Application of Extreme Value of Nonlinear Regression Function Based on RSI Expert System

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Abstract. This paper defines the waveform function and its corresponding concepts and axioms. The extreme value of stock price function is obtained from 24 known regression functions by using the method of seeking the extreme value, which is proven by the Shanghai stock index rising by 458.43%, 487.83% and 133.30% respectively in three different periods. This paper optimizes the expert RSI trading system with the method of mathematical extreme value, and writes the source code of the optimization formula, which provides a graphical and intuitive tool for investors. The average annual return, average winning rate and average net interest rate of waveform increasing function samples are 67.52%, 96.88% and 84.40%, respectively. The average annual return, average winning rate and average net interest rate of waveform decreasing function samples are 22.27%, 83.33% and 26.03%, respectively.

Keywords: Derivable time sequence function; Waveform function; Extreme value of function; RSI expert system.

1. Introduction
The extreme value of function is an important part of differential theory in mathematical analysis. In the fields of industrial and agricultural production, engineering technology and scientific experiments, we often encounter such problems: under certain conditions, how to make "the most products", with "the most economical materials", at "the lowest cost" and with "the highest efficiency", etc. in mathematics, this kind of problems can be summed up as the problem of finding the maximum or minimum value of a function, such as the problem of optimal batch size of inventory. In order to complete certain production tasks, enterprises must ensure the materials needed for normal production. However, under the condition of a certain total demand, the larger the quantity of the order and the less the ordering times, the less the cost of the order, and the storage cost will increase correspondingly; on the contrary, the more the order cost, the less the storage cost. Therefore, there is a problem of how to determine the order quantity to minimize the total cost.

Yao Xiaokui (2020) [1] Use Function to Conduct Marginal Analysis, So as to Provide Quantitative Basis for Enterprise Managers to Make Scientific Decisions.
Chen Yu (2016) [2] Use Engel Function to Solve the Problem of Maximum Demand and Cost Function to Solve the Problem of Maximum Profit.

Shan Mengdan (2019) [3] The Proposed Method of Solving Extreme Value of Univariate Function and Multivariate Function, and Solved the Problem of Optimal Inventory Management.

Qi Song (2012) [4] Use the Derivative and Function Extremum to Solve the Problems Such as the Best Batch Size of Inventory, the Optimal Time of Replacing the Old with the New, and the Production Volume with the Lowest Cost.

In this paper, 24 regression functions of 192 months in Shenzhen stock market are used to find all the extreme value (if there are extreme value) by using the mathematical waveform function and taking the winning rate, annual return rate and net profit rate as the management objectives. To find the maximum return of investment target, and then optimize the expert RSI trading system. Write the source code of optimization formula to provide investors with a graphical and intuitive tool.

2. Definition, Theorem, Calculation and Explanation

2.1. Basic Concept

Definition 1: If f(x) and g(x) is continuous, exists everywhere, the correlation coefficient of f(x) and g(x) is \( r \) (F test significant). If, then the image of the function f(x) and g(x) is highly similar, also known as the function f(x) and g(x) is highly similar.

Definition 2: If is called time sequence section

Definition 3: If is a nonlinear continuous function defined on a time sequence interval and the first derivative exists everywhere, then it is called a nonlinear differentiable time sequence function.

Definition 4: Suppose is nonlinear derivable time sequence function,
If, is waveform increasing function, (See Figure 1)
If, is waveform decreasing function, (See Figure 2)

2.2. Basic Theorem

Axiom 1: There are only three ways to change the price of financial trading products: rising (increasing the function value), decreasing (decreasing the function value), and horizontal price movement (the function value remains unchanged).

Axiom 2: The closing price line of financial trading products must be a nonlinear derivative time sequence function.

Explanation: From the global closing price lines of oil, gold, securities and futures, since the prices are fluctuating, they are obviously nonlinear or wavy, and because the independent variable is time, axiom 2 is established.

Axiom 3: The closing price line of bull (or bear) shares must be waveform increasing function (or waveform decreasing function).
2.3. Calculation and Market Interpretation

From the quarterly closing line of Shenzhen Stock Index (see Figure 3), we can know that the quarterly closing line of Shenzhen composite index is a waveform increasing function [5]. The following two types of wave increasing function (bull market) and waveform decreasing function (bear market) are used to analyze the market connotation of mathematical results.
Figure 3. Quarterly Closing Line of Shenzhen Composite Index

Table 1. System detection settings.

| Time         | Function | LL extreme value point |
|--------------|----------|------------------------|
| 1996.03~2001.06 | $y = 96.92 - 0.205x - 0.005x^2 + 0.0000731x^3$ | 60.94/ Minimum point |
|              | $y = -4.932 + 0.379x + 0.006x^2 - 0.0001x^3$ | 51.78/ Maximum point |
| 2001.06      | $y = -25.467 + 1.955x + 0.029x^2 - 0.001x^3$ | 52.65/ Maximum point |
|              | $y = -269.983 + 24.091x - 0.38x^2 + 0.002x^3$ | / Monotone increasing function |
| 2001.07~2005.06 | $y = 57.359 - 2.053x + 0.025x^2 - 0.0000435x^3$ | 41.51/ Minimum point |
|              | $y = 0.823 - 0.262x + 0.003x^2$ | 43.67/ Minimum point |
|              | $y = 2.952 - 1.011x + 0.011x^2$ | 45.95/ Minimum point |
|              | $y = -27.526 + 10.364x - 0.11x^2$ | 47.11/ Maximum point |
| 2005.07~2007.09 | $y = 77.562 + 1.543x - 0.038x^2 + 0.001x^3$ | 22.25/ Maximum point |
|              | $y = 1007.015 - 115.642x + 3.816x^2 - 0.033x^3$ | 56.36/ Maximum point |
|              | $y = -24.044 - 30.593x + 1.915x^2 - 0.019x^3$ | 57.92/ Maximum point |
|              | $y = -1797.012 + 115.605x - 1.508x^2 + 0.007x^3$ | Monotone increasing function |
| 2007.09      | $y = 48.148 - 1.627x + 0.022x^2$ | 36.98/ Minimum point |
|              | $y = 16.93 - 1.425x + 0.014x^2$ | 50.89/ Minimum point |
|              | $y = 19.752 - 1.663x + 0.017x^2$ | 48.91/ Minimum point |
|              | $y = -532.309 + 53.477x - 0.536x^2$ | 49.89/ Minimum point |
|              | $y = 45.676 + 1.148x - 0.01x^2$ | 57.4/ Maximum point |
| 2009.01~2010.12 | $y = -26.751 + 0.248x + 0.061x^2 - 0.001x^3$ | 42.6/ Maximum point |
|              | $y = -185.848 + 10.344x - 0.099x^2$ | 52.24/ Maximum point |
|              | $y = -1162.641 + 76.493x - 0.643x^2$ | 59.48/ Maximum point |
|              | $y = 73.089 - 2.362x - 0.026x^2$ | 45.42/ Minimum point |
| 2011.01~2012.09 | $y = 15.936 - 1.205x + 0.012x^4$ | 50.21/ Minimum point |
|              | $y = 26.57 - 2.009x + 0.02x^2$ | 50.23/ Minimum point |
|              | $y = -564.248 + 71.325x - 0.734x^2$ | 48.59/ Maximum point |

Table 2. Mathematical Results of Waveform Increasing Function (Bull Market)

| Time         | Market growth (%) | Maximum winning point | Maximum annual rate of return | Maximum point of net profit rate | Maximum value point of annual transaction times |
|--------------|-------------------|-----------------------|-------------------------------|----------------------------------|-----------------------------------------------|
| 1996.03~2001.06 | 458.43            | 60.94 (Minimum point) | 51.78                         | 52.65                            | Monotone increasing function                  |
| 2005.07~2007.09 | 487.83            | 22.25                 | 56.36                         | 57.92                            | Monotone increasing function                  |
| 2009.01~2010.12 | 133.30            | 57.40                 | 42.60                         | 52.24                            | 59.48                                         |
It can be seen from the results mentioned above that in the bull market, the average value of the maximum value of the winning rate is: 31.30; the average value of the maximum value of the annual return rate is: 50.00; the average value of the maximum value of the net profit rate is: 51.23; the average value of the maximum value of the annual transaction times is: 57.14 or the function of the annual transaction times is a monotonic increasing function. The market implication is that when the RSI is above 31.30, the winning rate of buying stock shares is the highest (the loss is the least); when the RSI is above 50.00, the annual return rate of buying stock shares is the largest (making the most money); when the RSI rises over 51.23, the annual net profit rate of buying stock shares is the largest (making the fastest money). When the RSI exceeds 57.14 or the value of RSI increases higher and higher, the success rate of the transaction increases. At this time, the stock market is a strong market, and the value of RSI is always in the high range.

Table 3. Mathematical Results of Waveform Decreasing Function (Bear Market)

| Time          | Market growth (%) | Maximum winning point | Maximum annual rate of return | Maximum point of net profit rate | Maximum value point of annual transaction times |
|---------------|-------------------|-----------------------|-------------------------------|---------------------------------|-----------------------------------------------|
| 2001.07~2005.06 | -60.39            | 41.51 (Minimum point) | 43.67 (Minimum point)         | 45.95 (Minimum point)           | 47.11                                         |
| 2007.10~2008.12 | -63.90            | 36.98 (Minimum point) | 50.89 (Minimum point)         | 48.91 (Minimum point)           | 49.89                                         |
| 2011.01~2012.09 | -33.86            | 45.42 (Minimum point) | 50.21 (Minimum point)         | 50.23 (Minimum point)           | 48.59                                         |

Judging from the results mentioned above, we can see that in the bear market, the winning rate, annual return rate and net profit rate have no maximum point, only a minimum point. The average value of the minimum winning rate point is 40.20; the average value of the minimum point of the annual return rate is 46.69; the average value of the minimum point of the net profit rate is 47.78; the average value of the maximum point of the annual transaction times is 45.79.

Taking 2007.10 - 2008.12 as an example, the regression function images of winning rate, annual return rate, net profit rate and annual transaction times are listed as follows (Figure 4, figure 5, Figure 6, Figure 7).

Figure 4. The regression function of winning rate
It can be seen from Figure 4 that when the winning rate is a decreasing function of RSI, and its market connotation is that the larger the value of RSI, the less the times of investment profits; when , the winning rate is the increasing function of RSI, and its market meaning is that the greater the value of RSI, the more times of investment profits.
It can be seen from Figure 5 and Figure 6 that when, the annual return rate and net profit rate are the decreasing function of RSI and are negative numbers. The market connotation is that the larger the value of RSI is, the smaller the annual return rate and net profit rate of investment are, the greater the loss is. When the annual rate of return and net profit rate are the increasing functions of RSI, and they are also negative numbers. The market connotation is that the larger the value of RSI, the greater the annual return and net profit rate of investment, the smaller the loss is but still belongs to the loss.

It can be seen from Figure 7 that the maximum number of transactions per year is 46.24, which means that the number of successful transactions is the highest. When the number of transactions per year is a decreasing function of RSI, and its market connotation is that the larger the value of RSI, the less times of successful transactions are.

In conclusion, from the perspective of investment profit, RSI expert system can not guide investors to make profits in bear market.

2.4. Visualization results of RSI expert system
If priority is given to winning rate, optimize source code:

\[
\begin{align*}
N: & \quad 2.00 \ 50.00 \ 14.00 \ 3.00 \\
LL: & \quad 0.00 \ 70.00 \ 30.00 \ 5.00 \\
LH: & \quad 65.00 \ 100.00 \ 80.00 \ 5.00 \\
LC:=& \text{REF(CLOSE,1)}; \\
WRSI:=& \text{SMA(MAX(CLOSE-LC,0),N,1)/SMA(ABS(CLOSE-LC),N,1)*100}; \\
ENTERLONG:=& \text{CROSS(WRSI,LL)}; \\
EXITLONG:=& \text{CROSS(LH,WRSI)};
\end{align*}
\]

If priority is given to annual return rate and net profit rat, optimize source code:

\[
\begin{align*}
N: & \quad 2.00 \ 50.00 \ 14.00 \ 3.00 \\
LL: & \quad 0.00 \ 70.00 \ 30.00 \ 5.00 \\
LH: & \quad 65.00 \ 100.00 \ 80.00 \ 5.00 \\
LC:=& \text{REF(CLOSE,1)}; \\
WRSI:=& \text{SMA(MAX(CLOSE-LC,0),N,1)/SMA(ABS(CLOSE-LC),N,1)*100}; \\
ENTERLONG:=& \text{CROSS(WRSI,LL)}; \\
EXITLONG:=& \text{CROSS(LH,WRSI)};
\end{align*}
\]

The following Figures 8 and 9 show the images of RSI indicators before and after the same stock optimization, and the profit results of Figure 9 are obviously better than those of Figure 8.
Figure 8. RSI indicator before optimization

Figure 9. RSI indicator after optimization
Table 4: Sample Data of Waveform Increasing Functioned Scheme comparing.

| Stock code | Buying conditions | Selling conditions | Annual return | Winning rate | Net profit rate | Transaction times | Yield in the observation period |
|------------|-------------------|--------------------|---------------|--------------|-----------------|-------------------|---------------------------------|
| 002353     | RSI rises over 55 | RSI drops below 65 | 64.62%        | 87.50%       | 80.78%          | 6.40              | 64.60%                         |
| 600111     | RSI rises over 30 | RSI drops below 72 | 44.11%        | 100.00%      | 55.14%          | 1.60              | 128.3%                         |
| 002176     | RSI rises over 50 | RSI drops below 70 | 66.86%        | 100.00%      | 83.57%          | 3.20              | 136%                           |
| 600160     | RSI rises over 50 | RSI drops below 70 | 94.50%        | 100.00%      | 118.12%         | 3.20              | 211.6%                         |

Table 5: Sample data of waveform subtraction function

| Stock code | Buying conditions | Selling conditions | Annual return | Winning rate | Net profit rate | Transaction times | Yield in the observation period |
|------------|-------------------|--------------------|---------------|--------------|-----------------|-------------------|---------------------------------|
| 002351     | RSI rises over 30 | RSI drops below 64 | 30.90%        | 75.00%       | 38.63%          | 3.20              | -33.19%                        |
| 002362     | RSI rises over 25 | RSI drops below 57 | 31.86%        | 75.00%       | 39.82%          | 3.20              | -70.62%                        |
| 002379     | RSI rises over 20 | RSI drops below 60 | 33.76%        | 100.00%      | 42.19%          | 2.40              | -46.11%                        |
| 002387     | RSI rises over 50 | RSI drops below 60 | 7.21%         | 66.67%       | 9.01%           | 2.40              | -18.92%                        |

Table 6: Sample data of waveform function

| Waveform function                                  | Average annual return | Average winning rate | Average net profit rate |
|----------------------------------------------------|-----------------------|----------------------|-------------------------|
| Waveform increasing function                      | 67.52%                | 96.88%               | 84.40%                  |
| Waveform decreasing function                      | 22.27%                | 83.33%               | 26.03%                  |

The results mentioned above indicate that: for individual stock, whether it’s the waveform increasing function or waveform decreasing function, the RSI indicator can outperform the market with minimal risk.

3. Conclusion

The paper defines the waveform function and its corresponding concepts and axioms. The method of mathematical function theory is used to find the extreme value of stock price function for 24 known regression functions. In three different periods, we get that the Shanghai stock index has increased by 458.43%, 487.83% and 133.30% respectively. The method of mathematical extreme value is applied to optimize the expert RSI trading system, and the source code of the optimization formula is written to provide a graphical and intuitive tool for investors. The average annual return, average winning rate and average net profit rate of waveform increasing function samples are 67.52%, 96.88% and 84.40%, respectively. The average annual return, average winning rate and average net profit rate of waveform decreasing function samples are 22.27%, 83.33% and 26.03%, respectively. The optimization system provides an intuitive and quick tool for investors.
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