

Measurement of Trading Strategy Based on Model

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Abstract

In the changing capital market environment, every trader pursues profit maximization. Based on the historical price of investment products, traders make trading moves that maximize their portfolios.

In this paper, several models are established: Model 1: Moving Average Model; Model 2: HPY Model-Calculate the Holding Profit Rate. We also utilized some economic models such as Expected Return on Investment Model to better express our opinions.

We use the moving average model, set the moving average, test the optimal moving average cycle by the way of moving average, and assume the two cases of full investment in BTC and gold, judge the buy and sell trading signals of BTC and gold, and get the maximum profit rate. Next, we use the previous evidence. By comparing methods A, B and C, we worked out the situation with the highest return of gold and BTC and formulate investment strategies. In addition, we explain the relevant information of income from the point of view of economics. Finally, we find out that the sensitivity analysis shows that the algorithm has strong robustness in the case that the average model established by us receives changes in the proportion of commission, and has no impact on the strategy made by the model, but affects the results.

Keywords: Bit-con, gold, portfolio, diversification, risk

1. Introduction

1.1 Problem Background

The recent financial market environment has prompted investors to explore innovative investment opportunities. Traders seek the maximum return they can get by buying and selling different combinations of investment assets. From the perspective of investment, BTC is more like a "high-volatility" tactical asset, while gold is a tried-and-true strategic investment. COVID-19, geopolitics, loose global monetary policy and other uncertainties are all contributing to volatility in capital markets, which brings value fluctuation of gold and BTC. In the past, BTC's price rise has been accompanied by significant volatility and downside risk. Meanwhile, as an international precious metal investment product, gold market price changed rapidly. If traders can effectively buy and sell portfolios based on historical price movements of gold and BTC, they will achieve the goal of maximizing profits. Therefore, it is necessary to develop a strategy for evaluating the purchase and sale of investment assets.

1.2 Restatement of the Task

Considering the background information and restricted conditions identified in the problem statement, we need to accomplish the following objects:

Analysis the two data files (*LMBA-GOLD* and *BCHAIN-MKPRU*) about the historical market value of gold and BTC respectively, to construct model and establish the best trading strategy. Use our investment strategy to predict the market value of \$1000 on September 10, 2021.

Reasonable argument: Our strategy is the best strategy.

Analyze the sensitivity of transaction costs according to our best strategy and determine how our strategy and outcome will be influenced by transaction costs.

1.3 Literature Review

Portfolio diversification has been a hot topic of discussion in recent years and there is no doubt that society will be open to investment products in the future. As the development of digitization, citizens will have greater acceptance of "digital gold".

Statistically, BTC brings significant diversification benefits. As BTC's low correlation with other assets has resulted in a reduction in overall portfolio risk, these reductions have not been offset by BTC's high volatility (Symitsi, E., & Chalvatzis, J. K., 2019). The empirical results show that gold is better for portfolio diversification because it reduces portfolio risk more effectively. On the other hand, BTC increases risk level as it creates higher returns (Pho, K. H., et al., 2021). BTC-based portfolios are dominated by the gold-based portfolios. In the financial market, gold plays an important role. Gold tends to turn to quality investments in times of market distress, whereas BTC has a positive correlation with falling markets. The research results of Jing-Ping Li et al. show that BTC has a tendency to dramatically improve the risk-return profile of investors. Once BTC is included as an investable asset, the efficiency that will be on the rise at the efficiency front becomes obvious (Li, J.-P., et al., 2021).

Moreover, we've also known that financial pressures in the US exchange market and the Chinese stock market greatly affect the market value of BTC, while gold is mainly influenced by financial stresses in the U.S. exchange market. These results are important for investors and policy makers to make decisions in times of uncertainty (Zhang, H.-W., & Wang, P.-J., 2021). For a long time, most investors preferred gold as the most stable investment. BTC, known for its high risk and high returns, is gradually becoming gold's strongest rival, however. Therefore, one of the key concerns for investors is how to conduct an efficient portfolio and strategy to maximize returns.

1.4 Our Work and Model Overview

The work we have done in this problem and our model are mainly shown in the following figure.

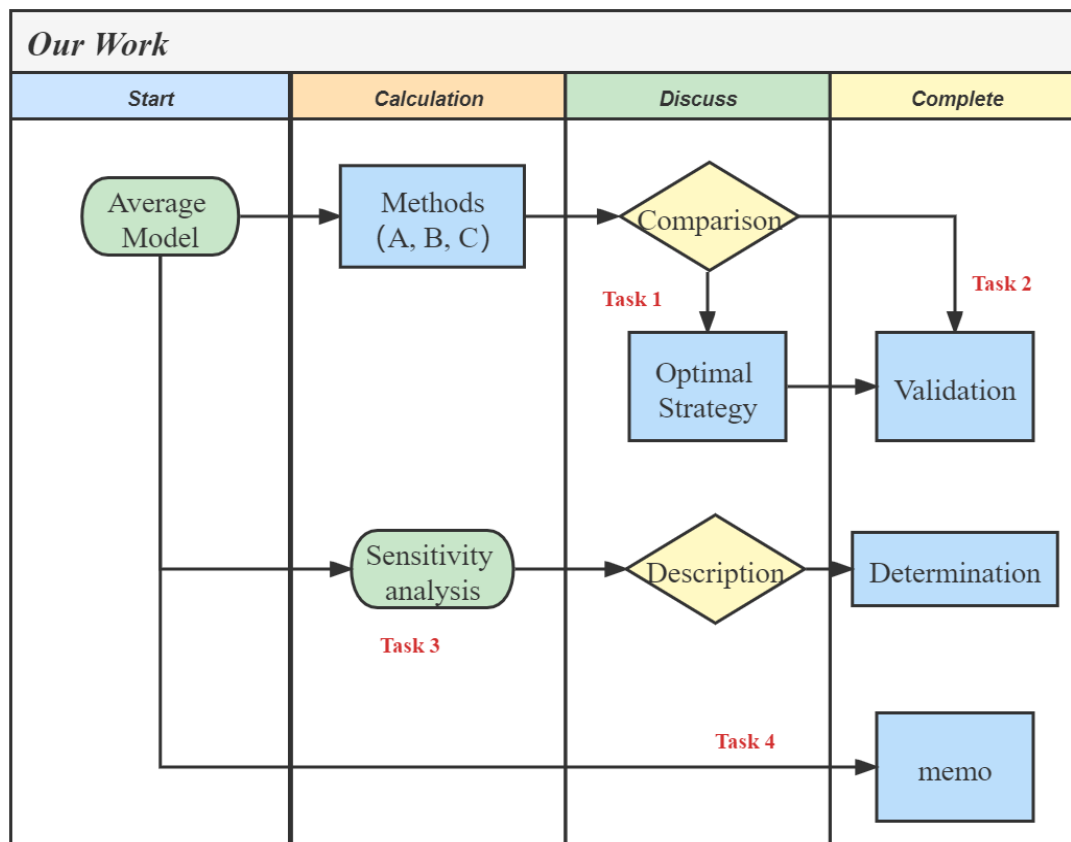


Figure 1. The structure

2. General Assumptions and Explanations

In the process of problem solving, there is not only the gap between theory and practice, but also different influences of major and minor factors. Thus, it is necessary to take these facts into full consideration and make reasonable assumptions when building the model. The assumptions are listed as follows:

Assumption 1: The data source is valid and there is no error in the statistical process.

Assumption2: Assuming that there is no artificial manipulation of the stock market's direction, everything appears to be random.

Assumption 3: Ignore other external factors, such as market supply and demand, financial events, only consider the price of the decision.

3. Model Preparation

3.1 Notations and Definitions

3.1.1 Notations

The key mathematical notations used in this paper are listed in Table 1.

Table 1. Notations used in this paper

Symbol	Description
	The price of BTC on the day
	The price of gold on the day
MA _k	The k day's average price of BTC for the day
MA _k	The k day's average price of gold for the day
GOLD_Aver _α	Gold price moving average parameter with a period of α days
GOLD_DIF	The difference between the short-term 13-day average and the long-term 21-day average of gold prices
GOLD_DEA	GOLD_DIF's 8-day average
GOLD_MACD	Twice the difference between GOLD_DIF and GOLD_DEA
BTC_Aver _β	BTC price moving average parameter with a period of β days
BTC_DIF	The difference between the short-term 13-day average of BTC prices and the long-term 21-day average
BTC_DEA	BTC_DIF's 8-day moving average
BTC_MACD	Twice the difference between BTC_DIF and BTC_DEA
	Interest rate of day i

Note: Some variables that are not listed in the table will be discussed in the specific sections.

3.1.2 Definitions

MA: Moving average. MA is a technical index used to observe the trend of stock price changes by averaging the stock price (index) in a certain period and connecting the average values of different times.

Opportunity cost: Another income forgone when a given resource is used to obtain a given income.

BTC: BTC.

3.2 The Data

3.2.1 Data Observation

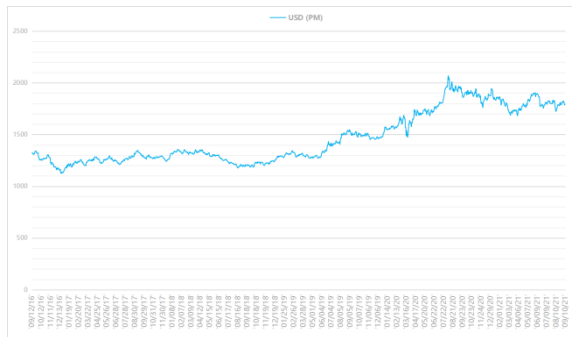


Figure 2. Price trend of BTC

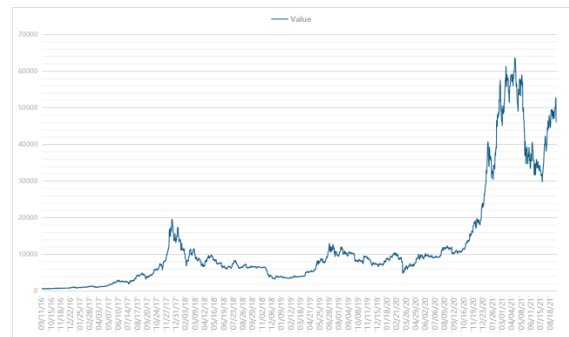


Figure 3. Price trend of gold

We took a preliminary observation at the provided data set and made pictures of BTC and gold price trends. The figure shows that BTC’s value fluctuated from 0USD to about 6400USD, while gold’s price stayed between 1200 to 2200. And BTC’s peaks and troughs are much more visible than gold’s.

We conclude that BTC prices have been more volatile than gold.

Then we observed the correlation of BTC and gold’s price and the coefficient is 0.649, which means there is a positive correlation. The correlation is not obvious, however.

Table 2. Matrix of correlations

Variables	(1)	(2)
(1) value	1.000	
(2) usdpm	0.649	1.000

3.2.2 Data Pre-processing

To smooth the modeling process, we do the normalization work of the date in DATE FILES and summarize the data in one-to-one correspondence according to the time. Furthermore, in some specific processes such as calculating for correlation coefficients between Bit-coin and gold, once some days were not trading days for gold, we remove the data of investments on those days in order to find the exact correlation.

4. Task 1: Trade Decision Model

4.1 Model Establishment

4.1.1 Establishment of the Model

According to the requirement, we need to create a model illustrating a portfolio of gold and BTC, with decrease represents the selling action and the increase represents the buying action. Based on the price data set (as shown in Figure 4) and trading strategies given in the question, we make the following explanations for the establishment of MA model:

- (1) We adopt the principle of "moving average" in economics, and can intuitively reflect the trend of the current trading price according to its smoothness, stability and characteristics of rising and falling.
- (2) According to the 5-day, 13-day and 55-day moving averages, the intersection of these 3 lines and price K line forms different moving averages models.
- (3) Using the average model, we can judge trading signals according to the intersection between the averages, determine whether to buy or sell investment transactions, and find out the best investment opportunity.
- (4) Through the idea of our average trading model, we can realize the visual output in the trend market, better

track the trend of BTC and gold trading prices, and bring investors higher returns.



Figure 4. BTC and GOLD trading price trends

4.1.2 The Solution of the Model

Based on the above ideas, we solve the problem of how to efficiently and reasonably test the initial investment value of \$1000 starting from October 9, 2021 with only historical price data according to the ema model. The request mentioned that the commission for each transaction (purchase or sale) costs $\alpha\%$ of the amount traded. Assume $\alpha_{gold}=1\%$ and $\alpha_{bitcoin}=2\%$. For computational convenience, we order that $\alpha=1$. The analysis steps are as follows:

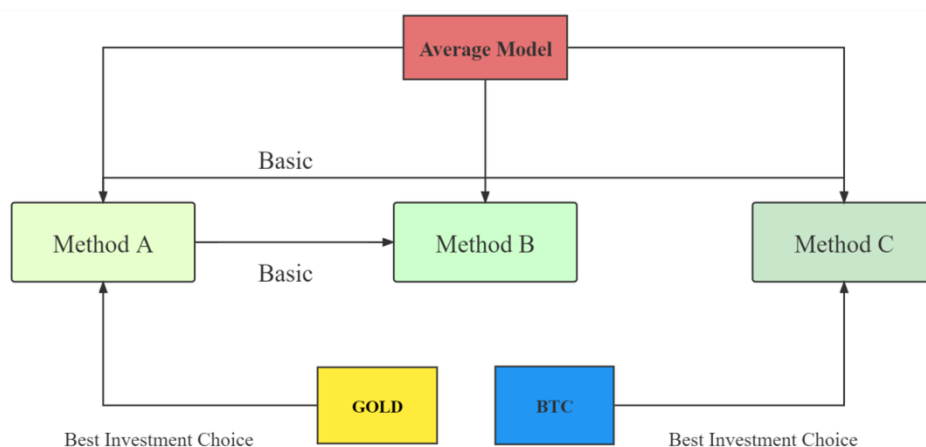


Figure 5. Diagram of the construction steps of the model

Step 1: Method A

We use moving averages to decide buy and sell actions. As shown in Figure 6 and 7, we select the 5-day, 13-day and 55-day moving averages of BTC and gold. We buy when the price just exceeds the average and sell when the price just falls below the average. Meanwhile, we need to consider the impact of transaction costs. Sell all your investments on the last trading day. Its formula is expressed as follows:

Buy signal: Sell signal:



Figure 6. Trend of BTC price and averages

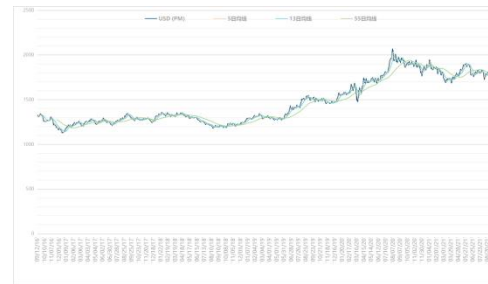


Figure 7. Trend of GOLD price and averages

According to the above content, we took MA cycle as a variable, tested the corresponding profit margin, and finally selected the MA cycle corresponding to the maximum profit margin as the optimal MA cycle. We defined this method method A.

Assume that the two situations of investing all in BTC and all in gold are analyzed:

(1) Invest all money in BTC

Traversing MA cycle 5~233, when MA cycle 123, the maximum profit margin is 8123.56%.

(2) Invest all money in gold

When the MA cycle is 655, the maximum profit margin is 38.55%.

Step 2: Methods B and C

We improve on the first step: when buying and selling are only judged by an average, all trading days before the first buy date are chosen to wait.

Assuming that the average period is N, the corresponding first buy date is the trading day. Since there is no MA for the previous (n-1) trading days, buy and sell judgments can only be made from the trading day.

Assumption: For the last (n-1) trading day, if the average price is the average of all the prices on the trading day and before, then we can decide buy and sell from the first trading day. In this case, there are two methods (B and C):

Method B:

decide the buy and sell behavior from the first trading day, continue (in this process, the trading day may not be the buy date), and sell all the investment product on the last trading day (Figure 8).

(1) Invest all in BTC

Traversing the MA period from 5 to 233, when the MA period is 134 or 135, the maximum profit margin is 9643.56%.

(2) Invest all in gold

When the MA period is traversed from 5 to 999, the maximum profit margin is 10.53% when the MA period is 578.

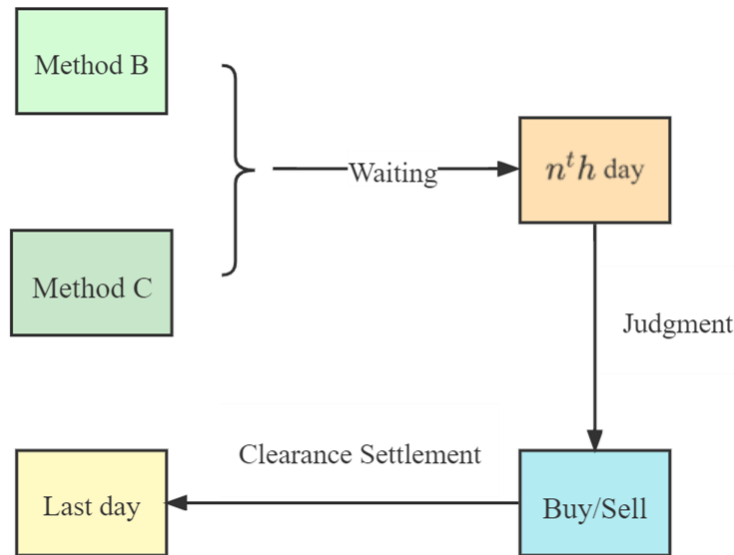


Figure 8. Method Operation Diagram

Method C:

Decide the buy and sell from the first trading day, sell all investment product on the trading day, wait until the trading day to buy, continue, and sell all investment product on the last trading day.

Analysis of full investment in BTC and full investment in gold:

(1) Fully invest in BTC

When MA cycle 5~233 is traversed, when MA cycle 123, the maximum profit margin is 10619.99%.

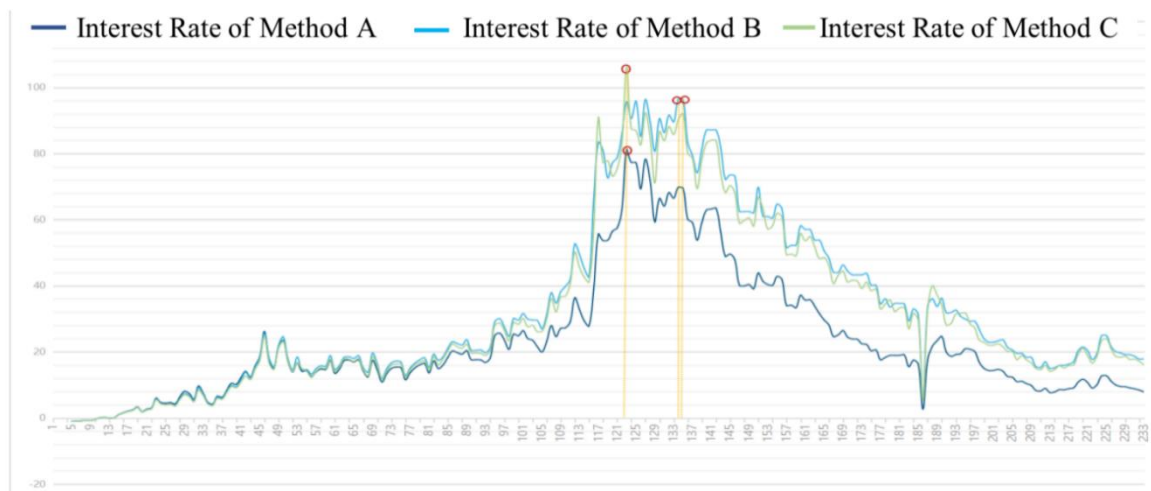


Figure 9. All Invest BTC

(2) Fully invest in gold

When the MA cycle is 983, the maximum profit margin is 14.19%.

As shown in the figure above, according to method A, B and C, we conclude that:

the maximum profit rate of BTC: 10619.99% > 9643.56% > 8123.56%,

the maximum profit rate of gold :38.55% > 14.19% > 10.53%.

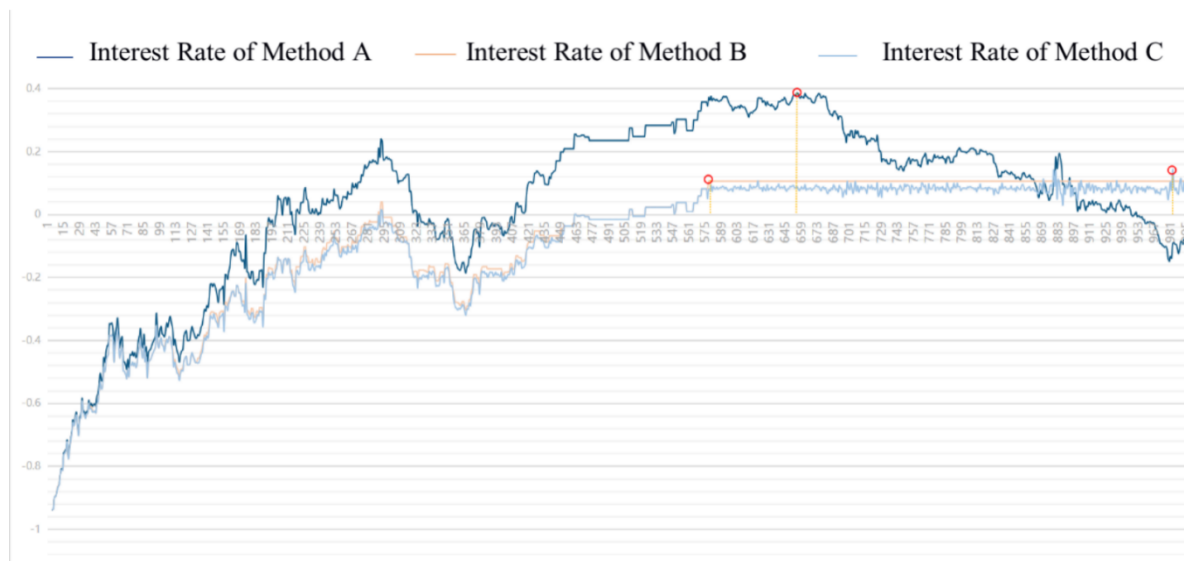


Figure 10. All Invest GOLD

Therefore, if you invest in BTC, you should choose method C with MA period of 123, and if you invest in gold, you should choose method A with MA period of 655.

Step 3: Predict the best strategy

The duration of open position is all the time that the asset has been held, and the final yield (i.e., the maximum profit margin) divided by the duration of open position is the one-day open yield. The single-day position returns of fully invested BTC (method C, MA cycle 123) and fully invested gold (Method A, MA cycle 655) were calculated respectively:

Analysis of full investment in BTC and full investment in gold:

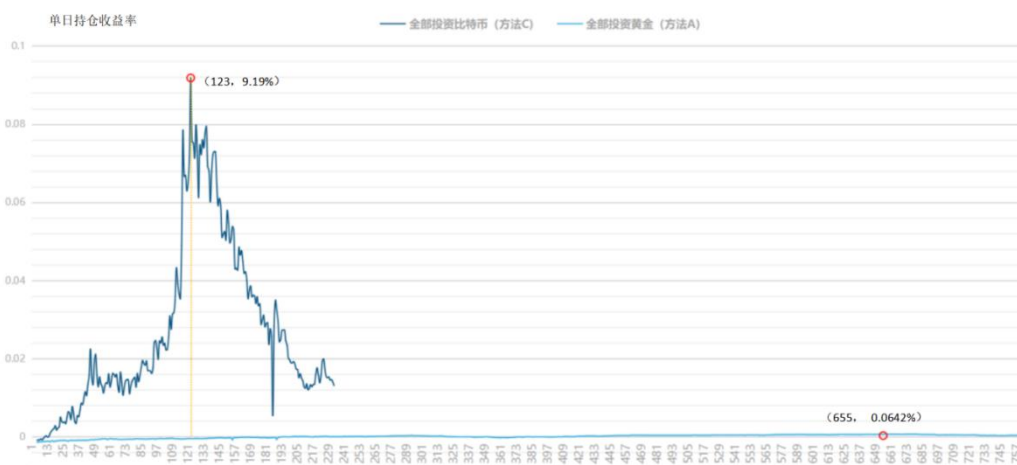
(1) Fully invest in BTC

One-day open position yield = 9.19%

(2) Fully invest in gold

One-day open position yield = 0.0642%

Since BTC and gold prices are positively correlated over time, the correlation coefficient is 0.6495. And $9.19\% \geq 0.0642\%$, it can be concluded that the optimal investment share should be BTC 100%, gold 0%.



4.2 Decision Result

According to the above, we can invest all BTC according to method C, set MA cycle as 123, and all trading dates (including buy date and sell date) are shown in the following table:

Table 3. BTC Trading Dates

Buy Date	Sell Date
09/18/16	09/19/16
09/30/16	05/16/10
06/16/10	10/17/01
11/17/01	03/24/17
03/27/17	01/30/18
02/18/18	02/22/18
05/18/03	06/18/03
07/23/18	01/18/08
02/18/09	05/18/09
03/15/19	09/22/19
01/15/20	09/20/03
04/30/20	09/24/20
09/25/20	05/13/21
07/21/08	10/21/09

Therefore, we set to invest all \$1000 in BTCs -- that is, buy all BTCs on the calculated buy date, sell all BTCs on the calculated sell date, and do not buy or sell any other days. According to this trading strategy, we can get the investment value:

$$IV = BIC + BIC \times R_{max} \quad (1)$$

According to Formula (1) and combined with the optimal investment strategy, we get the initial investment value of \$1000 starting from October 9, 2021:

$$(10619.99\%+1)*1000=107199.9 \text{ USD}$$

5. Task 2: Why it is a Reasonable Model

5.1 Accuracy Testing and Analysis

The strategy was to invest the entire \$1,000 in BTC, traversing the range for each moving average for a profit margin, and setting the moving average at 123 days.

In our solution of Task1, we calculated that the investment profit rate of BTC and gold in three different trading method, and the result is:

$$10619.99\% > 9643.56\% > 8123.56\%, 38.55\% > 14.19\% > 10.53\%$$

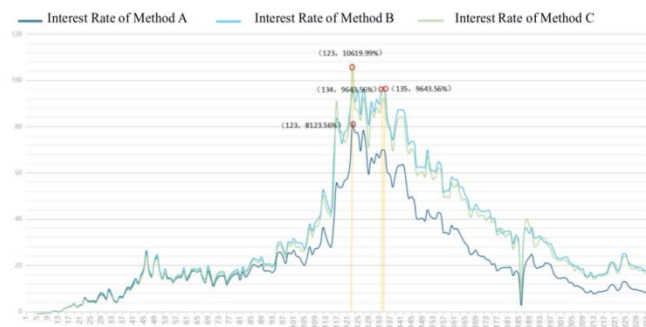


Figure 11. The profit margin-invest all the money in BTC: based on MA cycle

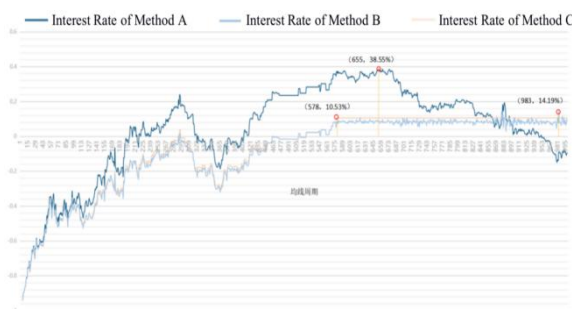


Figure 12. The profit margin-invest all the money in gold: based on MA cycle

The highest interest rate is the strategy of using all the asset to buy BTC and the optimal average period of BTC is 123.

If trader makes a sell and buy judgment from the first trading day, sell all the investment product on the trading day. After that, he waits until the trading day and buy on that day. Then continues this action, sell all assets on the last trading day, the maximum profit rate he will get is 10619.99%.

5.2 Views in Economic Terms

Based on the theory of opportunity cost, we explain the rationality of the model from economics.

After calculating the interest rate of BTC and gold of various periods, we draw a conclusion that BTC has much higher profit margin than gold.

Obviously, profits on BTC investments show very high volatility, but also very high returns. In our model, the diversified portfolio reflected can be seen as the low correlation between BTC and other assets (gold) to compensate for the high risk. Based on BTC's highly volatile nature, including even a small portion of BTC in a diversified portfolio has the potential to dramatically improve the risk-reward profile. As a virtual currency, BTC values need to be taken seriously by traders.

For the expected return of investment asset and interest on asset portfolio

$$E(r_p) = \sum_{j=1}^m E(r_j)A_j,$$

where $E(r_p)$ is the expected profit rate of asset j , A_j is the weight of asset j in the total asset, m is the number of types of assets in a portfolio.

We can assume that gold and BTC are two products with different rates of return in the formula. A portfolio should be configured to both enhance returns and reduce aggregate risk. By choosing to invest in BTC, you are abandoning some of your other stable and low-risk strategy of investments. People often pay attention to the explicit cost, but the silent cost is also worth paying attention to. From the perspective of opportunity cost, since BTC is characterized by higher returns and higher risks, gold is characterized by lower returns and lower risks than BTC. If you invest in gold, you're forgoing BTC's gains, and gold's gains are likely to be much smaller than BTC's. Similarly, if you choose to invest in BTC, the return of BTC may be more and larger than that of gold.

But the opportunity cost of choosing BTC is that we would have gotten gold's profit, which is far less than that of BTC. Therefore, investors should have an accurate understanding of opportunity cost.

6. Task 3: The Sensitivity of the Strategy to Transaction Costs

6.1 The Basic Logic of Sensitivity Analysis

The stability of the stock market is closely related to macroeconomic development. Macroeconomic fluctuations affect different assets such as BTC and gold, and volatility risks are easily spread. The stock market is a complex system with a certain operating cycle, and even the importance of BTC and gold to the stock market occupies an important position in the whole modeling process.

Risk appetite in global financial markets has shifted sharply under the influence of macro and micro market liquidity and policy factors. As stock market volatility deepens and BTC falls sharply, gold can be a hedge against big risks. Gold prices tend to rise when stock markets fall or the economy grows too fast. Different investment portfolios differ in risks and returns, and there is a certain interaction between stock market and gold price. However, investors should take all factors into consideration and formulate reasonable investment strategies when judging the trend of gold. Therefore, the essence of our modeling of BTC and gold in the financial market through the MA model is to map the operating rules of the stock market cycle through the historical information of the market, and then make a predictive investment on the future price fluctuations of BTC and gold in the market.

We use the moving average cycle model to test the sensitivity of BTC and gold under different commission conditions by increasing or decreasing the percentage of commission. This method is used to verify the rationality of the constructed index system and determine the sensitivity of the moving average model to different data sets. Test the sensitivity of BTC and gold under different commission conditions by increasing or decreasing the percentage of commission. After calculating the moving average period, we divided it into two groups according to the analysis data type: BTC data and gold data. By changing the α parameter one by one, we tested whether the moving average period corresponding to the maximum profit rate changed significantly.

6.2 Sensitivity-Decision Results

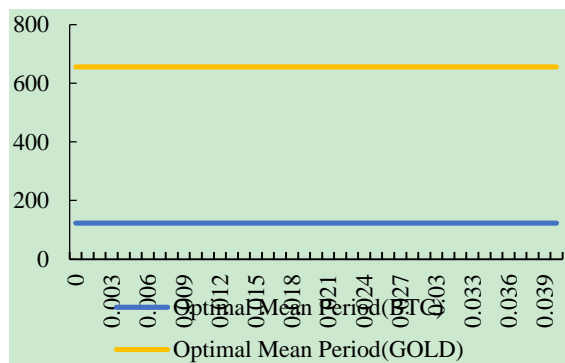


Figure 13. Optimal Mean Period Charts

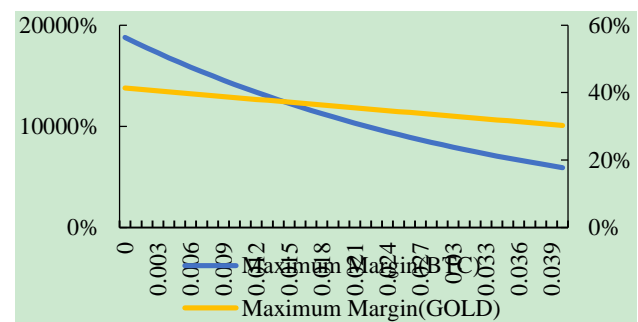


Figure 14. Maximum Margin Trend Charts

We assume that the transaction cost ratio is $\alpha\%$ and set the fluctuation range of parameter α at $(0,0.04)$. The results verified by Python are shown in the figures below:

From Figure 13, we can clearly see that although the commission ratio of BTC and gold fluctuated, the average period chosen for this model does not change. The optimal average period of BTC is 123, and the optimal average period of gold is 655. Figure also shows straight lines, which means that the strategy made by this model is not sensitive to the transaction costs of BTC and gold. Therefore, its sensitivity coefficient is not high. Assuming that the rate of change of commission proportion is 0.01, the calculation formula is as follows:

where is the sensitivity coefficient of the mean cycle indicator to factor, is the rate of change of the uncertainty factor of transaction costs (%), and is the rate of change of the mean cycle indicator when the uncertainty factor changes by (%).

From the above equation, we concluded that its sensitivity is 0. Also, our model has no effect on the strategies made by constructing the model based on the data obtained in the case of receiving a change in the commission

percentage, which also proves the strong robustness of our model.

Figure 14 shows a decreasing trend, which indicates that the maximum profit margin gradually decreases as the commission ratio increases. It indicates that the change in transaction costs affects its results. For example, the larger its transaction costs, the smaller the final result (where since the investment ratio between BTC and gold is 100%:0, the final result = 1000*maximum profit margin, which means that the final result varies equally with the maximum profit margin). In short, fluctuations in commission rates do not affect their strategy, but do affect the outcome.

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