Financial Engineering and Risk Management (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/ferm.2022.050209
ISSN 2523-2576 Vol. 5 Num. 2

Predict the Price change over time based on GM (1,1) model

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Keywords: GM (1,1), Grey prediction

Abstract: To predict the future five years traders how to the decision-making of assets, according to the price of gold and currency data continuity and periodicity, we established the grey forecasting model to reduce the computational complexity based on GM (1,1) model. Use investment data from the initial period to conduct model training and predict gold and bitcoin prices for the next period. To better reflect the cyclical fluctuations of price in the investment market, the weighted results of the expected price and the actual price of the previous year are taken as the expectations of this period.

1. Introduction

As the main trading varieties, gold and bitcoin have become the focus of attention because of their volatile characteristics. To maximize the profits of market traders, it is necessary to establish a model that can predict the price in the next few days according to the price today.

XGBoost [2] model and lightGBM [3] in machine learning can be used for this problem. The former is a large-scale parallel boosting tree tool, which can quantize according to the number of samples with the second-order derivative value, and find the most splitting method of the leaf nodes of the decision tree. However, in the process of node splitting, it still needs to traverse the data set, and the amount of calculation is huge; The latter uses the first derivative to quantize the number of samples, which appropriately controls the amount of calculation compared with the XGBoost algorithm. However, for the size of the data set of this problem, it is still not the best choice.

2. Model Establishment and Solution

2.1 GM (1,1) model

To ensure the feasibility of the GM (1,1) modeling method, it is necessary to test and process the known data.

First, it is necessary to calculate one accumulation of the original data to generate a series, as shown in Equation (1).

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i), k = 1, 2, \cdots, n \tag{1}$$

Where $x^{(0)} = (x^0(1), x^0(2), \ldots, x^0(n))$ is the original data after preprocessing, and $x^{(1)}$ is the number sequence generated by one accumulation of $x^{(0)}$.

Then calculate the order ratio of the x_0 sequence in Equation (2).

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

If all the order ratios fall within the admissible coverage interval a, the series X (0) can establish the GM (1,1) model and carry out grey prediction. Otherwise, the data is translated so that the order ratio of the data column falls within the allowable coverage.

When establishing GM (1,1) model, assuming that x_0 meets the above requirements, Equation (3) is obtained:

$$x^{(0)}(k) + az^{(1)}(k) = b \tag{3}$$

where a and b are the parameters to be calculated, and $z^{(1)}(k)$ is the adjacent value of sequence $x^{(1)}(k)$ to generate a sequence.

The estimated values of a and b are obtained by regression analysis [5], so the corresponding whitening model is:

$$\frac{dx^{(1)}(k)}{dt} + ax^{(1)}(k) = b \tag{4}$$

The corresponding solution in:

$$x^{(1)}(k) = \left(x^{(0)}(1) - \frac{b}{a}\right)e^{-a(k-1)} + \frac{b}{a} \tag{5}$$

The final predicted value is:

$$\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k), k = 1,2,\cdots,n-1 \tag{6}$$

Then use the data in t_1~t_{k1} time to predict t_{k1+1} bitcoin price in the period. If the effect is satisfactory, $k1$=2. On the contrary, $k1$=$k1$+1, and use the data in t_1~t_{k2} time to predict t_{k2+1} gold price in the period. If the effect is satisfactory, $k2$=2. On the contrary, $k2$=$k2$+1, and the maximum values of $k1$ and $k2$ are 6.

Finally, use the $k1$ week data before the $x1$ day to predict the bitcoin price on the $x1$ day, and use the $k2$ week data before the $x2$ day to predict the bitcoin price on the $x2$ day until 2016.

2.2 Forecast revision

Since the gold price and bitcoin price of investment products similar to stocks may have the same characteristics at a specific time, and considering that the GM(1,1) model only uses the adjacent data for prediction and insufficient factors, this part judges the growth rate of the prediction results of the GM(1,1) model on September 10, 2017, and beyond, When the growth rate is not much different from that of the previous year, it will not be handled and the prediction results will be used directly. On the contrary, a weighting process is carried out, and the formula is:

$$\widehat{w} = w_{last} * 50\% + \widehat{w}_0 * 50\% \tag{7}$$

First, we do not make any investments or trades during the initial period, but use this data to train the GM (1, 1) model and predict the price of gold and the price of bitcoin for the next period. If the prediction is not satisfactory, please continue to extend the training data until the prediction meets the accuracy requirement or the training data reaches the specified upper limit. After each prediction, the training data is rolled forward with the predicted period, and the final estimated returns of our model

are satisfactory through error calculation and visual analysis. However, the model can only describe expectations from the most recent period to the later period and does not reflect well the impact of cyclical changes in the investment market on the volatility of gold and bitcoin prices, so we have improved the model. Expectations should be corrected when the forecasted gold price or bitcoin price volatility in the second year is significantly different from that of the previous year. The weighted result of the expected price and the actual price of the previous year is used as the expectation for that period. This method effectively reduces investment risk, improves the robustness and robustness of the forecasting model, and results in more stable decisions over the last five years.

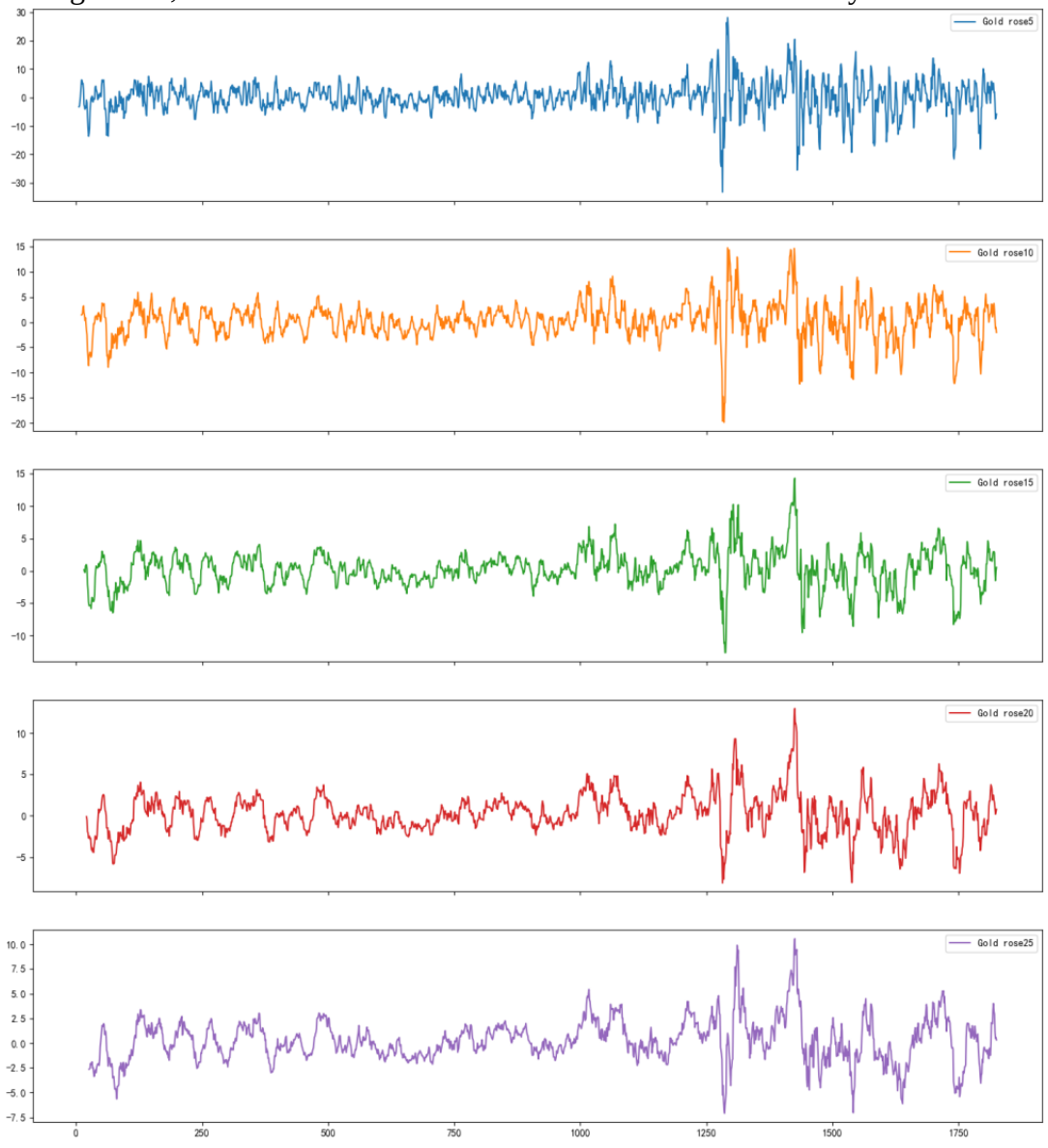

Figure 1: Comparing the average value of gold gains over time

2.3 Model validation

Gold: RMSE=37.93, MAE=28.48, R^2=0.98.

Bitcoin: RMSE=3182.93, MAE=1392.63, R^2=0.95.

MSE, RMSE of the predicted values of gold and bitcoin are not high, and $R^2$is close to 1. Therefore, the accuracy of the model is high.

3. Conclusion

The GM (1,1) used is friendly to small data volumes [7] and facilitates rapid iteration of data and rolling forward. The model not only incorporates recent market influences on prices but also incorporates cyclical changes in prices to make returns as high as possible using limited data while making the model more risk-tolerant. Models are simple to build and can be used more quickly and flexibly than machine learning.

However, the predictions of the model gradually decline over time. And the factors considered to simplify the model are not comprehensive enough, resulting in poorer model predictions in some areas.

Compared with the commonly used XGBoost and lightGBM models, our grey forecasting model performs better after Modell training. After considering the continuity [8] and periodicity of the data on time, we use python software for visual analysis, and we also use the weighted result of the expected price and the actual price of the previous year as the expectation for the period, which effectively reduces investment risk and This method effectively reduces investment risk and effectively improves the stability of the decision.

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