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The Application of Grey System in Futures Price Forecasting

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ABSTRACT

With the development of China's futures market, investors' concept is maturing day after day, investors begin to trade from blind to the rational investment, programming trading system is also more and more getting the attention of investors. So programmed trading system can help investors to capture the law of profit and control the risk and position management plays an important role. In addition, using programmed trading system can help traders in the actual operation before using historical data to test operation method, can effectively reduce the cost of trial and error. This paper, by using Dalian corn futures price data as the research object, first elaborated the futures price and the reason for choosing grey model , secondly to grey GM (1, 1) model of the introduction and model are discussed, and thus constitute the futures price gray forecasting model, and using this model, the futures price reasonable prediction. Then using Dalian corn futures price data set up GM (1, 1) model, and applied the grey system tool analysis and model test, to predict the futures price. So it can be concluded that the grey system could be a forecasting model of the futures price.

Keywords: *futures price ; grey system prediction ; GM (1, 1) model*

1. INTRODUCTION

Trading system is a set of perfect trading rules, trading rules should be objective, quantitative, the only, it strictly stipulated the investment of each link, requirement completely according to its investors rules of operation. A good trading system, users must conform to the psychological characteristics of the statistical features of the object, the investment and the risk characteristics of investment funds. The practice proved to achieve long-term, stable income trading rules through the computer language automated trading, which is programmed trading system.

Gray prediction [1] GM (1, 1) is a gray system theory the most widely used in a grey dynamic prediction model, mainly used for complex system a dominant factors of characteristic value of the simulation and prediction, in order to reveal the leading factors change rule and the future development trend. It is uncertain system as the research object, and through the "part" known information generation, development and extract valuable information, realize to the system operation behavior, the evolution law of the correct description and effective monitoring, so as to predict the future development of the business situation. This model is a kind of time column prediction model, it can be according to the less information modeling and forecasting, and widely application [2].

The futures price is refers to the transaction after the establishment of the buyers and sellers in a certain date agreed the delivery price. It is to point to futures market through the public bidding forms of futures contract price of the subject matter. The rise in price, the futures price higher than the spot price; In the price to fall, the futures price is lower than the spot price. In normal circumstances, the futures to burden more storage charges, insurance premium and interest, its price is usually better than spot prices high. Futures market public bidding mode mainly has two kinds: one kind is the computer automatic brokered transactions way, another kind is open outcry way. In China's futures exchange, all adopt the computer automatic brokered transactions way, in this way, the futures price formation must follow the price priority, the principle of time priority. The so-called price priority principle, it is to point to trading instruction in the exchange host, the optimal price clinch a deal first, that is the highest bid price and the lowest selling price declaration first clinch a deal. Time priority principle, it is to point to in the price the same situation, first enter trading system trading instruction to clinch a deal. Exchange host by clicking the above two principles to enter the host instructions to be automatic matching, and find out the buyers and sellers are acceptable price, finally conclude the transaction, feedback to clinch a deal the member. Futures prices are at the opening and closing price, highest, lowest price, clearing the concepts. In China's exchange, opening price refers to after the start of trading the first clinch a deal valence; The closing price refers to trade when closing the last clinch a deal valence; Highest and lowest separately referred to the trading of the highest price and the lowest clinch a deal valence; Settlement price is refers to the diurnal trade weighted average price.

In this paper the grey prediction is to use grey model GM (1, 1) forecast. This method is easy and simple, and how much to sample size no high requirements, less amount of calculation, etc., and to the result of the futures price data prediction is applicable.

2. THE ESTABLISHMENT OF THE MODEL [3]

Set the original sequence is:

$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(k))$,we get a accumulation formation sequence:

$x^{(1)} = (x^{(1)}(1), x^{(1)}(2), ..., x^{(1)}(k))$, $x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i)$, $k = 1, 2, ..., n$ Is a accumulation formation sequence $\{x^{(1)}(k) \mid k = 1, 2, 3, ..., n\}$ can rule by solving one order linear differential equation:

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

To get solution, including α and b for undetermined parameter [4], α is called development factor, b is called gray action.

Set u for undetermined parameter vector, $u = (a, b)^T$, By use of least squares method solving available:

$$u = (B^T B)^{-1} B^T Y$$

Among them：

$$B = \begin{pmatrix} -0.5\left[x^{(1)}(1) + x^{(1)}(2)\right] & 1 \\ -0.5\left[x^{(1)}(2) + x^{(1)}(3)\right] & 1 \\ \vdots & \vdots \\ -0.5\left[x^{(1)}(n-1) + x^{(1)}(n)\right] & 1 \end{pmatrix}, \quad Y = \begin{pmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{pmatrix}$$

Estimate the parameter and b after, then $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$ solution, namely time response function is:

$$x^{(1)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-ak} + \frac{b}{a}, \quad k = (0, 1, 2, ..., n)$$

The response function can be forecast to $x^{(1)}$, and the Lei Ian generation to get original data sequence simulation sequence value, namely

$$x^{(0)}(k+1) = x^{(1)}(k+1) - x^{(1)}(k), \quad k = (0, 1, 2, ..., n)$$

3. MODEL TEST

GM (1, 1) model of the test is divided into three aspects: residual examination correlation degree examination. Posterior difference test [5].

3.1 Residual Test

The size of the residual error inspection, namely the model value and the actual value of the residual point by point inspection is according to the first model to calculate $x^{(0)}(i+1)$, will be $x^{(0)}(i+1)$ regressive generation $x^{(0)}(i)$, finally calculated the original sequence $x^{(0)}(i)$ and $x^{(0)}(i)$ absolute residual sequence and relative residual sequence

$$\Delta^{(0)} = \{\Delta^{(0)}(i), i = 1, 2, ..., n\},$$

$$\Delta^{(0)}(i) = \left| x^{(0)}(i) - x^{(0)}(i) \right|$$

And relative residual sequence

$$\phi = \{\phi_i, i = 1, 2, ..., n\}, \quad \phi_i = \left[\frac{\Delta^{(0)}(i)}{x^{(0)}(i)}\right]_{\%}$$

And calculate average relative residual

$$\bar{\phi} = \frac{1}{n} \sum_{i=1}^{n} \phi_i$$

Given α, when $\bar{\phi} < \alpha$, and $\phi_n < \alpha$ founded, say the model for residual qualified model.

3.2 Correlation Test

Correlation test, that is, through the investigation model value curve and modeling sequence curve of similar degree test. According to the mentioned correlation calculation method, and calculates the $x^{(0)}(i)$ and $x^{(0)}(i)$ correlation coefficient, and then calculate the correlation degree, according to the experience, correlation degree more than 0.6 is satisfactory.

3.3 Posterior Difference Test

Posterior difference inspection is i.e. on residual distribution statistical properties of the inspection.

1) Calculate the average of the original sequence:

$$\bar{x}^{(0)} = \frac{1}{n} \sum_{i=1}^{n} x^{(0)}(i)$$

2) Calculating the original sequence $x^{(0)}$ mean square error：

$$S_1 = \left(\frac{\sum_{i=1}^{n} \left[x^{(0)}(i) - \bar{x}^{(0)} \right]^2}{n-1} \right)^{1/2}$$

3) Calculating residual mean:

$$\overline{\Delta} = \frac{1}{n}\sum_{i=1}^{n}\Delta^{(0)}(i)$$

4) Calculating residual mean square error:

$$S_2 = \left(\frac{\sum_{i=0}^{n}\left[\Delta^{(0)}(k)-\overline{\Delta}\right]^2}{n-1}\right)^{1/2}$$

5) Calculation variance ratio C:

$$C = \frac{S_1}{S_2}$$

6) Calculation small residual probability:

$$P = P\left\{\left|\Delta^{(0)}(i)-\overline{\Delta}\right| < 0.6745S_1\right\}$$

Make

$$S_0 = 0.6745S_1,\quad e_i = \left|\Delta^{(0)}(i)-\overline{\Delta}\right|,\quad p = p\{e_i < S_0\}.$$

If for a given $C_0 > 0$, when $C < C_0$, say the model for mean variance ratio qualified model. As for the given $P_0 > 0$, when $P > P_0$, say the model for small residual probability qualified model.

Table 1: Posterior Difference Test Discriminant Reference Table

P	C	Model accuracy
> 0.95	< 0.35	Optimal
> 0.80	< 0.5	Qualified
> 0.70	> 0.65	Forced to pass the exam
< 0.70	> 0.65	The unqualified

4. GM (1, 1) MODEL OF THE PROPERTY [6]

1) Model has differential, difference, index compatible with the nature.
2) Model parameters strictly, adjustable, not the only one, so parameters are gray.
3) Model of the structure, the change from time to time, so the structure is grey.
4) Model similar to differential equation is not general differential equation, and the shape of difference equation is not general difference equation, and the shape of exponential function is not completely is exponential function, it shows that the mechanism of model not uniqueness, i.e., the structure of the model of the mechanism is grey.
5) Model is often coefficient properties, yet reject some factor, so the model and parameter inclusion relation is the only, namely model parameter distribution is grey.

5. GRAY PREDICTION STEPS

5.1 Data inspection and processing

First of all, in order to guarantee the feasibility of modeling method, it is necessary to make the necessary known data column inspection treatment. A reference data for $x^{(0)} = (x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n))$, calculation sequence stage than

$$\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)},\quad k = 2,3,\ldots,n$$

If all the level than $\lambda(k)$ have fallen on can let cover $\left(e^{-\frac{2}{n+1}}, e^{-\frac{2}{n+2}}\right)$ inside, series $x^{(0)}$ can be used as a model GM (1, 1) of grey prediction data. Otherwise, need to series $x^{(0)}$ make the necessary transformation processing, make its fall into can let cover inside. Namely take appropriate constant c, for translational transformation

$$y^{(0)} = x^{(0)}(k) + c,\quad k = 1,2,\ldots,n$$

Make series $y^{(0)} = (y^{(0)}(1), y^{(0)}(2), \ldots, y^{(0)}(n))$ level than $\lambda_y(k)$ fall into can let coverage area.

5.2 Made Model

Set up GM (1, 1) model, it can be concluded that an accumulator series expression for:

$$x^{(1)}(k+1)=\left[x^{(0)}(1)-\frac{b}{a}\right]e^{-ak}+\frac{b}{a}\quad k=(0,1,2,...,n)$$

The predicted value for:

$$x^{(0)}(k+1)=x^{(1)}(k+1)-x^{(1)}(k)\quad k=(0,1,2,...,n)$$

6. NUMERICAL EXAMPLE

We through the analysis of the historical data and international related futures trend to analyze the future of futures market, front we establish the gray system forecast futures price. To each data inspection and processing. And Dalian is futures development good city, we use Dalian futures price of historical data to test our model is correct.

6.1 Modeling Data Selection

Dalian corn futures trading hours for normal weekly Monday to Friday, Saturday closed on Sunday. So data selection on July 4, 2011 to July 8, 2011 5 days Dalian Commodity Exchange corn futures price data to predict the settlement price of corn, establish the model of the sample data sequence for $X^{(0)}=\{2286,2284,2292,2290,2291\}$; To create the original GM (1, 1) model. And then introduction of July 11, 2011 data {2288}, sample data sequence for $X^{(1)}=\{2286,2284,2292,2290,2291,2288\}$, the establishment of new information GM (1, 1) model. Finally eliminate on July 4, 2011 data {2286}, sample data sequence for $X^{(2)}=\{2284,2292,2290,2291,2288\}$ to establishment of metabolism GM (1, 1) model.

6.2 Model Establishment Process

Because of this a few model of the process is the same basically, the only difference is modeling data selected different, accordingly, we only to the original GM (1, 1) model description of the modeling process.

First of all, the original price series $X^{(0)}=\{2286,2284,2292,2290,2291\}$ use grey system forecasting tools to predict model, it is concluded that the average relative error is 0.080816 is less than 0.2, so we can use the gray system to set up model for corn futures price forecast. Using grey forecasting model a = 0.000829, b = 2283.55815 is the original GM (1, 1) model

$$\frac{dx^{(1)}}{dt}+(-0.000829)x^{(1)}=2283.55815$$

Responsive function for:

$$X^{(k+1)}=2755356.210526e^{-0.000829k}+2753070.210526$$

According to the model to restore the July 4, 2011 to July 8, 2011 respectively predicted for {2294.000904, 2295.904473, 2297.809621, 2299.71635, 2301.624661) and 11 July 2011 to July 15, 2011 respectively predicted for {2293.997267, 2297.104709, 2300.216361, 2303.332228, 2306.452315), finally respectively on the simulation results of the residual inspection. Make three model accuracy comparison forms.

Table 2: Three kinds of Model Prediction Accuracy is the step

Three kinds of model accuracy comparison					
Model category	parameters		Simulation prediction	residual	Relative error
	a	b			
The traditional model	-0.000829	2283.56	2289.198	0.198	0.080816
New information model	-0.000306	2286.56	2288.300	2.399	0.104879
Metabolism model	0.00048	2293.55	2289.699	0.300	0.030568

7. CONCLUSION

1) Based on GM (1, 1) model predictions, the data selection, lead to the result of model is different also, especially parameter a and b inconsistent results, it shows that different time the price of corn for the whole price prediction model prediction results, the influence of inconsistent;

2) From the table to see, metabolism the prediction precision is higher than the new information model, new information model prediction accuracy higher than the original model, this basically is the new information cognitive function is greater than the old information, new information can timely reflect the change of the whole system. Therefore, in the corn futures price prediction, to timely to join the new price information, and at the same time puts forward the old information, timely keep the whole model of fresh sex, in order to ensure the precision of the forecast price;

3) The GM (1, 1) model of the relative error value is very important, if the relative error is less than 0.2, then we can use the gray system to predict corn futures price, if more than 0.2 cannot use the model prediction. In addition, development factor a has important significance to determine the model is suitable for long-term forecast or short-term forecasting. When - a less than 0.3, can be used to forecast for a long time, when - a in (0.3, 0.5) between, can be used for the short-term forecast, but forecast for a careful with, When - a in (0.5, 0.8) between do short-term forecasting should be cautious; When - a in (0.8, 1) between should be used when residual item to set up GM (1, 1) model. When - a larger than 1, should not use GM (1, 1) model. From the above analysis result, the three kinds of model development factor are: 0.000829, 0.000306 and 0.00048, far less than 0.3 the critical value, so the three models can be applied to medium and long-term prediction;

4) From the analysis results, the metabolism model and new information model to predict the price of the residual amount of variation is larger, and the original model although residual error is small, the relative error is also more stable; Therefore, to predict the long-term cotton futures price, the original GM (1, 1) model is more reliable.

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