Proposition and modeling analysis of two asset trading strategies of gold and bitcoin under market trading

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Abstract. With the progress of economic globalization, market transactions and investments occur frequently. For a long time, two assets, gold and bitcoin, have become the research hotspot due to payment means, circulation means, storage means, value scale, and world currency. To this end, we built two models. The model I: Diversified BP neural network model. Model II: Portfolio strategy based on mean-standard deviation model. For Model I, we have to predict the future prices of gold and Bitcoin based on past data. We can regard the past price data as a time series. There are relatively mature methods for predicting future values based on time series. For Model II, with future prices predicted, we can invest. It brings up three more questions: should I buy or sell or do nothing now? Buy or sell only gold and bitcoin or both gold and bitcoin? When buying, how should the cash for gold and bitcoin be distributed? Finally, the specific investment strategy is determined by linear programming. Then, we analyzed the effect of commissions on final earnings and derived the relationship between total assets held last and commissions.

Keywords: BP neural network, Mean-standard deviation model, Sensitivity analysis.

1. Introduction

"Learn to trade, simulate first, futures are not casinos, trading is gambling with technology and logic, and this technology results from continuous learning and ac- cumulation of experience." A senior of market trading scholars said. The market is like a battlefield, and you may lose everything if you are not careful. In 1952, the American economist Markowitz proposed the portfolio theory. The modern investment theory developed based on it believes that the formulation of an investment strategy must be comprehensively considered from the two dimensions of maximizing returns and minimizing risks[3]. In recent years, traders in international markets have frequently bought and sold volatile assets to maximize total returns. A commission usually accompanies every purchase and sale. Currently, two such trading assets are gold and Bitcoin.

1.1 Problem Background

Figure 1 Gold daily prices, U.S. dollars per troy ounce.

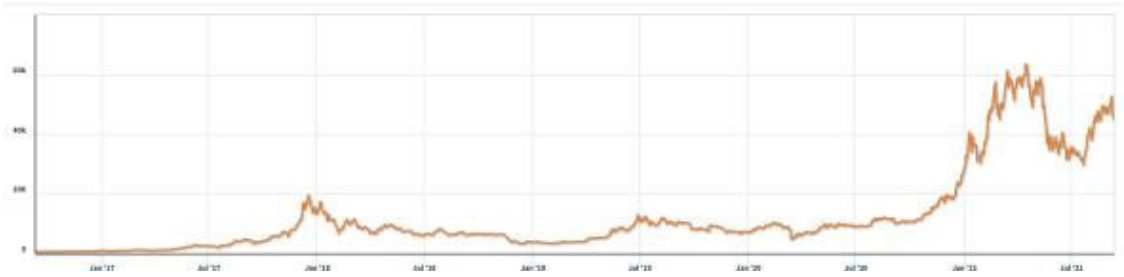

Figure 2 Bitcoin daily prices, U.S. dollars per bitcoin.

The above two data tables, of which Figure 1 is from the London Bullion Market Association, and Figure 2 is from an electronic securities trading institution in the United States - Nasdaq. In the context of economic globalization, market transactions occur frequently, and investors increasingly use idle funds to invest in financial products such as stocks and funds to obtain higher returns. With the increase of investors' investment frequency and investment knowledge, investors gradually realize that they cannot only focus on returns without considering risks in the securities market. Rational investors should reasonably avoid risks and maximize expected returns. As seen from the above two graphs and the two pricing data files given, Bitcoin can be traded every day, but gold is only traded on open days. We begin on November 9, 2016, with an initial asset of $1,000 and will use a five-year trading period to maximize total returns. Because of the above situation, it is essential and urgent to propose and model gold and Bitcoin's two asset trading strategies under market trading.

1.2 Restatement of the Problem

Market transaction behavior refers to the behavior implemented by the market subject to establish a direct commodity exchange relationship, in which the investment portfolio strategy and quantitative transaction are very complex. Through in-depth analysis and research on the background of the problem, combined with the specific constraints given, the reproduction of the problem can be expressed as:

•Firstly, a multi-factor BP neural network model is established, and economic factors that significantly affect the price of gold and bitcoin are added to the prediction model, which improves the prediction accuracy.

•Based on this model, the price of gold and bitcoin is predicted to rise or fall in the future based on past historical data.

•On the other hand, a mean standard deviation model is established, and a portfolio strategy study based on this model is used to determine the percentages of gold and bitcoin that are bought and sold.

•Considering the above model results, prepare a one or two-page annotated budget request and submit it to the trader with corresponding strategic recommendations for individual investments. In terms of investors in the gold market, individual investors still need to invest in the market, and they need to invest rationally.

1.3 Literature Review

This question is primarily about using only the daily price stream in the past to date to determine whether a trader should buy, hold or sell an asset in his portfolio. In recent years, people's attention has been paid to financial time series forecasting and related neural network algorithms, which can generally be divided into spatiotemporal forecasting of quantitative financial trading, traditional time series forecasting, and time forecasting based on machine learning. This paper mainly discusses the two pro- posed models.

•First, predict the prices of gold and bitcoin-based on past data to determine when the assets should be sold to obtain returns based on future price fluctuations.

•Secondly, the construction of the diversified BP neural network model mainly includes the input layer, the hidden layer, the output layer, and more than three layers. The algorithm consists of two parts. The first is the forward propagation of information. The input layer reaches the hidden layer

and finally reaches the output layer; the second is the backward propagation of information; finally, the error is controlled within the set range after repeated corrections.

•Finally, based on the mean-standard deviation model, it discusses investors' in- vestment strategies in investment decision-making, avoids unsystematic risks in investment, and pursues maximization of benefits and minimization of risks. Investor utility is a function of the expected return and standard deviation of a portfolio, determined by the investor's risk aversion, the project's expected return, and risk.

1.4 Our Work

This problem requires us to develop a model that gives the best daily trading strategy based only on the day's price data. Our work mainly includes the following aspects:

A multivariate BP neural network prediction model was established based on the data in the two spreadsheets provided.

Gives trading strategies for two assets, Gold and Bitcoin, noting whether they can be traded on the day;

Using the predicted results of the two assets, the relationship between investment risk and return is discussed based on the mean-standard deviation model, and a trading strategy that maximizes the total return is obtained. validity and applicability.

2. Assumptions and Explanations

Considering that practical problems always contain various complex and variable factors, first of all, we need to make reasonable assumptions to simplify the model, and each assumption has a corresponding explanation:

Only the impact of the data given in the title on the future trends of the two assets is considered, while other factors such as global economic conditions and national policies are ignored. Explanation: Since the title requires us to only use the data in the two spreadsheets provided and cannot find other data as the reference data for the model, we automatically ignore some external factors to simplify the model.

The two assets of gold and Bitcoin will not develop smoothly. Explanation: Since this topic is designed for economic development, economic development has never been smooth sailing, and there will always be strong winds and waves in the economic circle. Therefore, our prediction is only based on the assumption that the economy is developing steadily and applicably.

The data in the two spreadsheets provided in the title are considered reliable and, to some extent, reflect future changes in the two assets.

Additional assumptions were made in order to simplify the analysis of individual parts. These assumptions will be discussed in the appropriate place.

3. Notations

Table 1 shows the symbols used in this article and their corresponding meanings.

4. Model Preparation

4.1 Model Overview

Our model is divided into two parts, and the first model is based on BP neural network for price prediction. The second model is to formulate investment strategies based on the mean-standard deviation model.

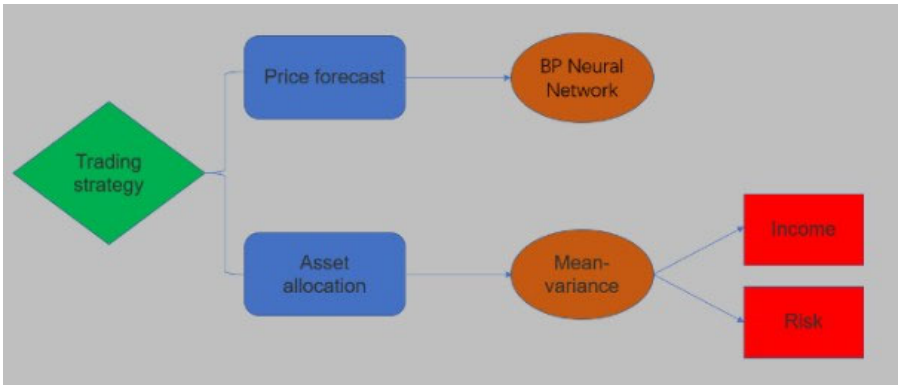

Figure 3 Model Mind Map

For the model I, we need to predict the future prices of gold and bitcoin-based on past data. We can regard the past price data as a time series [v1, v2, vn]. There are relatively mature methods for predicting future values based on time series. For example, the ARIMA model, GM(1,1) model, BP neural network, etc. Cheng Ming has done a good job of using these three models for price forecasting. After research, it is found that the prediction effect of the BP neural network is the best among the three models. So we decided to use BP neural network for gold and bitcoin price prediction.

For model II, With future prices predicted, we can make investments. It raises three more questions: should we buy or sell or do nothing now? Buy or sell only gold and bitcoin or both gold and bitcoin? When buying, how should the cash for gold and bitcoin be distributed? Zola[2] does a good job of researching investment strategies. Here we introduce and improve his mean-standard deviation model. Control risk by finding the mean and standard deviation. Finally, the specific investment strategy is determined by linear programming.

4.2 BP neural network

BP (backpropagation) neural network is a multilayer feedforward neural network trained according to the error backpropagation algorithm and is one of the most widely used neural network models. Its basic idea is the gradient descent method. The learning process of the BP neural network is divided into two stages, namely forward propagation and backpropagation. During forward propagation, input samples are passed from the input layer, processed layer by layer in each hidden layer, and then transmitted to the output layer. If the actual output of the output layer does not match the expected output (teacher signal), it turns to the backpropagation stage of the error. The output is transmitted back to the input layer by layer through the hidden layer in some form during backpropagation. The error is apportioned to all units of each layer, which obtains the error signal of each layer unit. This error signal is used as the correction unit—the basis of weight.

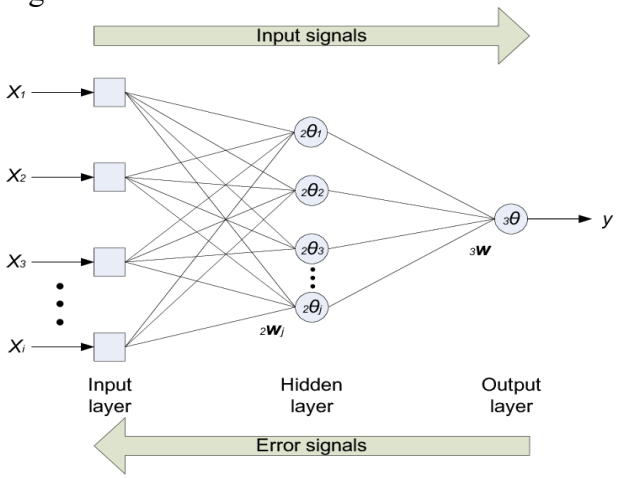

Figure 4 BP neural network

In this paper, we use the price of the past 14 days as training data to train the BP neural network and predict the price of this day. By analogy, all gold prices and bitcoin prices can be predicted.

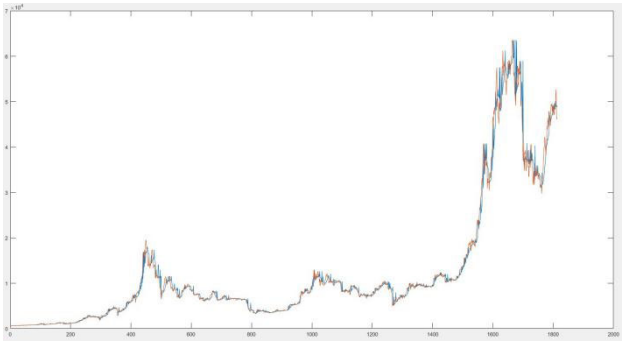

Figure 5 Real vs. Predicted Bitcoin Price

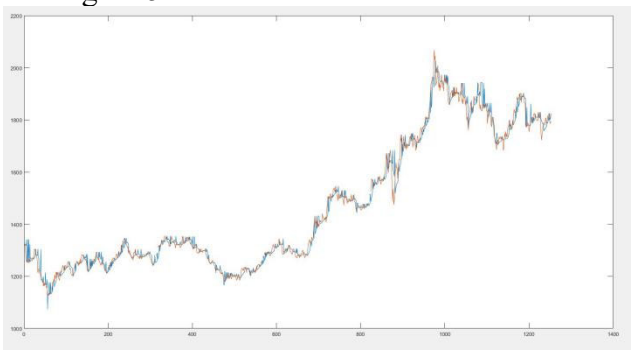

Figure 6 Real vs. Predicted gold Price

The blue line represents the predicted value in the pictures above, and the red one represents the actual value. It can be seen that the predicted result is very close to the actual value.

Table 1. Notations used in this paper

Symbol	Description
x_i	Amount used to buy gold or bitcoin
z	Expected maximum returns on a single transaction
δ_i	Standard deviation of gold or bitcoin returns over the last week
δ_{max}	Largest return standard deviation in history
r_i	Returns in Gold or Bitcoin
$m_i(n)$	Value of cash, gold, or bitcoin on day n
s_i	Gold or Bitcoin sold on day n
V_n	Value of total assets held on day n

4.3 Mean-standard Deviation

4.3.1. Determine when to buy and sell

In Model I, we already have a predicted value of the futures price, and the natural idea is to buy if the price goes up in the future and sell if the price goes down. However, considering that the transaction will charge a commission, we must reduce the number of transactions as much as possible while ensuring the profit. For this reason, when predicting the price trend, we need to predict the price in one day and the price of gold in 5 days, and the price of Bitcoin in a week. If the profit after one day is greater than the commission, then buy. If the profit is less than the commission, we also buy, but we cannot buy gold for 5 days and Bitcoin for 7 days. We do the same for losses. If we do not, we will earn less than our commissions, and our equity will continue to shrink.

4.3.2. Determine the amount to use for the buy

After determining when to buy and sell, we need to determine how much to spend on buying and how many shares to sell when we sell. Since the difference between the predicted price and the actual price we got in Model 1 is minimal, we believe that the best option is to sell the total share when selling. So the crux of the matter is determining how much to spend on buying.

Due to market uncertainty, we may face substantial losses in the amount we invest. So we found the maximum loss rate of gold price and the maximum loss rate of Bitcoin price based on historical data and took the smaller value as the maximum loss rate we can bear. Then find the largest loss value in history from the historical data, and use this as the largest loss value we can endure. Loss of the amount we used to buy is:

$$C = \frac{\max loss\ value}{\min\{\max \text{ loss } rate\,(bitcion), \max\ loss\ rate\,(gold)\}} \tag{1}$$

After determining when to buy and how much to buy, we have to determine the portfolio: how much to spend on gold and how much to spend on bitcoin. Let us assume x1 is used to buy gold and x2 is used to buy bitcoin. δ1 represents the standard deviation of gold's return in the last week, δ2 represents the standard deviation of Bitcoin's return in the last week, and δmax represents the largest standard deviation of returns in history. Obviously, the standard deviation represents the greater the risk. So we need to make the weighted average of the standard deviations in our portfolio less than the largest standard deviation in history. We set r1 as the yield of buying gold and r2 to buy Bitcoin. So we can use linear programming to solve the portfolio strategy:

$$\begin{gathered} x_1 + x_2 = C \\ \max z = x_1 r_1 + x_2 r_2 \\ x_1\delta_1 + x_2\delta_2 < \delta_{max} C \\ x_1 > 0 \\ x_2 > 0 \end{gathered} \tag{2}$$

This investment strategy can pay off well, and as the chart shows, our returns have been growing almost all the time. The final value of our holdings was $18,269.06.

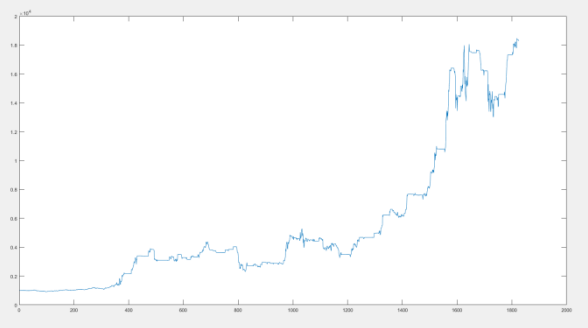

Figure 7 Growth trend graph of the held value

4.4 Sensitivity analysis of return to the commission

According to the problem, we get the relationship between the value of the assets held on the day n and the commission. Because the assets held on a specific day are only related to the assets held on the previous day, we can get the relationship between the assets of a certain day and the assets of the previous day. We set the commission for gold transactions to be t1 and the commission for Bitcoin transactions to be t2. Then we can get the following formula:

$$V_{n+1} = V_n + m_2(n)r_1 + m_3(n)r_2 + (1 - t_1)(r_1 + 1)x_1(n) + (1 - t_2)(r_2 + 1)x_2(n) - r_1 s_1(n) - r_2 s_2(n) \tag{3}$$

Since we only analyze the impact of commissions on assets, we can regard all variables other than commissions as constants, denoted as a, so it is not difficult to see that commissions have a linear relationship with assets. So in the end we get the relation as:

$$Vn+1 = Vn - a(t1 + t2) + b \tag{4}$$

a and b in the above equation are constants.

5. Conclusion

BP neural network is a classic algorithm for data prediction. Its core idea is to set different weights for the input amount by setting the "neurons" of the "hidden layer" as the medium, compare the output

value with the actual value, and then adjust the weight by adjusting the weight. To reduce the error, and finally approach the actual value. The methodology team analyzed the five-year gold and bitcoin price forecasts and actual graphs.

Markowitz emphasized the importance of risk and returned when he proposed portfolio theory in 1952. Therefore, the team found the maximum loss rate of gold price and the maximum loss rate of Bitcoin price based on historical data and took the smaller value as the maximum loss rate we can bear. Then find the largest loss value in history from the historical data, and use this as the largest loss value we can endure.

Next, we must consider how to arrange the holdings of various assets reasonably. It is supposed x1 is used to buy gold and x_2 is used to buy bitcoin. δ_1 represents the standard deviation of the return of gold in the last week, δ_2 represents the standard deviation of the return of Bitcoin in the last week, and δ_{max} represents the largest standard deviation of the return in history. The standard deviation represents the greater the risk. So it is only necessary that the weighted average of the standard deviations in the portfolio is less than the largest standard deviation in history.

After running the model, it was found that the effect was good, the return was almost always increasing in the long run, and the final asset was $18,269.06. The above is the model of the team. From the perspective of the final assets, the model meets the requirements of the actual situation.

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