Research on the Trading Strategy Model Between Gold and Bitcoin

Zhilin Yao*, Jingdan Su and Jingwen Hu

Weihai Campus, Beijing Jiaotong University, Beijing, 100044

*Corresponding author: yaozhilin220316@163.com

Abstract. In this paper, we build an autoregressive integrated moving average (ARIMA) model and analyze the short-term trends of the gold price (GP) and bitcoin price (BCP) based on historical data. In addition, we use MATLAB to perform statistics and analysis on the data, find that the probability of continuous depreciation or appreciation after day 5 decreases exponentially, and find the maximum and minimum fluctuations. Further, we build a trading strategy model that uses the Apriori algorithm to calculate the number of subsets where prices have risen or fallen for 5 consecutive days. Finally, we perform a sensitivity analysis on the established model.

Keywords: Trading strategy; autoregressive integrated moving average (ARIMA) model; Apriori algorithm; MATLAB.

1. Introduction

With the gradual increase in consumption, simple wages have not met people's living needs. More and more people hope to get extra income through market transactions to subsidize their living. However, high returns also come with an exceptionally high risk, especially when there is insufficient information and predictions. Gold and Bitcoin are investment products in the market, and they have many advantages over common stocks, such as price stability and capital preservation during a recession. During COVID-19, converting cash into gold and bitcoin can be used to hedge against market downturns, thereby reducing losses during recessions [3]. Therefore, forecasting gold price (GP) and bitcoin price (BCP) trends and determining optimal investment portfolios is significant for investors to maximize total returns and minimize losses.

Through searching materials, we found several pieces of research to reveal the role of gold and bitcoin in the market and their relationship. For example, Dyhrberg summarized that bitcoin could be classified as something between the dollar and gold [1]. Su et al. used bootstrap-full and subsample rolling-window Granger causality tests to find the result that the status of gold will not be affected by Bitcoin [4]. They are not a competitive relationship but a complementary relationship. As the price of Bitcoin increases, the value of gold decreases, which is essential for investors to optimize asset allocation and for a state to control the overall financial environment.

Therefore, predicting the future GP and BCP trend and understanding the investment behavior of traders in the corresponding situation is meant for individuals and countries.

In this paper, we build a model to predict the future trend of daily GP and BCP based on price and determine the best daily trading strategy based on the development trend. An analysis of the transaction costs that affect the strategy and revenue results is presented, and an analysis of the sensitivity of strategy to transaction costs.

2. ARIMA Model

The future trend of stock value has a great influence on the decision-making of investors [5]. The future trend is divided into long-term and short-term. In the long-term, investors can see that the stock is in an upward or downward trend through the data of the past few years, so we will only discuss the short-term trend in this paper.

The autoregressive integrated moving average (ARIMA) model is a statistical analysis model that uses past data to predict future values [2]. First, we do a stationarity test to see if the data can be used for the ARIMA model, then we will determine the specific model based on ACF and PACF.

For bitcoin or gold, let y_t denote the current predicted value, *t* indicates that the predicted value is the data on the *t* day, μ is the constant term, p is the order, φ_i is the autocorrelation coefficient, ϵ_i is the error, and θ_i is the parameter that best fits the error term, so we get the formulate as follows:

$$y_t = \mu + \sum_{i=1}^{p} \varphi_i y_{t-i} + \epsilon_t + \sum_{i=1}^{q} \theta_i \epsilon_{t-i}, t \in Z \quad (1)$$

Where $\mu + \sum_{i=1}^{p} \varphi_i y_{t-i} + \epsilon_t$ is used to describe the relationship between the current value and the historical value and use the historical value to predict itself. And $\sum_{i=1}^{q} \theta_i \epsilon_{t-i}$ is concerned with the accumulation of error terms.

First, we assume that the model is *ARMA (p, d, q)*. Since the *t* value in the model is different due to the accuracy and the value that can be obtained, the predicted value varies on the day. In this paper, data from September to early November 2016 will be used as an example to illustrate in detail. When the difference is 0 order, *p'*=0.991>0.05, so we do first-order differencing, *p'*=0.153>0.05, it does not meet the requirements, and data needs to be differentiated again. When the difference is 2 orders, *p'*=0.033<0.05, which meets the requirements and means that the series is a stationary time series, so d is equal to 2.

Then we draw the ACF and PACF diagram to determine the specific model. As shown in Fig. 1 and Fig. 2, both the ACF chart and the PACF chart are tailed, indicating that we need to use the *ARMA* model, excluding *AR* and *MA* models. According to the observation of the graph and combined with the AIC information criterion, we find that the optimal parameter is p=2, q=1.

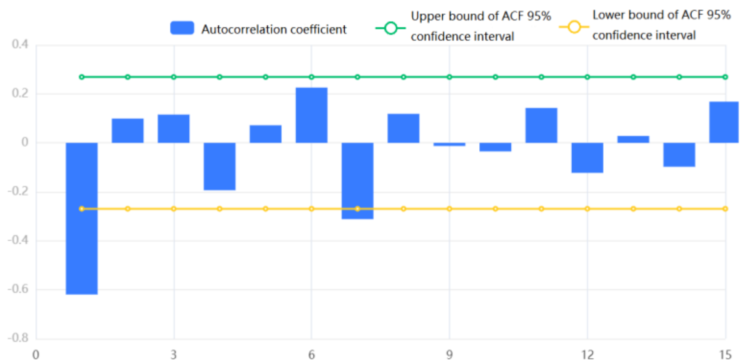

Fig. 1 Bitcoin's ACF chart in September-November 2016

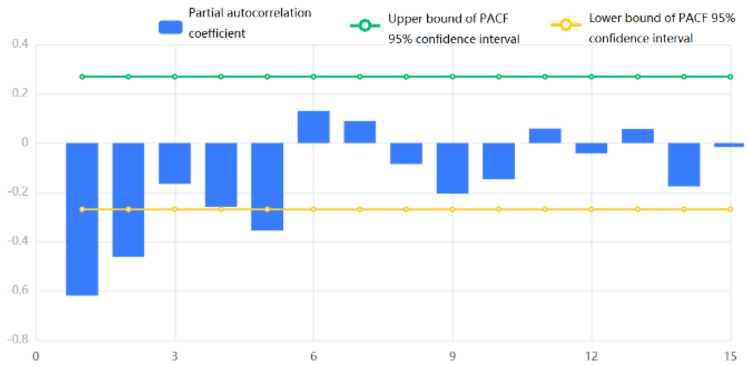

Fig. 2 Bitcoin's PACF chart in September-November 2016

Thus, we determine our model as ARMA (2, 2, 1). We came up with the following equation.

$$y_t = 0.103 - 0.413 * \mathrm{y(t-1)} - 0.299 * \mathrm{y(t-2)} - 0.999 * \epsilon(\mathrm{t}-1) \quad (2)$$

We drew the fitting curve and the trend of data changes in the next seven days, which is shown in Fig. 3. The price of bitcoin will show an upward trend in the next seven days.

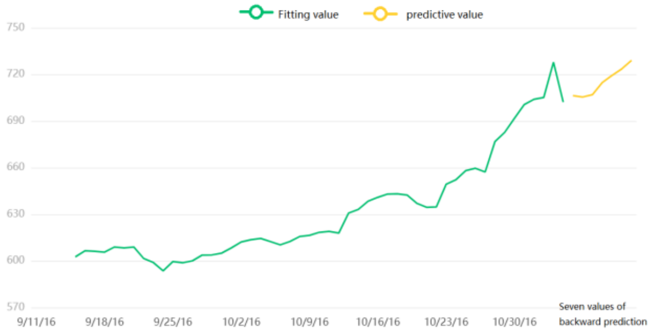

Fig. 3 Fitting curve and trend in the next seven days

3. Trading Strategy Model

For investors eager for precise trading, it is unrealistic and uneconomical to buy and sell all assets every time for price changes because it also involves commission issues and the recovery of value after a short-term decline. Therefore, it is necessary to design a transaction model that can adapt to the vagaries of value to determine the volume of each transaction.

The formulation of the trading strategy needs to be determined from two aspects. One is to discuss the number of times the investment target is out or added when it appreciates or depreciates, respectively; another determines the amount to increase or decrease the position. A trading strategy model based on historical fluctuations can be obtained from these two aspects.

The price inertia of the trading market determines that the prices of financial products tend to change continuously in the same direction in the short term. According to historical price data, the process of obtaining price changes for two consecutive days through MATLAB. According to the statistical results, the likelihood of ongoing depreciation or appreciation after the fifth day drops rapidly and becomes very minimal. As long as it considers the circumstance of 5 consecutive days of ups and downs, more than 90% of the instances can be handled, as shown in Table 1.

Table 1. Five-day ups and downs of gold and bitcoin prices

	GOLD		BITCOIN	
	Appreciation	Depreciation	Appreciation	Depreciation
2 Days	362	298	510	351
3 Days	188	156	169	154
4 Days	101	85	144	74
5 Days	50	47	79	29
6 Days	28	25	79	29
7 Days	14	10	43	9

Further, filter and analyze the data to obtain the parameters required to build the model, which is shown in Table 2.

Table 2. Parameters related to the continuous rate of change of gold and bitcoin

Accumulated change	Bitcoin		Gold	
Decline	Median	-5.36%	Median	-1.43%
	90%	-17.43%	90%	-3.68%
	10%	-1.08%	10%	-0.53%
Increase	Median	6.69%	Median	1.50%
	90%	19.06%	90%	3.57%
	10%	1.53%	10%	0.43%

To maximize profit regardless of a crash, savvy investors can buy at the lows and sell at the highs. Here Apriori algorithm is adopted to tackle the position adjustment model. When successive depreciations are predicted to occur, ideally, the magnitude of each depreciation is the same, and its cumulative decline is M, divided into μ times. For adding positions, dividing it into multiple times can effectively avoid risks, so let the number of distributed positions P be n.

Undoubtedly, when a losing streak occurs, the first few additions in position will cause the investor's equity to decrease until the price recovers. However, when the gold or bitcoin returns to the value-added range, its investment will generate dividends from the last time it is added. Therefore, in order to minimize the impact of the partial depreciation of the position increase, we make the price begin to return to positive after the last position increase, and the benefits it brings are precisely equal to the assets lost in the previous positions, as follows:

$$P_n m^+ + \sum_{i=1}^{n-1} \left(\frac{m^-}{\mu}\right)^i P_{n-i} = 0 \tag{3}$$

On this basis, as long as the initial addition amount or the total amount of the position addition is limited, the position adjustment model under this restriction can be obtained, and an exponential growth model can be acquired.

$$y = ae^{bn} \tag{4}$$

Taking gold trading as an example. For a conservative estimate, let m^+ be the 10% ratio of the cumulative increase ${m_{0.1}}^+$, and m^- be the 90% ratio of the cumulative decline ${m_{0.9}}^-$. μ is the highest general cumulative number of declines, here is 5, and the number of positions to increase is equal to μ. Randomly take $P_1 = 100$, which is shown in Fig.4.

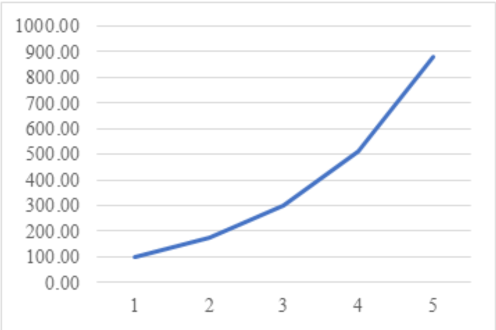

Fig. 4 Gold trading

The fitting equation is:

$$y = 58.125e^{0.5443n} \tag{5}$$

Where $R^2 \approx 1$.

On the contrary, experienced investors will take a step-by-step approach to sell their shares when the value rises gradually. The same conservative estimation is made. It is estimated that m^- is the cumulative decline rate of 10% ${m_{0.1}}^-$ and m^+ is the cumulative increase rate of 90% ${m_{0.9}}^+$. Remaining other parameters are unchanged, which is shown in Fig.5.

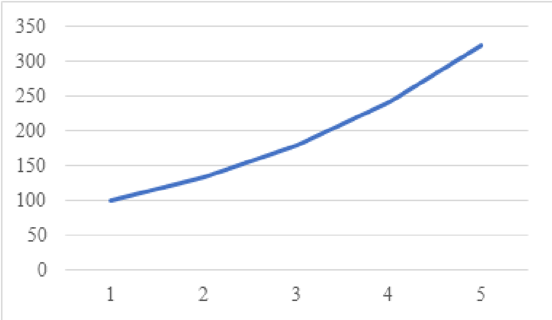

Fig. 5 The trend of rising prices

The fitting equation is:

$$y = 74.399e^{0.2936n} \tag{6}$$

On this basis, the position adjustment model of gold under normal circumstances is obtained. It is worth noting that in each transaction, the trader needs to pay α% of the transaction amount as the transaction cost. However, this does not affect the calculation of the position management model at this stage. Because it is not difficult to see that after considering it, according to the multiplication rule, the actual result is still obtained.

$$P_n(1-\alpha\%)m^+ + \sum_{i=1}^{n-1}\left(\frac{m^-}{\mu}\right)^i P_{n-i}(1-\alpha\%) = 0 \tag{7}$$

In particular, when a small probability event, such as the continuous rise or fall of the value of gold or Bitcoin, we will not be able to continue to use the previous model. At this time, a targeted adjustment trading strategy should be implemented. In the short term, and when the numbers are small, there is a very high similarity between exponential functions and polynomials of a high degree. It turns out that a quartic polynomial can get a high enough match for replacement.

According to P_1 to P_5, the equivalent quartic polynomial is obtained by fitting. If the number of consecutive fluctuations is greater than 5, which can be expressed as:

$$y = an^4 + bn^3 + cn^2 + dn + f \tag{8}$$

When gold and Bitcoin first started trading, since investors did not know the future direction of the value of the two, the total investment was divided into two halves and divided into μ to consider the problem of multiple positions. Therefore, the initial investment amount of both of them is set as:

$$P_g{}^+ = \frac{P_0}{2\mu} \tag{9}$$

Moreover, since the number of consecutive declines μ for both is 5, the initial investment in gold and bitcoin is set at \$100 at the beginning. After that, according to the estimated trend and the position management model, the amount of each increase and decrease is obtained. Based on the research background and MATLAB programming software, we can build a scientific automated investment plan based on the investment strategy model.

First of all, unlike Bitcoin, gold is traded at intervals, and the program can analyze whether the gold market is in a trading period before trading. In addition, for each transaction, whether buying or selling bitcoin or gold, the trader must pay the transaction cost α. When buying, deduct the increased amount P from the cash, and increase the assets of $P(1-\alpha)$ in the corresponding investment product. When selling, the investment product reduces assets worth P, and the investor gets

$P(1-\alpha)$ in cash. The program also needs to judge the cumulative number of ups and downs to determine whether it is necessary to recalculate the amount of the increase and whether there are more than 5 consecutive ups and downs so that the fitting formula can be used to increase or decrease the position continuously. Finally, the results of each trade are recorded, allowing traders to understand their overall return.

After the result is obtained, the value of the transaction cost α or the initial capital P_0 can be changed many times to obtain the influence of the transaction cost on the investment and sensitivity analysis results. In summary, the whole modeling process can be shown in Fig.6.

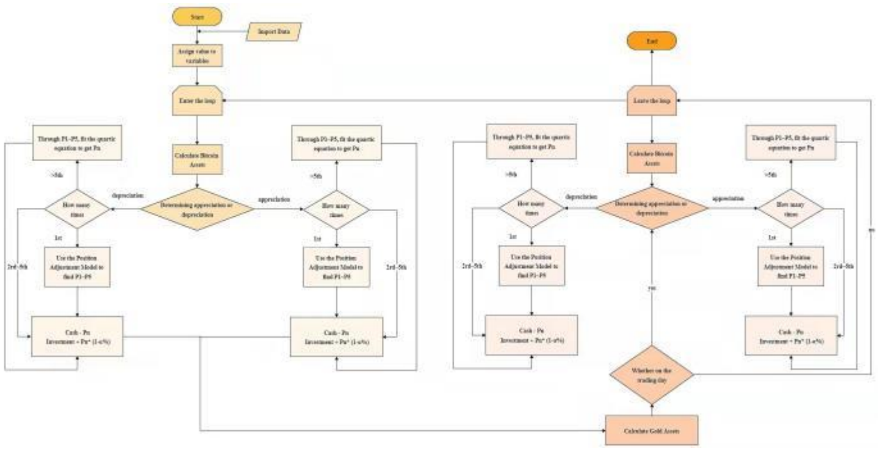

Fig. 6 Modeling process

4. Sensitivity Analysis

In Fig. 7, we plot the variation curves of different transaction costs α and initial funds. As can be seen from Fig.7, it is not difficult to find that although transaction costs have an effect on the magnitude of the curve change and the value of each point, the effects are generally parallel to each other and do not affect the essence of the model. The same situation also occurs in the example of the change of the initial capital. If the ordinate is erased, it is almost impossible to see that these are two curves with different parameters.

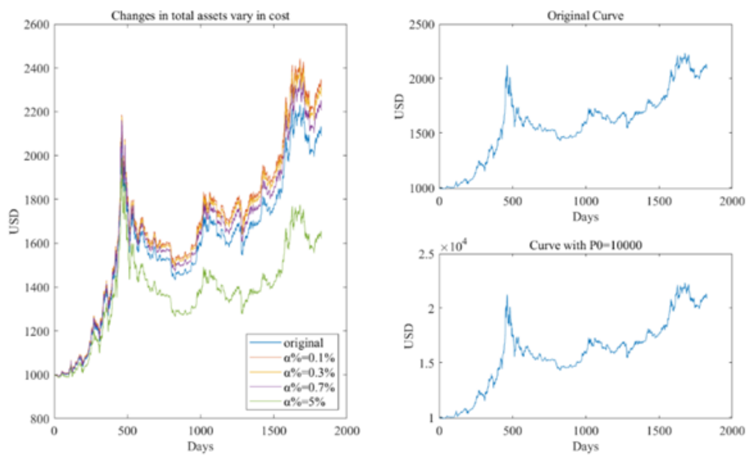

Fig. 7 Curves with different parameters

The results show that the return on investment will increase as transaction cost decreases, and increasing transaction cost or initial amount will not affect the investment trend. It is demonstrated the importance of correct model building for investment profitability. The analysis results are consistent under various parameters, which proves the rationality and robustness of the trading strategy model.

Transaction costs also have a specific impact on our earnings. To see their relationship more intuitively, we did a sensitivity analysis of transaction costs and calculated the daily average earnings under different commissions. Changes in commissions will also lead to trading strategies, and our analysis shows that the general trend is that the lower the commission, the higher the average return. While our model can have some implications for financial investment, it is risky to treat it as the overall standard. After all, the economic environment is ever-changing. Like a butterfly flapping its wings can also bring about a hurricane at the right time, many factors can affect the rise and fall of the stock market. Exponential addition and reduction of positions can undoubtedly reduce risks, but at the same time, do not forget to pay attention to changes in the entire social environment and see the reasons behind the data through intricate factors, such as the epidemic and national policies.

We refer to the Apriori algorithm to build a long-term profitable investment strategy model. We not only considered the response strategy of the value up and downtrend in the short-term five days but also considered the small probability events.

Our strategy estimates the maximum probability of rising and falling times and models based on this. For special low-probability events, we extend our model utilizing fitting. It turned out that with our strategy, we could more than double our profits after five years. In addition, through the sensitivity test, our model achieves a high rate of return while also having strong stability, which is not easily disturbed by the external financial environment, such as transaction costs and investment amount.

5. Conclusion

In this paper, we establish the ARIMA model, which can predict the price of any day in a given period and make predictions to different degrees according to the amount of data collected. Additionally, we build a trading strategy model that uses the Apriori algorithm to calculate the number of subsets where prices have risen or fallen for 5 consecutive days. Finally, using extensive sample data to evaluate corporate strategies scientifically improves decision-making accuracy. Sensitivity tests show that the model is robust and can adapt to different investment environments.

References

[1] A. H. Dyhrberg, Bitcoin, gold and the dollar–A GARCH volatility analysis, Finance Research Letters, 2016, 85-92.

[2] A. Hayes, Autoregressive Integrated moving average (ARIMA). Investopedia. 2022, from https://www.investopedia.com/terms/a/autoregressive-integrated-moving-average-arima.asp

[3] N. Reiff, Gold vs. bitcoin: Which is better? 2022, from https://www.investopedia.com/news/should-you-buy-gold-or-bitcoin/

[4] C. W. Su, M. Qin, R. Tao, X. Zhang, Is the status of gold threatened by Bitcoin? Economic research-Ekonomska istraživanja, 2021, 33 (1), 420-437.

[5] T. I. Team, How does the performance of the stock market affect individual businesses? 2022, from https://www.investopedia.com/ask/answers/042215/how-does-performance-stock-market-affect-individual-businesses.asp