Research on Stock Market Investment Based on Brin Band Strategy Modified by Adaptive Filtering Method

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Abstract: Investment in gold and bitcoin is essentially investment in the stock market. According to the stock market investment strategy, using the Bollinger bands strategy under the quantitative investment theory, this paper constructs an adaptive filter model to modify the Bollinger bands strategy, and finally obtains the modified Bollinger bands model. The data sources are London Bullion Market Association and NASDAQ, 9/11/2021. By the date of September 10, 2021, the gold held was 0.1625 troy ounces, with a total value of 296.613 USD. The number of bitcoins held was 1.642, with a total value of 76124.656 USD. The sensitivity of the model is analyzed by percentage floating and standard deviation floating to ensure the rationality of the model. Finally, it is considered that the gold brin band model and the bitcoin brin band model have good sensitivity to the transaction price, and can adapt to stock market investors with different personalities.

Keywords: Stock market investment; Bollinger bands strategy; Adaptive filtering model.

1 Introduction

As an important part of the capitalist market, there are many factors affecting the change. In recent years, time series model has been a common model to predict the trend of stock price. Chen Qianqian [1] said that the time series model could reasonably predict the stock price in the short term. Deng Yaoyao [2] believed that quantitative investment was a quantitative way. Wu Haitao [3] cited three significant advantages of quantitative investment. Wang Yan [4] made a preliminary discussion on the theoretical basis and development status of quantitative investment theory. Zhang Hongfan [5] believed that the brin belt up and down track breakthrough strategy is often used in quantitative investment. Deng Yaoyao [2] mentioned that the boll index was often used in stock market analysis. Zhou Xu [6] studied the feasibility of brin belt trend strategy in digital money market and designed brin belt trading system.

The purpose of this study is to address the following issues:

(i) Establishing a mathematical model that can provide the optimal trade strategy, and conduct a simulated trade through the collected data.

(ii) Explaining the impact of transaction price on trade strategy and results through the impact of transaction price on the sensitivity of the model.

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2 Theory and method

2.1 Establishment of Adaptive filtering model

Adaptive filtering model is a kind of time series model. Compared with the subjective weighting of weighted moving average method, its weighting method based entirely on the historical observations of time series already belongs to the category of machine learning. It can effectively avoid the prediction error caused by subjective cognitive deviation and improve the accuracy of prediction. The establishment steps of the model are as follows:

(i) Taking the number of moving item N and initially assign the weight w_i(i=1,2,…,N);

(ii) For a given time series y_i(i=1,2,…,n), the initial weight is substituted, and the weighted moving average method is used for the first prediction;

$$\hat{y}_{N+1} = w_1 y_N + w_2 y_{N-1} + ... + w_N y_1 = \sum_{i=1}^{N} w_i y_{N-i+1} \tag{1}$$

Where represents the predicted value of phase N+1 and yN+1 represents the historical observation value of phase N+1.

(iii)Calculating the error e_{N+1} of phase N+1 and setting the step factor K;

$$e_{N+1} = y_{N+1} - \hat{y}_{N+1} \tag{2}$$

(iv)Generating a new weight w'$_i$(i=1,2,…,N) according to the weight adjustment formula;

$$w_i^{'} = w_i + 2ke_{N+1}y_{N-i+1} \tag{3}$$

(v)Discarding the first data, introducing a new data, and repeating the process from step (ii) to step (iv);

(vi)Iterating repeatedly until a set of weights with the smallest prediction error is generated, that is, the best combination w^1_i(i=1,2,…,N);

(vii)The prediction of adaptive filtering model for phase t(t=N+1,…,n) is:

$$\hat{y}_{t+1} = w_1^1 y_t + w_2^1 y_{t-1} + ... + w_N^1 y_1 = \sum_{i=1}^{N} w_i^1 y_{N-i+1} \tag{4}$$

2.2 Establishment of modified Brin zone model

(i)Brin belt is divided into upper rail Up , lower rail Dn and Brin belt moving average Mid :

$$Mid = \frac{1}{n} \times \sum_{i}^{n} p_i \tag{5}$$

Where n represents the previous n trading days and p_i represents the share price on the i trading day of these trading days.

$$Up = Mid + m \cdot \sigma \tag{6}$$

$$Dn = Mid - m \cdot \sigma \tag{7}$$

Where m represents the adjustment parameter and represents the standard deviation of σ in the previous n trading days.

(ii)The average value $\overline{p}$ of the prediction of the time series for the next n^* days is supplemented by the correction of the brin zone average, which is recorded as the brin zone corrected average $\overline{Mid}$ after correction.

$$\overline{Mid} = \alpha \cdot Mid + (1-\alpha) \cdot \overline{p} \tag{8}$$

Where α is the adjustment factor $\alpha \in (0,1)$. In the same way, the modified brin belt upper rail and Brin belt lower rail are generated.

$$\overline{Up} = \overline{Mid} + m \cdot \sigma \tag{9}$$

$$\overline{Dn} = \overline{Mid} - m \cdot \sigma \tag{10}$$

3 Result and discussion

3.1 Solution of Adaptive filtering model

Solution of adaptive filtering model for gold

The gold price takes 22 working days a month as a cycle, and takes half a cycle as the number of moving items, i.e. N=11. Therefore, the adaptive model of gold price is:

$$\hat{y}_{t+1} = 0.969y_t + 0.095y_{t-1} - 0.074y_{t-2} - 0.103y_{t-3} + 0.045y_{t-4} + 0.044y_{t-10}$$
$$-0.010y_{t-5} + 0.119y_{t-6} - 0.014y_{t-7} - 0.022y_{t-8} - 0.048y_{t-9} \tag{11}$$

The image is compared for any period of time, the predicted value curve of gold price is very close to the actual value curve, and the response to the change trend is basically the same (as shown in **Fig 1**).

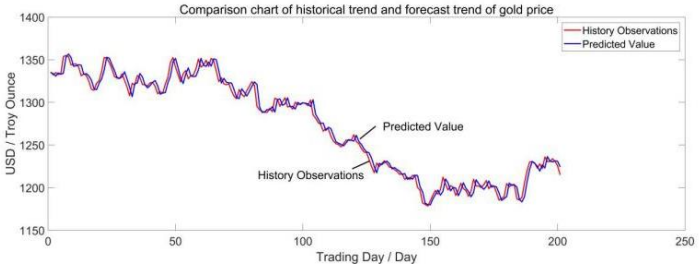

Fig. 1. Comparison chart of historical trend and forecast trend of gold price

(Photo credit: Original)

Solution of adaptive filtering model for Bitcoin

Bitcoin price takes 30 trading days as a cycle, and takes half as the number of mobile items, i.e. N=15. Therefore, the adaptive model of Bitcoin price is:

$$\begin{aligned}\hat{y}_{t+1} &= 0.432y_t + 0.288y_{t-1} + 0.179y_{t-2} + 0.104y_{t-3} + 0.050y_{t-4} \\ &+ 0.019y_{t-5} - 0.003y_{t-6} - 0.013y_{t-7} - 0.002y_{t-8} - 0.001y_{t-9} \\ &- 0.013y_{t-10} - 0.025y_{t-11} - 0.010y_{t-12} - 0.008y_{t-13} + 0.003y_{t-14}\end{aligned} \tag{12}$$

Similarly, the predicted value curve of Bitcoin price is very close to the actual. (as shown in **Fig 2**).

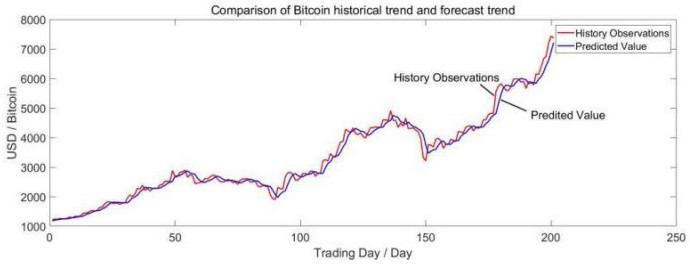

Fig. 2. Comparison of Bitcoin historical trend and forecast trend

(Photo credit: Original)

3.2 Solution of Boll model

Paper takes the start-up funds in the proportion of 8:2 as the first investment in Bitcoin and gold.

Solution of golden Boll model

When investing in gold, take half a cycle to the gold adaptive filtering model as observation, and make a decision on the last day of half a cycle.

Taking α=0.69. Let n* travers 1 to 100, and taking n* with the largest total yield in five years as the final value of n*, so finally take n*=2. After repeating adjustment, it is found that $\alpha \in [0.10,1)$, the model can have obvious feedback on the adjustment coefficient. Some cases are shown in Table 1.

Table 1. Total return gold yield and operation times under different values of α

(Table credit: Original)

Value of α	0.1	...	0.6	...	0.98	...
Total return	0.255	...	0.365	...	0.4	...
Number of operations/Second	47	...	35	...	27	...

It is found that when the adjustment coefficient approaches 0, the operation frequency increases significantly. In stock market, high operating frequency often means that investors need to have

more sensitive control over the stock market and bear more risks. Low operating frequency is by contrary. Therefore, this paper modifies the brin belt model to take into account the individual needs of stock market activists and stock market conservatives.

Under the condition of adjusting the coefficient α=0.69, the specific results are shown in **Table 2**.

Table 2. Return on gold investment when $\alpha = 0.69$

(Table credit: Original)

Total return	0.458
Static yield	0.355
Comparative growth rate	0.291

The final total rate of return is 0.458, the total rate of return on gold standing is 0.355, After the guidance of the revised Bollinger Belt strategy, the comparative growth rate reaches 0.291.

Solution of Bitcoin Boll model

Similarly, when n*=1, the yield is the largest. When $\alpha \in [0.80,1)$ the model can have obvious feedback on the adjustment coefficient, the results show that the closer the adjustment coefficient α is to 1, the higher the total yield of Bitcoin is, and the number of operations required also increases significantly.

The adjustment coefficient is taken as α=0.9, and the investment operation is carried out with the modified brin belt strategy Bitcoin (as shown in **Table 3**). The specific results are shown in **Table 4**.

Table 3. Bitcoin investment operation when $\alpha = 0.9$

(Table credit: Original)

Scale in/Second	142	948	1154
Close a position/Second	633	1123	-

In five years, the optimal investment of Bitcoin can be completed only by 3 positions increased and 2 positions closed, a total of five operations.

Table 4. Bitcoin investment income when $\alpha = 0.9$

(Table credit: Original)

Total return	94.156
Static yield	73.590
Comparative growth rate	0.279

The total return rate of Bitcoin is 94.156, and the total return rate of static is73.590. Under the guidance of the revised brin belt strategy, the comparative growth rate reaches 0.279.

4 Conclusions

This model is the organic combination of adaptive filtering model and Boll strategy. The two models themselves can also be applied to the prediction of other stock markets, and the modified Boll model can be applied to bonds, funds and other industries.

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