all shares at closing price)
Trading index stock selection: technical trading index: RSI14(14) trading index line RSI below 80.00 [daily line].

Table 2. System detection report

| System detection report |
|-------------------------|
| Detecting stocks        | 1512          |
| Net profit of stock     | 2,023,316.00RMB |
| Net profit margin of stock | 13.38%        |
| Total profit            | 2,054,560.00RMB |
| Number of trading       | 250           |
| Winning rate            | 94.80%        |
| Number of profit / loss trading | 237/13     |
| Total trading volume    | 4,059,453.50RMB |
| Trading fee             | 3,706.53RMB   |
| Maximal single profit   | 43,021.69RMB  |
| Maximal single loss     | -3,773.80RMB  |
| Average stock earnings  | 8,218.24RMB   |
| Average stock loss      | -63.71RMB     |
| Average stock profit    | 8,093.26RMB   |
| Average stock loss      | -12,898.64    |
| Number of maximal continuous profits | 75:1          |
| Average number of stock trading cycles | 286.08       |
| Average period of stock profit trading | 280.98    |
| Average cycle of stock loss trading | 379.08     |
| Stock profit coefficient| 0.98          |
| Maximal Stock floating profit | 17,135,250.00RMB |
| Maximal Stock floating loss     | 0.00RMB      |
| Maximal stock profit and loss  | 17,135,250.00RMB |
| Total investment          | 15,120,000.00RMB |

Statistics of all buying signal points, regardless of the signal deletion caused by funds and strategies in trading detection
Trading success rate: 94.96%
Number of stock signals: 402
Annual average number of stock signals: 76.57
Table 3. Detection and calculation results data table

| Time     | Shenzhen composite index increase rate (%) | LL | Winning rate | Annualized return | Net profit margin | Number of trading per year |
|----------|-------------------------------------------|----|--------------|-------------------|------------------|----------------------------|
| 1996.3~2001.6 | 458.43                                    | 20 | 91.12        | 3.63              | 18.74            | 74.13                      |
| 1996.3~2001.6 | 458.43                                    | 25 | 90.88        | 6.91              | 35.71            | 129.48                     |
| 1996.3~2001.6 | 458.43                                    | 30 | 88.63        | 8.88              | 45.87            | 173.61                     |
| 1996.3~2001.6 | 458.43                                    | 35 | 86.28        | 9.79              | 50.57            | 200.32                     |
| 1996.3~2001.6 | 458.43                                    | 40 | 84.50        | 10.86             | 56.09            | 218.52                     |
| 1996.3~2001.6 | 458.43                                    | 45 | 85.27        | 14.15             | 73.12            | 237.87                     |
| 1996.3~2001.6 | 458.43                                    | 50 | 85.40        | 14.94             | 77.20            | 251.81                     |
| 1996.3~2001.6 | 458.43                                    | 55 | 83.42        | 14.38             | 74.30            | 262.65                     |
| 1996.3~2001.6 | 458.43                                    | 60 | 83.02        | 13.57             | 70.12            | 270.19                     |
| 1996.3~2001.6 | 458.43                                    | 65 | 82.87        | 12.50             | 64.59            | 280.26                     |
| 1996.3~2001.6 | 458.43                                    | 70 | 84.28        | 11.63             | 60.09            | 294.19                     |
| 1996.3~2001.6 | 458.43                                    | 75 | 85.93        | 8.21              | 42.43            | 301.16                     |

2.2. Numerical regression analysis

SPSS software was used to make regression analysis on the data in Table 3

Table 4. Regression analysis of winning rate from 1996.03-2001.06

According to the above table, \( R = 0.927 \), \( \text{sig} = 0.000 \).
The regression function is, and the function image is shown in Figure 1.

Table 5. Regression analysis of winning rate from 1996.03-2001.06

It can be seen from the above table that the \( R = 0.965 \), and the \( \text{sig} = 0.000 \). Using MATLAB software to re fit (cubic polynomial fitting) for the accuracy of coefficient \( b_3 \) of cubic term is not enough. The regression function is \( y = -4.932 + 0.379x + 0.006x^2 - 0.0001x^3 \), and the function image is shown in Figure 2.
Table 6. Regression analysis of winning rate from 1996.03-2001.06

| Equation | R Square | F   | df1 | df2 | Sig. | Constant | b1   | b2   | b3   |
|----------|----------|-----|-----|-----|------|----------|------|------|------|
| Cubic    | .965     | 73.268 | 3   | 8   | .000 | -25.467  | 1.955 | .029 | -.001 |

It can be seen from the above table that the $R^2 = 0.965$, the sig = 0.000, the regression function is $y = -25.467 + 1.955x + 0.029x^2 - 0.001x^3$, and the function image is shown in Figure 3.

Table 7. Regression analysis of winning rate from 1996.03-2001.06

| Equation | R Square | F            | df1 | df2 | Sig.   | Constant | b1   | b2   | b3   |
|----------|----------|--------------|-----|-----|--------|----------|------|------|------|
| Cubic    | .998     | 1640.120     | 3   | 8   | .000   | -269.983 | 24.091| -.380| .002 |

It can be seen from the above table that the $R^2 = 0.9985$, the sig = 0.000, the regression function is $y = -269.983 + 24.091x + -.380x^2 + .002x^3$, and the function image is shown in Figure 4.

For the regression function $y = 96.92 - 0.205x - 0.005x^2 + 0.0000731x^3$ of winning rate analysis, $y' = -0.205 - 0.01x + 0.0002193x^2$, $y'' = -0.01 + 0.0004386x$,
Let \[0.0002193x^2 - 0.01x - 0.205 = 0\] to get the stagnation point \[x_1 = 60.94\] and \[x_2 = -15.34\]. It can be seen from Fig. 1 that the minimum point is omitted because the RSI value is greater than zero, and \[x = -15.34\] is omitted.

For the regression function \[y = -4.932 + 0.379x + 0.006x^2 - 0.001x^3\] of annual return analysis, according to \[y' = 0.379 + 0.012x - 0.0003x^2\] and \[y'' = 0.012 - 0.0006x\], it can obtain the stagnation point of \[x_1 = 60.78\] and \[x_2 = -20.78\]. As can be seen from Figure 2, the maximum point \[x = 60.78\] is omitted for the RSI value is greater than zero.

Similarly, for the regression function \[y = -25.467 + 1.955x + 0.029x^2 - 0.001x^3\] of net profit analysis, the maximum point \[60.78\] can be obtained.

According to the regression function of annual trading times and its figure 4, \(y\) is a monotone increasing function of \(x\).

According to the above method, all the results are listed as follows, in which the functions are arranged in the order of winning rate regression analysis, annual return regression analysis, net profit regression analysis and trading times regression analysis.

### Table 8. Calculation results of extreme points of regression function

| Time       | Function                                                                 | LL extreme points                      |
|------------|---------------------------------------------------------------------------|----------------------------------------|
| 1996.03    | \[y = 96.92 - 0.205x - 0.005x^2 + 0.0000731x^3\]                          | 60.94 Minimum point, 51.78 Maximal point, 52.65 Maximal point |
| 2001.06    | \[y = 25.467 + 1.955x + 0.029x^2 - 0.001x^3\]                           | 41.51 Minimum point, 43.67 Minimum point, 45.95 Minimum point, 47.11 Maximum point |
| 2005.07    | \[y = 100.715 - 115.642x + 3.816x^2 - 0.033x^3\]                        | 32.25 Maximum point, 56.30 Maximum point, 57.92 Maximum point |
| 2007.09    | \[y = 24.044 - 30.593x + 1.915x^2 - 0.019x^3\]                         | 36.98 Minimum point, 50.89 Minimum point, 48.91 Minimum point, 49.89 Minimum point |
| 2009.01    | \[y = 48.148 - 1.627x + 0.022x^2\]                                      | 57.42 Maximum point, 42.62 Maximum point, 52.24 Maximum point, 59.48 Maximum point |
| 2010.12    | \[y = 16.93 - 1.425x + 0.014x^2\]                                       | 45.42 Minimum point, 50.21 Minimum point, 50.23 Minimum point |
| 2011.01    | \[y = 19.752 - 1.663x + 0.017x^2\]                                      | 48.59 Maximum point, 48.59 Maximum point |
| 2012.09    | \[y = -532.309 + 53.477x - 0.536x^2\]                                  | 57.42 Maximum point, 42.62 Maximum point, 52.24 Maximum point, 59.48 Maximum point |

### 3. Conclusion

This paper takes four kinds of statistical regression functions (winning rate, annualized return, net profit rate and trading rate) as the management objectives, and makes nonlinear regression analysis on the 192 month historical data of Shenzhen stock market. 24 regression functions are obtained by analysis and the method of extreme values from mathematical function theory is obtained in the state of waveform increasing function: the average number of maximal points of the first regression function is 31.30; the
average number of the maximal points of the second regression function is 50.00; the average number of the maximal point of the third regression function is 51.23; the average number of the maximal point of the fourth regression function is 57.14 or monotone increasing function without extreme value. The first three types of statistical regression functions have no maximal point but only minimum point in the state of waveform decreasing function, and the average number of the minimum points are 40.20, 46.69, 47.78.

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