Volatile Asset Price Prediction Model Based on Grey Prediction

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Abstract. How to obtain higher returns in the investment of volatile assets has always been one of the most concerning issues for investors. This is of great significance for the rational planning of financial investment to seek maximum benefits. At present, the mainstream forecasting methods in related fields include the time series research method, the BP neural network research method, etc. However, these research methods need to take long-term price data as the reference, and cannot accurately describe the gray system of volatile asset price changes. For this reason, the author puts forward a grey prediction model research method that matches the grey system. Firstly, the volatility asset price data of the first seven days were tested to ensure that the data had a quasi-exponential law. Secondly, the above data are used to generate new discrete data columns that weaken randomness. Finally, the differential equation model is established to obtain the approximate estimated value of the original data, to predict the volatility asset price on the eighth-day. This article takes gold and bitcoin as examples to experiment. Based on the data of their historical prices，the price of each seven-day period is used to predict the price of the eighth-day. The residual value is much less than 10%. Therefore, this model can predict the price of volatile assets.

Keywords: Volatile asset, Grey prediction, Quasi exponential test, Residual test

1 Introduction

In recent years, with the development of the social economy, more and more people choose to invest their idle funds in volatile assets such as stocks in order to get extra income. Reasonable an investment plan is the dream of the majority of investors, and the first step of making an investment plan is to make a reasonable prediction of the price trend of volatile assets.

The price movement of volatile assets in a gray system, may fluctuate greatly in a short time and is also affected by a variety of unpredictable factors. At present the existing price forecasting research methods include the time series research method, multiple linear regression research method, the BP neural network research method and so on. These research methods are based on long-term price data and can only take into account some of the factors that affect price movements. Therefore, the existing research methods can not accurately predict the price trend of volatile assets.

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Therefore, this paper innovatively proposes a gray forecasting model based on short-term price data, which can achieve the effect of using the data of the first 7 days to predict the price trend data of the eighth day. First, a quasi index test is conducted on the volatility asset price data of the previous 7 days. Secondly, using the above data to generate a new rule discrete data column, a sum; Third, the differential equation model is established to predict the volatility of the asset prices on the eighth day. Finally, the residual test is carried out to judge the accuracy of the model results.

The contributions of this paper are as follows:

1) According to the grey characteristics of the volatility asset, the grey prediction method can be used to avoid inaccurate prediction due to unknown information.

2) Grey forecasting is a research method of short-term forecasting. In today's environment where volatile assets can change dramatically in a short time, this model is perfectly adapted to this situation.

2 Related work

At present, the mainstream research models include: time series research method, multiple linear regression research method, BP neural network research method, etc.

For the time series research method, Xu Chen [1] made a statistical analysis, and established a quadratic curve fitting model to make a short-term prediction; Xi Jing [2] established the gold price ARMA model to dynamically depict the gold price data generation process; Xu Guiyang [3] cast aside the influence of other factors and established a black box type fluctuation model with time as the fluctuation factor. However, the time series method can only consider the influence of time factors, but the multiple linear regression method can solve this problem.

The multiple linear regression research method fits a variety of influencing factors in a linear way. Li Yunhao [4] used the partial least squares method as independent variables to establish a model for each variable to reflect the gold price. Dai Wei et al. [5] used SAS software to conduct multiple regression analysis to explore the impact of the Chinese dollar index and the Euro-pound exchange rate on gold. However, multiple linear regression can not consider the complex nonlinear factors in practical problems, but the BP neural network can solve this problem.

The BP neural network can consider complex nonlinear factors in practical problems. By establishing the BP neural network, Xu Xiangchao and Zhao Rui [6] took factors such as world sensitivity, the monetary policy of the United States and the monetary policy of China as input terminals of the network, and divided world the gold price into several intervals as output terminals of the network. Zeng Lian, Ma Dandi, Liu Zongxin [7] proposed an improved the BP neural network model based on projection pursuit optimization to improve the prediction accuracy of the gold price.

However, the above algorithms are based on long-term data to predict the volatility of asset prices. Therefore, this paper introduces the iterative gray prediction research method, solves the parameters in the gray differential equation according to the processed original data, and realizes the prediction of a volatile asset price.

3 The Grey Prediction Model

In this part, we build a grey forecasting model to predict the price trend of volatile assets. The framework of the model is shown. The grey prediction model makes use of the original data and weakens the randomness through a single accumulation. Then, the differential equation model is established to predict the subsequent development of the data. The model is divided into three parts: data verification, grey prediction model establishment and model solving, and result verification.

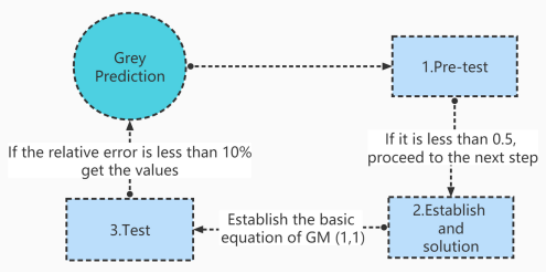

Fig. 1. Ideas of the model

3.1 Pre-test of the model

This model is based on the price data of the previous seven days. The price data of these seven days should conform to the law of the quasi index. Therefore, we conduct a quasi-exponential test on the price data. Here's how:

First, take the price of the financial product for seven consecutive days as the original sequence $x^{(0)}$. A sum is performed to obtain a cumulative sequence $x^{(1)}$. The KTH term of the cumulative sequence $x^{(1)}$ is the sum of the k terms before the original sequence.

Second, the smoothness ratio of the k-th term is defined as the ratio of the k-th term of the original sequence to the k-1 term of the first cumulative sequence. When the smoothness ratio of the sixth and seventh items is both greater than 0 and less than 0.5, the sequence meet the law of quasi index and can make the grey prediction.

3.2 Establishment and solution of the model

We can take the mean of the two adjacent terms of $x^{(1)}$ and sum them up once, and get the mean to produce the sequence $z^{(1)}$. The basic equation of the grey prediction model GM (1,1) is as follows:

$$x^{0}(k)+az^{(1)}(k)=b \tag{1}$$

a is the development coefficient. b is the grey action. GM (1,1) The first "1" means the equation is of the first order. The second "1" means the equation has only one variable.

Introduce the matrix form:

$$\mathbf{u} = (a,b)^T \quad ,\mathbf{Y} = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix} \quad ,\mathbf{B} = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \tag{2}$$

So $x^0(k) + az^{(1)}(k) = b$ can be represented as:

$$Y = Bu \tag{3}$$

Using the least-squares method, the estimated value of the parameter is

$$\mathbf{u} = \begin{pmatrix} \hat{a} \\ \hat{b} \end{pmatrix} = \left(\mathbf{B}^T\mathbf{B}\right)^{-1}\mathbf{B}^T\mathbf{Y} \tag{4}$$

The solution of the equation can be obtained by substituting the initial value -- the price on the first day into the basic equation of the grey prediction model:

$$\hat{x}^{(0)}(k+1) = (1-e^{a})[x^{(0)}(1) - \frac{b}{a}]e^{-ak} \tag{5}$$

Through this equation, only by substituting the value k into the equation, the volatile asset price on the day k+1 can be predicted.

3.3 Test of the model

The effect of the prediction can be tested by the residual test. The smaller the relative residual or residual value is, the higher the model accuracy is. The more the residuals conform to the normal distribution, the more practical the model is.

The relative residual: The ratio of the difference between the actual and estimated value to the actual value. When the error conforms to a normal distribution and the relative error is less than 10%, the model accuracy is considered to be at a high level.

4 Experiment

In this paper, two volatility assets, gold and Bitcoin, are selected for the price prediction experiment, which includes three parts, data processing and testing, gray prediction model establishment and result testing.

4.1 The data set

Table 1. The data set

Name	Gross	Start time	End time	Maximum	Minimum
Bitcoin	1826	2016.9.11	2021.9.10	63554.44	594.08
Gold	1255	2016.9.11	2021.9.10	2067.15	1125.7

4.2 Data processing and pre-inspection

To ensure that the data is valid, first, check the data in the attachment and use SPSS to check the following data for anomalies; We ignore missing gold data because the market is closed; After calculation, the above three cases are not found in the attachment. Good data integrity. Next, a quasi-exponential test is conducted on the data. All $\rho(k)$ is less than 0.5, which conforms to the quasi-exponential law.

4.3 The solution of prediction results

Each data series is substituted into the grey prediction model to solve the daily price between September 11, 2016 and September 10, 2021. The results are shown below:

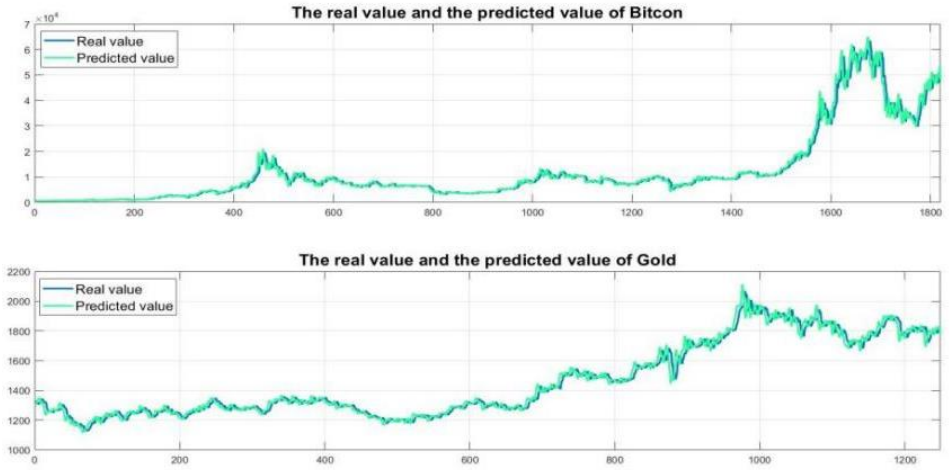

Fig. 2. The actual price versus the forecast price

It can be intuitively seen from Fig.4 that the predicted price trend curve and the real price curve have a very high coincidence degree.

4.4 Test of prediction results

The price data of the above prediction are tested by residual error, and the results are shown in the following figure

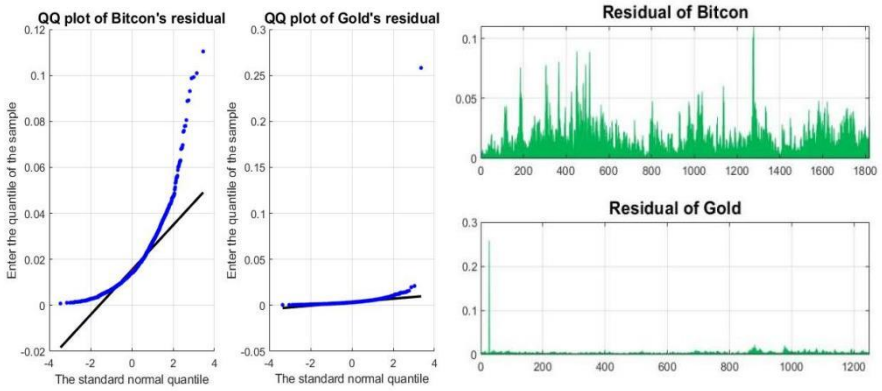

Fig. 3. Q-Q plot of normal distribution test and Residual test results

As can be seen from Fig. 3, the error follows a normal distribution, and the predicted result is statistically significant. And, the relative error is far less than 10%, indicating that the predicted result has high accuracy. So the experiment is successful.

5 Conclusion

In order to reasonably predict the price of volatile assets, we establish the iterative grey prediction model. The model is able to predict the price of the next day by using the data over a short time. It perfectly conforms to the price trend of volatile assets, which can provide a reference for investors when making an investment plan.

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