Dynamic Investment Strategy Based on Nonlinear Programming

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Abstract: Aiming at the trading problem of gold and bitcoin in the financial market, this paper establishes a trading strategy based on KDJ and MACD indicators, and establishes an effective frontier curve model based on the change of mean variance to determine the investment ratio, and uses Lagrange multiplier method to maximize the trader's return rate.

Keywords: Stochastic Oscillator (KDJ); Moving Average Convergence and Divergence(MACD); Mean-Variance Model; Portfolio Theory

1. Background of the problem

With more and more traditional financial forces participating in the cryptocurrency market, more and more institutional investors will accelerate their entry. In today's financial market in day trading, gold and bitcoin, as volatile assets of market traders, need a large market value as a storage currency before they can be widely traded. At the same time, the balance between security and convenience needs to be guaranteed. From the perspective of gold, there is a certain demand for gold from all walks of life. Bitcoin is also closely related to its underlying blockchain technology. Now Bitcoin also has investment attributes and payment attributes.

2. Analysis of problems

First, preprocess the data according to the title, and select useful data according to the model to be built and bring it into the model for better calculation.We need to establish the relationship between gold and bitcoin according to the selected indicators of model establishment, and we have determined how to buy or sell with the greatest benefit report, providing strategies for traders.After determining the model and the selected index, the result is calculated, and evidence is given according to the index to prove that the result given by the established model is the optimal strategy.

3. The best trading strategy model based on KDJ and MACD

Firstly, the concepts and usage methods of KDJ and MACD are introduced separately, and then the comprehensive use of KDJ and MACD can avoid their shortcomings and improve traders' profitability.

3.1 Stochastic Indicator（KDJ）

KDJ indicator, also known as Stochastic Indicator, originated from the futures market at the earliest. Characteristics of KDJ indicators:Overbought and oversold、Golden Cross、Cross of death、J line bottom、Passivate.

3.2 Moving Average Convergence and Divergence（MACD）

MACD Geral Appel put forward in 1979, usingclosing priceThe aggregation and separation between the short-term (usually 12 days) index moving average and the long-term (usually 26 days) index moving average, and the technical indicators for judging the buying and selling timing.
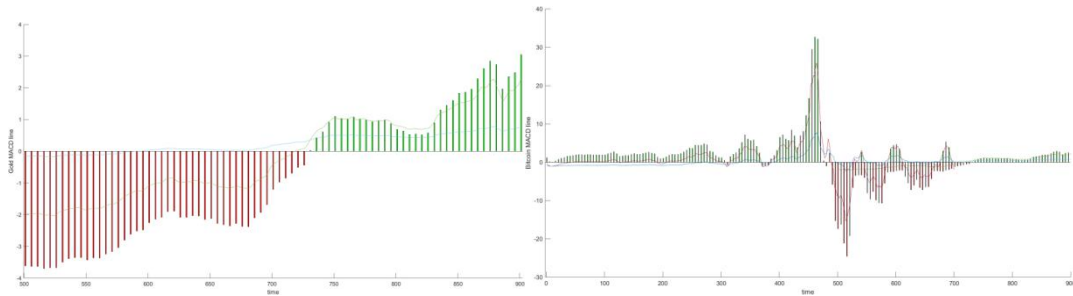
Fig. 1 MACD indicators of gold and bitcoin

3.3 Combining the characteristics of KDJ and MACD indicators to establish the model

Combining the advantages of KDJ and MACD indicators, the best trading strategy is formulated by establishing a buy-sell determination model.
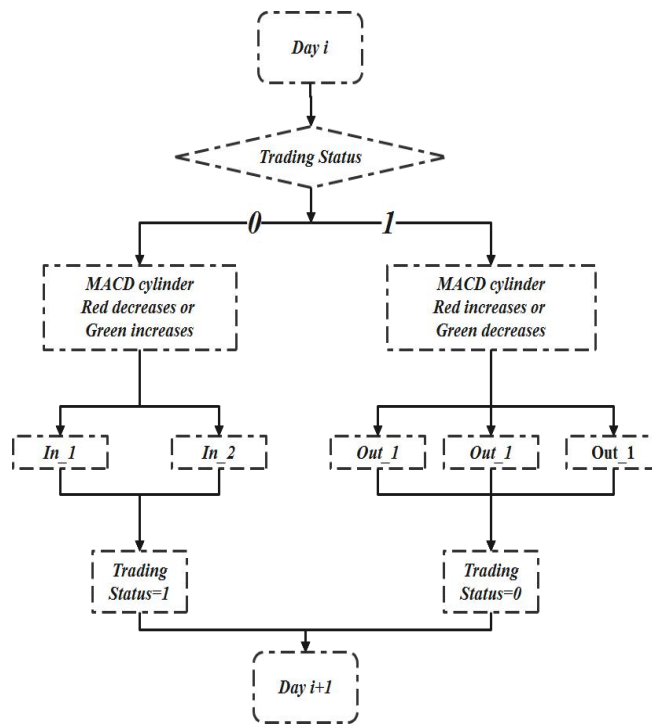

Fig. 2 The model is established by combining the characteristics of KDJ and MACD indicators.

（1）Transaction status

Traders' trading status can be divided into two types: currency holding and position holding, which can be expressed as:

$$\text{Trading Status} = 0 \text{ or } 1$$

Among them, 0 means that traders hold money and need to buy; 1 indicates that traders hold positions and need to sell.

（2）Buying point

In_1 (golden cross): The concept of golden cross has been introduced in 3.1.2. Assuming that on the ith day, Trading Status=0, In_1 can be expressed as:

$$J_{i-4} < K_{i-4} < D_{i-4} < 20$$
$$J_{i-3} < K_{i-3} < D_{i-3}$$
$$J_{i-2} < K_{i-2} < D_{i-2}$$
$$J_{i-1} < K_{i-1} < D_{i-1}$$
$$J_i > K_i > D_i > 20$$

Among them, you need to calculate the KDJ index in the I-day and the last 4 days, and buy when the above formula is met.

In_2(J-line bottoming): The concept of j-line bottoming has been introduced in 3.1.2. Assuming that on the ith day, Trading Status=0, in _ 2 can be expressed as:

$$J_{i-5} < 20, J_{i-4} < 20, J_{i-3} < 20, J_{i-2} < 20$$
$$J_{i-3} < J_{i-2} < J_{i-1}$$

Among them, you need to calculate the J-line on the first day and the last five days, and buy it when the above formula is satisfied.

(3) Selling point

Out_1 (death cross): The concept of death cross has been introduced in 3.1.2. Assuming that on the ith day, Trading Status=0, Out_1 can be expressed as:

$$J_{i-8} > K_{i-8} > D_{i-8} > 80$$
$$\vdots$$
$$J_{i-2} > K_{i-2} > D_{i-2}$$
$$J_i < K_i < D_i < 80$$

Among them, it is necessary to calculate KDJ indicators in the first day and the last 8 days, and sell them when the above formula is met.

Out_2 (stop loss point): record the last lowest price before the buying point as the stop loss point, assuming that on the ith day, Trading Status=0, and Out_2 can be expressed as:

$$\Pr ice(Type)_{k-5} > \cdots > \Pr ice(Type)_k < \cdots < \Pr ice(Type)_{k+5}$$
$$k + 5 <= i$$

Price(Type)$_k$ represents the price of gold or the price of bitcoin on the k-th day, and it will be sold when the price of the asset on the i-th day is less than or equal to price (type)$_k$.

Out_3 (moving average): the moving average for calculating asset prices, in which gold is the 50-day moving average and bitcoin is the 80-day moving average. Assuming that on the I-day, Out_3 can be expressed as:

$$MA(\text{period})_{i-8} < \cdots < MA(\text{period})_i$$
$$\Pr ice(Type)_{i-8} > \cdots > \Pr ice(Type)_i$$
$$\Pr ice(Type)_i <= MA(\text{period})_i$$

Among them, the 50-day moving average of gold and the 80-day moving average of bitcoin are calculated, assuming that the moving average is on the rise in the first 8 days of the I-day, and the asset price is on the decline, and the Price(Type) is less than or equal to the moving average of the asset on the I-day, and it is sold at this time.

4. Optimal portfolio model with variance variation

Trader's portfolio consists of cash, gold and bitcoin, and each part will affect the trader's income. By establishing the optimal portfolio model, the trader's income will be maximized.

4.1 Portfolio results

By solving the model, it can be concluded that traders have traded 12 times in gold and 14 times in bitcoin, and the assets owned by traders in each transaction are given.Show the results of gold trading.

Table 1 Portfolio when trading gold

Buy (date)	Portfolio (%)	Sell (date)	Portfolio (%)
12/5/16	(20.2%,79.7%,0)	2/1/17	(19.3%,80.6%,0)
7/13/17	(19.2%,80.7%,0)	10/13/17	(61.4%,38.5%,0)
12/18/17	(0,45.4%,54.6%)	3/6/18	(0,38.0%,61.9%)
5/25/18	(16.9%,13.0%,69.9%)	10/1/19	(40.2%,9.8%,49.9%)
12/4/19	(49.3%,14.7%,35.8%)	9/10/20	(11.1%,43.3%,45.5%)
4/1/21	(65.1%,22.1%,12.7%)	9/10/21	(23.6%,10.0%,66.3%)

From this table, it can be seen that in the early stage, our gold investment accounted for a large proportion, while in the later stage, bitcoin investment accounted for a large proportion, which is consistent with the growth level of both.

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