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Research on the Best Investment Strategies for Gold and Bitcoin

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Abstract

In this paper, we have developed some models to study the best investment strategies for gold and Bitcoin from 2016 to 2021. Specifically, we calculated the mean squared error by establishing an long short term memory (LSTM) forecast model. Furthermore, by building the Markowitz model and using the dynamic programming equations, the optimal strategy for the model under consideration is derived, and the optimal strategy is derived from the model. Finally, a sensitivity analysis of the model was performed.

Keywords

Long Short Term Memory (LSTM) Forecast Model; Markowitz Model; Dynamic Programming; Sensitivity Analysis.

1. Introduction

Under the current background of continuous development of computer technology and the expansion of market transactions, the Internet has brought massive amounts of data to the market. These data reflect the price data of assets and the constant changes in value, bringing great reference information to investments [1]. The difficulty in getting direct reference information on accurate trends is also a huge challenge for market traders. However, if information is used wisely and the data is used to guide the investment, the return and stability of the investment will go up significantly.

Specifically speaking, getting daily prices for gold and bitcoin provides an opportunity to build models for investments. In order to make better use of the data, analyzing and predicting price trends becomes key to investing. For maximizing total returns, it is also important to choose a defined metric for investing and disinvesting [2]. Moreover, investments are subject to certain risks such as price fluctuations, so sticking to one single asset in front of different assets is often not the best choice and requires capital allocation and capital flows among different assets to minimize risk. This requires analysis based on known data and continuous improvement of the model to get an optimal trading strategy that makes the highest final return.

In this article, we use long short term memory (LSTM) to train and test data, build predictive models, and visualize them. Further, the mean square error (MSE), root mean square error (RMSE) and other data are calculated. Applying Markowitz's portfolio theory to get the optimal portfolio. In addition, an analysis of stability investment risk and sensitivity is carried out.

2. LSTM Forecast Model

With the development of financial markets, standards for quantitative finance are also increasing day by day. In this background, machine learning algorithms have begun to grow vigorously in quantitative finance. Recent cases reported here illustrate that machine learning algorithms can do better, such as stock forecast, and calculate risks [3].

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LSTM is a variant of the RNN algorithm. LSTM solves the vanishing gradient problem by setting input gates, forget gates, output gates, and hidden layers which include memory blocks (cells). The mechanism of cells of LSTM roughly is shown in Fig.1.

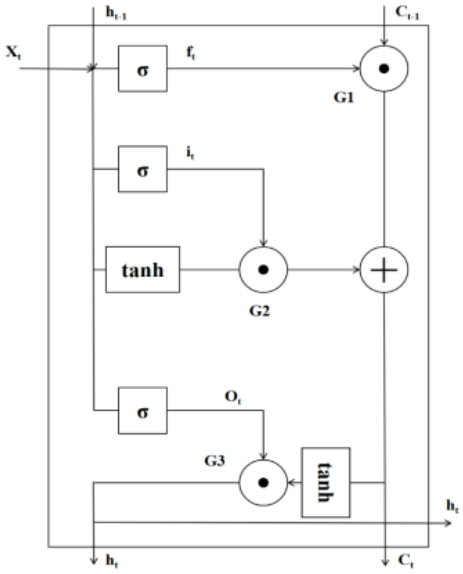

Figure 1. LSTM Mechanism

We will use the values during the period from 2016 to 2018 as a training set and the values during the period from 2019 to 2021 as a test set. So our $1,000 deal will start from 2019-1-1 to 2021-9-11. After training, we can get the prediction result of gold and bitcoin, which is shown in Fig.2 and Fig.3.

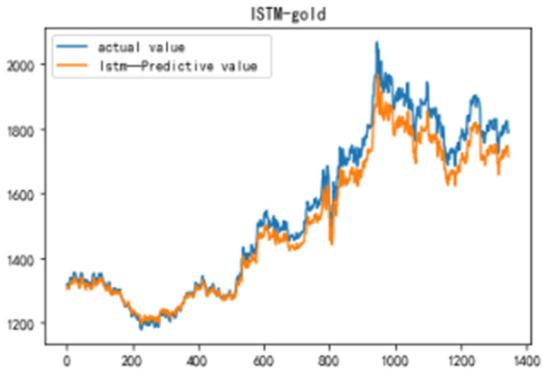

Figure 2. The prediction result of gold

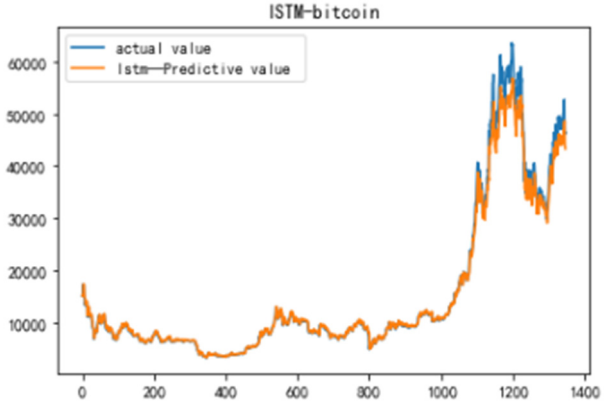

Figure 3. The prediction result of bitcon

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The function of MAE is:

$$MAE(X,h) = \frac{1}{m}\sum_{i=1}^{m}\left|x_{pre} - x_{test}\right| \quad (1)$$

where x_{pre} is predicted from the training set and x_{test} is actual value from test set.

3. Markowitz Model

Previous studies mostly defined short-term trading as refers to those trading strategies in a market in which the time duration between entry and exit is within a range of few days to few weeks, which means that the market is volatile and easily influenced. Compared to the gold market, the bitcoins market is a short-term market [4].

And in order to make more comprehensive and rational decisions, we have to add a few indexes to help us. So it is necessary here to introduce the rate of expected return exactly what is defined as:

$$\frac{r_{end} - r_{start}}{r_{start}} \quad (2)$$

So, we set the calculation period of bitcoin s rate of expected return as five days, while the period of gold is two weeks(14 days). Then we predict the rate of expected return by LSTM model. Meanwhile, we calculated the daily gain of bitcoin and gold and predicted it, which is shown in Fig.4 to Fig.7.

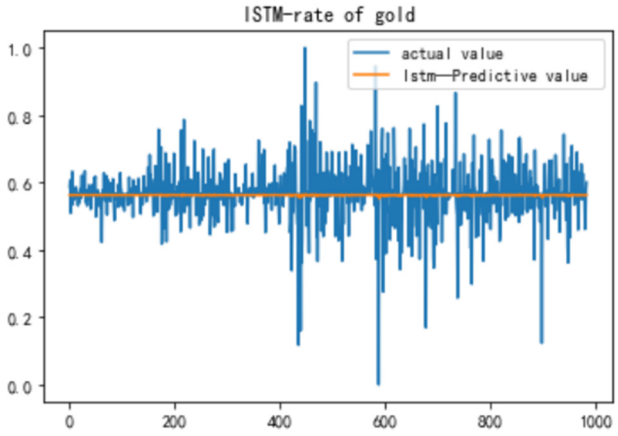

Figure 4. The daily gain of gold

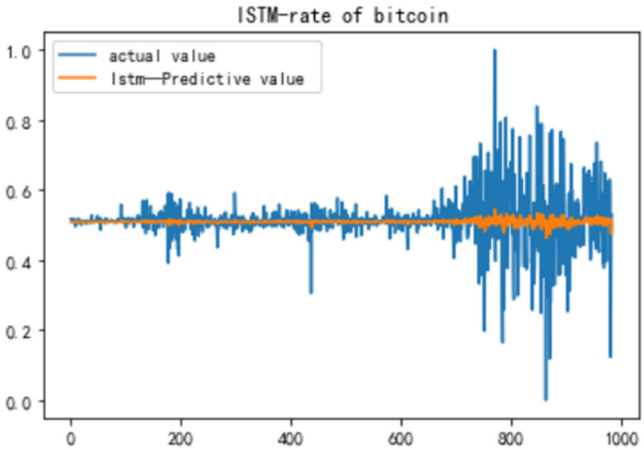

Figure 5. The daily gain of bitcoin

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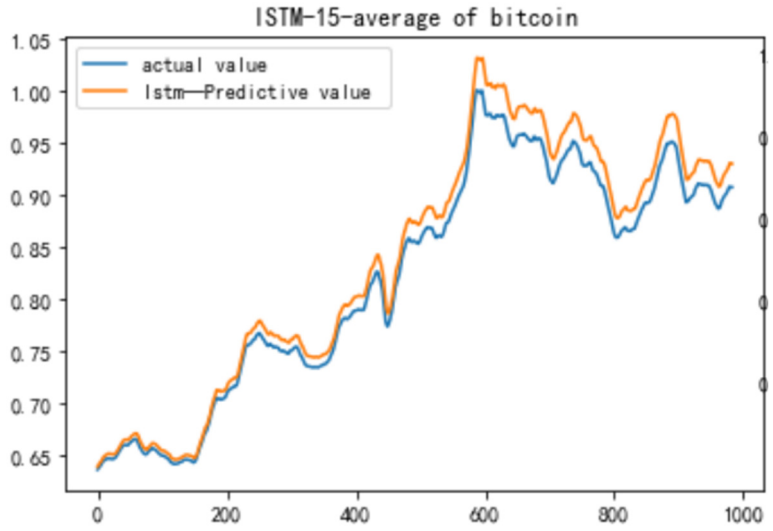

Figure 6. 15-days average price of bitcoin

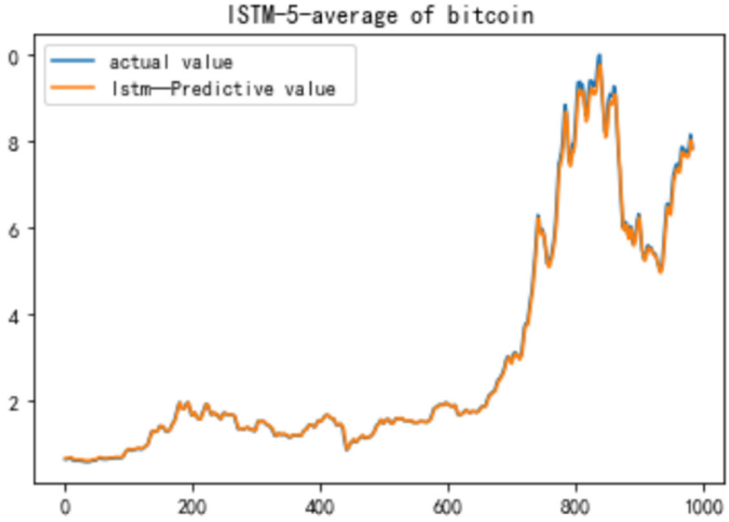

Figure 7. 5-days average price of bitcoin

As we know, gold and bitcoin are both risk assets. Therefore, in order to prevent the influence of some factors, the actual results may deviate greatly from the prior estimates of the parties, resulting in economic losses. We also have to take the risk into account, so we introduce here the Mean-Variance Model and Sharpe Ratio.

The Sharpe Ratio is a measure of investment performance, which can be expressed as:

$$\text{SharpeRatio} = \frac{E(r_p) - r_f}{\sigma} \tag{3}$$

where $E(r_p)$ is rate of the yearly expected of the portfolio, r_f is the rate of the yearly expected return of risk-free investment. And σ is the standard deviation of the portfolio.

At the same time, we are going to introduce the Markowitz Model (the HM model). The HM model is a portfolio optimization model, which can assist in the selection of the most efficient portfolio by analyzing various possible portfolios of the given securities and adjusting the rate of different investments [5].

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About bitcoin-gold market we the rate of yearly returnof gold is r_g , while w_g is weight and the rate of yearly return is r_b, weight is w_b, which is shown in table 1. The change curve of the obtained results is shown in Fig. 8 to Fig. 10.

Table 1. The rate of different investments

2019	$r_g = 0.178, r_b = 0.886$
2020	$r_g = 0.235, r_b = 10694$
2021	$r_g = -0.062, r_b = 1.061$

Then, we can derive variance and expectation of each rate of expected return, which can be expressed as:

$$\mathrm{E}(r_p) = w_g r_g + w_b r_b \tag{4}$$

$$\mathrm{Var}(r_p) = w_b^2 \mathrm{Var}(r_b) + w_g^2 \mathrm{Var}(r_g) + 2 w_b w_g Cov(r_b, r_g) \tag{5}$$

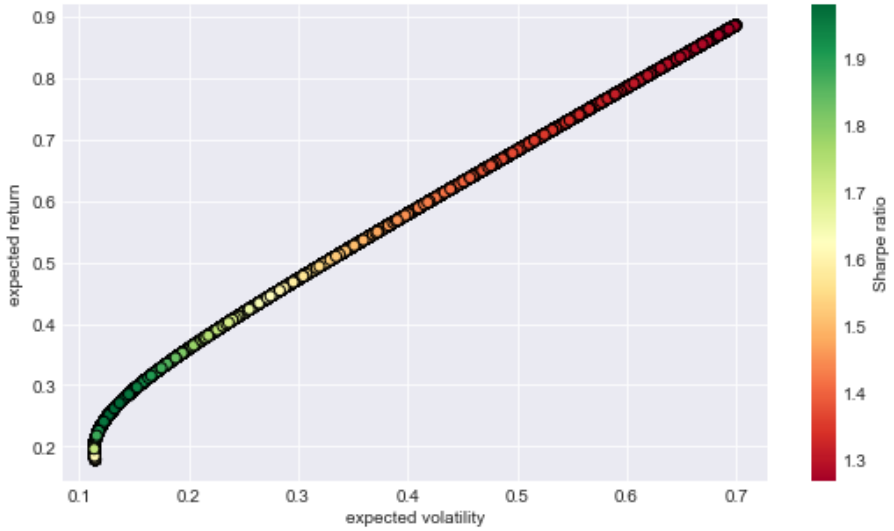

Figure 8. 2019

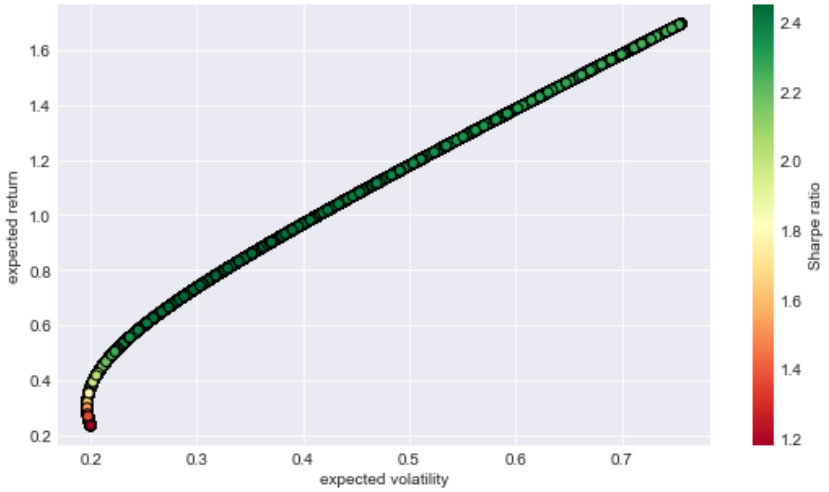

Figure 9. 2020

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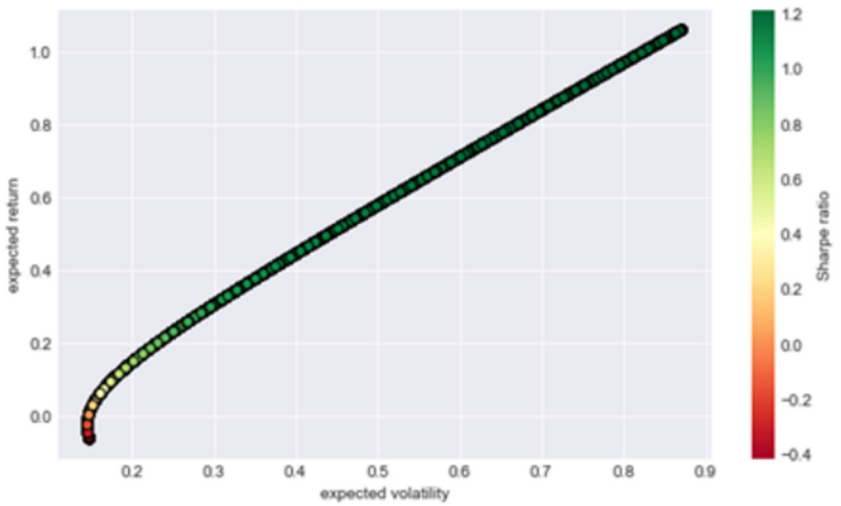

Figure 10. 2021

Then we trade according to the optimal investment configuration, use the greedy algorithm to calculate the maximum profit.

4. Dynamic Programming

Since the value of gold and bitcoin changes daily, it is difficult to make a static investment, one that requires only one investment at a given time and one withdrawal later. Faced with a daily changing value, we can only predict the next day's price action based on all the data available as of that day, thus deciding on the day's asset liquidity, while not wasting as many trades as possible to make each trade valid given the commissions. Specifically, we take one day as a trading cycle and continuously solve the optimal solution according to the trading strategy of the day, and simplify the calculation of the final optimal solution by solving the sub-problem, which is the dynamic programming algorithm we use [6].

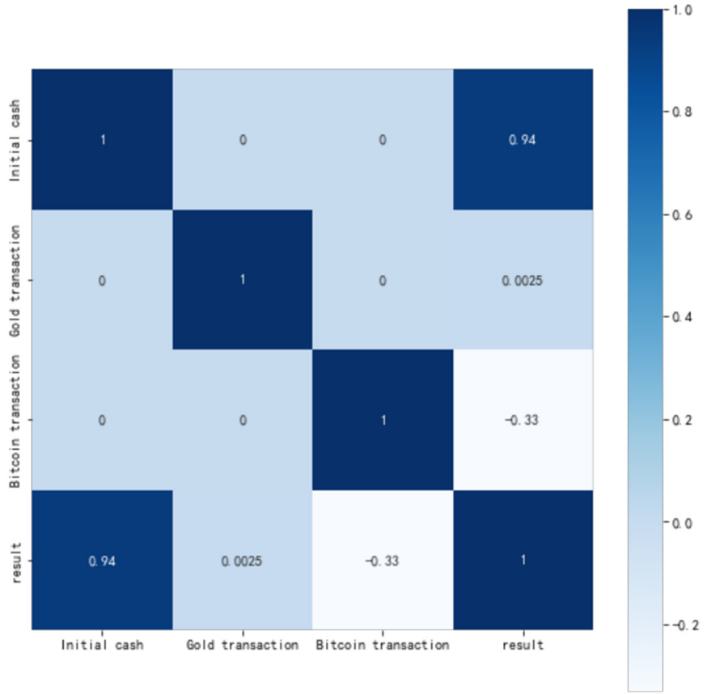

Figure 11. A heat map consists of initial cash, gold transaction, bitcoin transaction and result, which shows their relationship and sensitivity between each other

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For ease of understanding, we assume that the assets of cash, gold, and bitcoin are $[C_t, G_t, B_t]$at day t. It should be noted that here C_t, G_t, B_t are all greater than 0. In addition, according to the results of the LTSM prediction model, we can solve for the increase in funds on day t compared to day $t-1$. We assume that on day t, the increase in cash, gold and bitcoin is $[0, \Delta G_t, \Delta B_t]$, the absolute value of the change in assets of gold is g_t, and the absolute value of the change in assets of bitcoin is b_t.

On the basis of the above constraints, the objective function is constructed and the maximum payoff can be reached.

In market trading, uncertainty factors often cause changes in economic efficiency. To address this situation, in order to test the effectiveness and sensitivity of our previously determined strategy, we adjust the transaction cost from the original 1% and 2% to other values to see whether the strategy remains effective under the perturbation of the transaction cost. The result is shown in Fig 11.

Conditional on ignoring the effects of other information, the returns generated are positively correlated with principal and negatively correlated with transaction costs on gold or bitcoin, but are essentially not linearly correlated with changes in transaction on gold.

5. Conclusion

In this paper, we utilize LSTMs to predict future prices and growth rates and analyze their errors using MAE. In addition, the introduction of mean-variance model and sharpe ratio to calculate the effective investment, and get the best investment strategy. Finally, we analyze the sensitivity of the model.

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