

# Gold-Bitcoin Trading Strategy Based on Time Series Modeling

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**Abstract.** Market traders often earn income by buying and selling assets through market transactions with the goal of maximizing total returns. Since each asset purchased has a certain amount of gain and loss, traders need to develop a trading strategy, which may affect their total profit. In the case of gold and bitcoin, this paper develops an ARIMA daily price forecasting model and a trade strategy model based on price increases to help market traders develop optimal trading strategies for gold and bitcoin.

**Keywords:** ARIMA; Gold; Bitcoin; Trading Strategies.

## 1. Introduction

With the prevalence of globalization in the world economy, various economic problems in market trading have become a stumbling block to the economic development of the world today. In the process of market trading, stocks are commonly sought after by market traders. As a kind of securities, stocks can be transferred, bought and sold, and are a long-term credit instrument in the trade market. The goal of the market trader is to maximize profits through various means, the most common of which are buying and selling, where there are commission returns and losses. Gold and Bitcoin are two such assets [1].

We were given data on the price of gold and bitcoin (USD) from November 9, 2016, to October 9, 2021. On each trading day, a trader will have a portfolio consisting of cash, gold, and bitcoin [C, G, B] in USD, troy ounces, and bitcoin, respectively. The initial state is [1000, 0, 0]. The commission for each transaction (purchase or sale) is  $\alpha\%$  of the transaction amount. Assume  $\alpha = 1\%$  and  $\alpha = 2\%$ . There is no cost to hold the asset. Notice that Bitcoin can be traded daily, while gold can only be traded on open days (Monday through Friday). In this paper, we will develop a mathematical model that uses only past daily prices to determine whether a trader should buy or sell an asset in his or her portfolio. The best trading strategy for each day will then be given based on the price data up to that day [2].

## 2. Daily price prediction model based on ARIMA

To forecast the stock prices of gold and bitcoin for the current day through the previous day's data, we built a Daily Price Prediction Model for prediction and fitting based on the ARIMA model. After checking its reasonableness, we can predict the price of the day as required by the question based on this model [3].

To meet the needs of the ADF Test, a minimum of 10 samples per prediction is required to meet the number of valid samples in the ARIMA Model. To meet the test needs and the validity of the test, we chose to start predicting the data from day 25 based on the results after our testing.

Based on the above reasoning, we make the following steps:

(1) We collect data on the market value of Bitcoin and gold in the first 25 days.

(2) Then we sequentially use the ARIMA Model on  $n(n \geq 25)$  day to predict the data from day  $n+1$  to  $n+3$ :



$$\nabla^d P_t (t = 1, 2, 3, \dots, n) \tag{7}$$

2) After performing the difference once, we conclude that this time series has been smoothed by performing the ADF Test and the KPSS Test again. Then the number of differences is derived:

$$d = 1 \tag{8}$$

(5) To carry out the fixed order of the model: we use PACF (partial auto-correlation function) for auto-regression on the time series after being performed the difference (linear regression). The regression equation is:

$$\nabla^1 P_t = c + \phi_1 \times \nabla^1 P_{t-1} + \phi_2 \times \nabla^1 P_{t-2} + \dots + \phi_p \times \nabla^1 P_{t-p} + \varepsilon_t \tag{9}$$

( $\nabla^1 P$  is the observation at moment  $Y_t$  of the time series,  $\phi_i$  is the coefficient obtained by optimizing the model on the training data,  $\varepsilon_t$  is the residual at the moment  $t$ , and  $c$  is the constant term of the model)

(6) We perform a moving average of the time series using the ACF (auto-correlation function). The formula is:

$$\nabla^1 P_t = c + \varepsilon_t + \theta_1 \times \varepsilon_{t-1} + \theta_2 \times \varepsilon_{t-2} + \dots + \theta_q \times \varepsilon_{t-q} \tag{10}$$

(7) The auto-regressive moving average model is obtained. The formula is:

$$\nabla^1 P_t = c + \phi_1 \times \nabla^1 P_{t-1} + \phi_2 \times \nabla^1 P_{t-2} + \dots + \phi_p \times \nabla^1 P_{t-p} + \varepsilon_t + \theta_1 \times \varepsilon_{t-1} + \theta_2 \times \varepsilon_{t-2} + \dots + \theta_q \times \varepsilon_{t-q} \tag{11}$$

Then we can derive the values of  $p$  and  $q$  simultaneously.

(8) Use the `iddata` function to convert the data into data that can be recognized by the `armax` function, and then use the `armax` function to find out the value of AIC. The formula for calculating the AIC criterion is as follows:

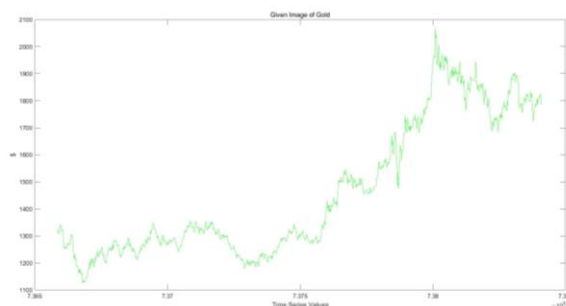
$$AIC = 2 \times (\text{Number of parameters in the model}) - 2 \ln \text{The great approximation function of the model} \tag{12}$$

(9) We choose the model with the minimum value of AIC and then perform the prediction of order  $d$ . Finally, we then perform a reduced difference and use the prediction trend to return the results from day 1 to day 2 of the prediction, taking the results of day 2 as the value of the prediction graph.

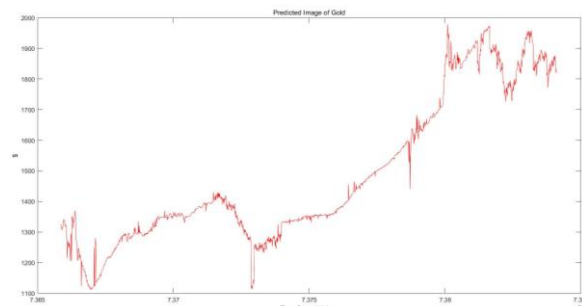
### 3. Daily Price Forecast

#### 3.1. Gold price

Based on the ARIMA model, we improved on it to derive the Daily Price Prediction Model. Based on the analysis, filtering and modification of the error values, we derived the daily price prediction data of gold, and then we used MATLAB software to plot the original and predicted images of gold price, as shown in Figures 2 and 3:



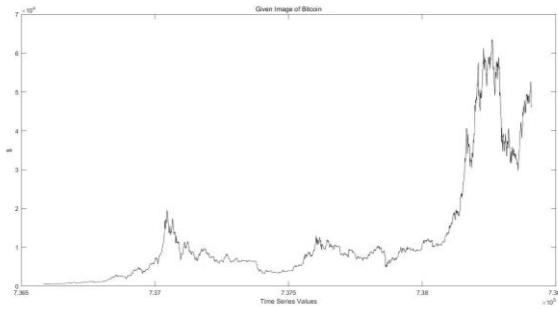
**Fig. 2** The Given Image of Gold



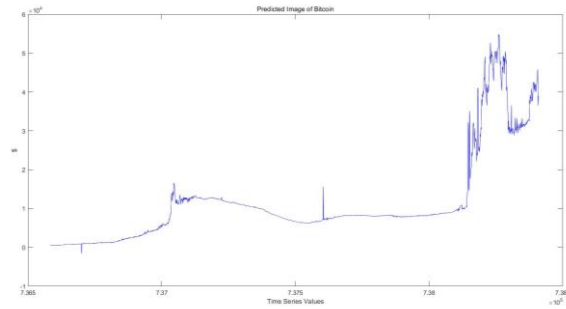
**Fig. 3** The Predicted Image of Gold

### 3.2. Bitcoin price

Based on the ARIMA model, we improved on it to derive the Daily Price Prediction Model. Based on the analysis, filtering and modification of the error values, we derived the daily price prediction data of bitcoin, and then we used MATLAB software to plot the original and predicted images of bitcoin price, as shown in Figures 4 and 5:



**Fig. 4** The Given Image of Bitcoin



**Fig. 5** The Predicted Image of Bitcoin

## 4. Best Trading Strategies

Based on the movement of the price increase, we modeled the trading strategy on the daily gold and bitcoin price increases to come up with the best trade strategy [5]. The model is as follows.

Note: Use an array  $d$  to mark the dates when the gold market is open as 1 and the dates when it is not open as -1.

(1) In the first 25 days, we use the Equal Weight Model for decision-making. Since gold is not open on the first day and the value of an ounce of gold is greater than the cash owned on the second day, gold is not considered in the equal weighting model on the first day. The formula of the model is

$$\sum w_i = \frac{1}{n} = \frac{1}{2} \tag{13}$$

That is, spend  $\frac{1}{2}$  of the cash  $c$  to buy bitcoin on the first day.

The cost of buying bitcoins is.

$$c_{b1} = \frac{1}{2}c \tag{14}$$

The remaining cash is

$$c_1 = 1000 - c_{b1} - \%1 \times c_{b1} \tag{15}$$

The number of bitcoins owned is

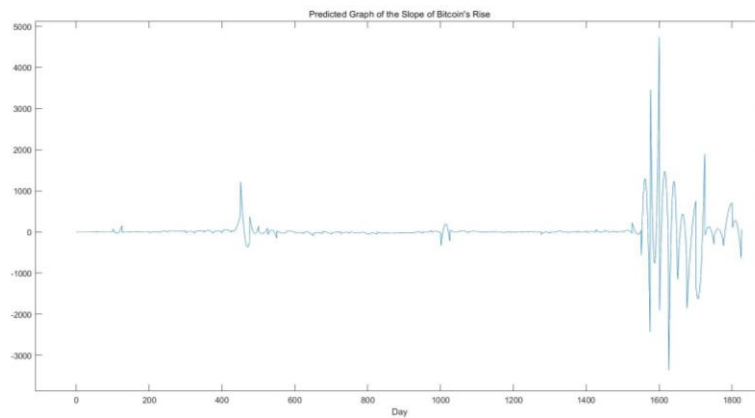
$$i_{b1} = \frac{c_{b1}}{P_{b1}} \tag{16}$$

(2) After 25 days, at day  $n$  ( $n = 25, 26, 27, \dots, 1826$ ), based on the price data of bitcoin and gold at day  $n+1$ ,  $n+2$ ,  $n+3$  predicted by the ARIMA Model, we find the approximate slope of the increase of bitcoin at day  $n$  for the next three days and the approximate slope of the increase of gold at day  $n$  for the next three days according to the equation:

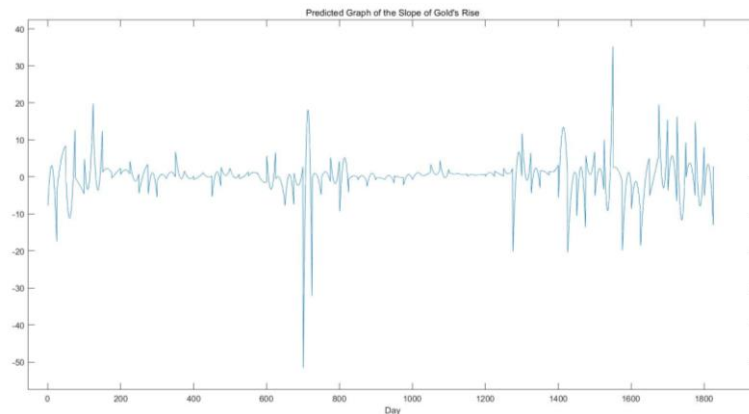
$$k_{bn} = \frac{\frac{P_{bn+1} + P_{bn+2} + P_{bn+3} - P_{bn}}{3}}{\frac{n+1+n+2+n+3}{3} - n} = \frac{\frac{P_{bn+1} + P_{bn+2} + P_{bn+3} - P_{bn}}{3}}{2} \quad (17)$$

$$k_{gn} = \frac{\frac{P_{gn+1} + P_{gn+2} + P_{gn+3} - P_{gn}}{3}}{\frac{n+1+n+2+n+3}{3} - n} = \frac{\frac{P_{gn+1} + P_{gn+2} + P_{gn+3} - P_{gn}}{3}}{2} \quad (18)$$

We can find the approximate slope of the rise of bitcoin on day n over the next three days  $k_{bn}$  and the approximate slope of the rise of gold on day n over the next three days  $k_{gn}$ . The image of  $k_{bn}$  and the image of  $k_{gn}$  are shown in Figures 6 and Figure 7.



**Fig. 6** Predicted Graph of the Slope of Bitcoin's Rise



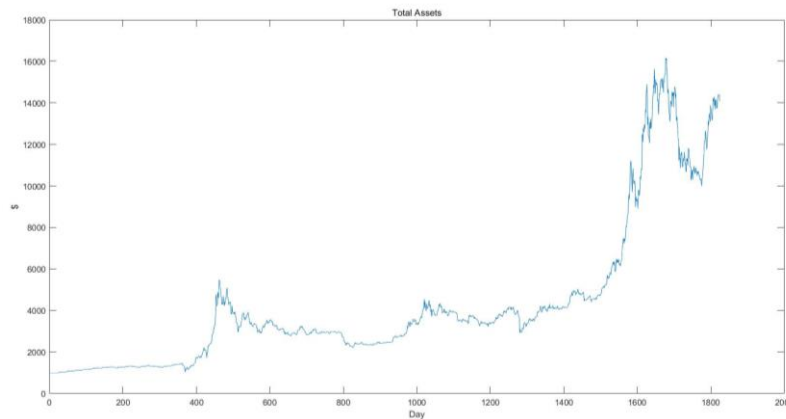
**Fig. 7** Predicted Graph of the Slope of Gold's Rise

(3) There will be four cases for the slope of the rise on day n ( $25 \leq n \leq 1826$ ).

(4) Based on the equation:

$$TA_n = c_n + P_{bn} \times i_{bn} + P_{gn} \times i_{gn} \quad (19)$$

We can calculate the total assets at day n and plot a line graph, as in Figure 8.



**Fig. 8** Total Assets

And we can calculate the total assets owned on the last day: **\$14100.48**.

## 5. Summary

In this paper, on the one hand, an ARIMA-based daily price prediction model is developed, which is very simple and requires only endogenous variables without resorting to other exogenous variables; and it is more accurate in its prediction of data. However, it requires time data to be static or stable after differencing; it can only capture linear relationships by itself but not nonlinear relationships; and it requires a large amount of data to provide a forecasting basis for the model.

On the other hand, this paper establishes a trade strategy model based on price increase, which can improve the accuracy of prediction based on the future slope; and it can reduce the risk value of the decision based on the accuracy of the prediction of the previous data, making the decision more secure. However, it relies too much on past data and requires a large amount of data to provide the model with a basis for prediction. In this paper, it is used as a decision-making model, which is more subjective, and the standard setting is not reasonable enough.

## References

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