Research on Quantitative Trading Strategy based on Moving Average

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Abstract: With the gradual maturity of electronic trading in the current stock and foreign exchange markets, the Quantitative Trading has become a hot spot in the field of investment research at home and abroad by virtue of its procedural, short positions and multiple transactions, overcoming the subjective weaknesses of human nature, and analyzing the characteristics of a large number of historical data winning by probability. Because the Moving Average (MA) is a very widely used and sensitive technical analysis indicators at present. This paper will take XAUUSD (Gold to Dollar) as an example to illustrate the application rules of the Moving Average, and discuss how investors can grasp the market trend and achieve higher long-term returns according to the MA technical analysis indicators. This paper simulates the intelligent transaction with historical data, and makes a clear contrast with Linear Weighted Moving Average (LWMA) in different cycle, and then discusses the practicability of this indicator. The test results show that when the short average cycle is 5 hours and the long average cycle is 30 hours, the strategy is more stable than the extreme strategy, thus can achieve the goal of relatively stable profitability.

1. Introductions

Once the trading strategy is translated into mechanized code, it moves into quantitative trading. Quantitative trading refers to the use of scientific mathematical models to replace the subjective consciousness of investor, and use computers to select various "high probability" events from historical data, which can bring high returns, so as to formulate strategy, greatly reduce the effects of investors' subjective consciousness, reduce emotional decisions in extreme market situations of euphoria or pessimism. As opposed to quantitative trading, it is subjective trading. Without objective experience, investors make trading decisions based on subjective ideas. Not all strategies can be quantified, such as wave theory or candle charts. Shape judgment depends on subjective consciousness to a great extent, which is fundamentally different from other technical indicators such as RSI. One of the great advantages of quantitative trading is that it prevents emotional fluctuations. Market volatility can significantly affect the mood of investors, and the fear and greed brought about by it can affect the overall results[1].

The quantitative strategy aims at "falsification" rather than "verification" in the actual back test. "Falsification" has certain verification function. Many of the strategies used in history retests have been completely ineffective, but some people still believe in them. Quantitative retesting is to help investors beat this part of the people. Financial transaction is an unknown game market. It is impossible for a trader to predict every change in the market, only need to see the feasibility of the strategy reflected in the data. which is the role of quantitative back testing[2].

2. Moving Average Indicators

2.1. Introduction

Moving Average is abbreviated as MA, It is a technical indicators put forward by Joseph E.Granvile, a famous American investment expert in the mid-20th century, MA are one of the most popular technical indicators in the foreign exchange market. It helps investors identify existing

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trends, identify upcoming trends, and spot trends that are about to reverse due to overextension.

2.2. Moving Average Technology Indicators

Moving Average is the most widely used and sensitive technical analysis indicators in foreign exchange market. It represents the average price of a variety within a given cycle of time. There are four variants of this indicator.

2.2.1. Simple Moving Average

N denotes the number of cyclic units, PRICE is the current price, There are several variables to choose from in this indicator attribute: maximum price, minimum price, opening price, closing price, intermediate price ((Maximum Price + Minimum Price) / 2), typical price ((highest price + lowest price + closing price) / 3), weighted closing price ((highest price + lowest price + closing price) / 4) or data of the previous indicators.

$$SMA = \frac{\sum_{i=1}^{n} PRICE_i}{n} \quad (1)$$

2.2.2. Exponential Moving Average

EMA (i-1) is the previous value and F is the smoothing factor (share of the price used). Coefficient F is chosen randomly from 0 to 1, n is the number of cyclic units, PRICE is the current price value.

$$EMA = PRICE_i \cdot F + (1 - F) \cdot EMA_{i-1} \quad (2)$$

2.2.3. Smoothed Moving Average

SMMA (i-1) is the previous value, n is the number of cyclic units, PRICE is the current price value.

$$SMMA = \frac{SMMA_{i-1} \cdot (n-1) + PRICE_i}{n} \quad (3)$$

2.2.4. Linear Weighted Moving Average

n is the number of cyclic units, PRICE is the current price value.

$$LWMA = \frac{\sum_{i=1}^{n} PRICE_i \cdot i}{\sum_{i=1}^{n} i} \quad (4)$$

Figure 1 shows four variations of a 15-cycle Moving Average at closing prices. SMA moves slightly in the horizontal direction, which can create false trading signals. As can be seen from the figure, SMA looks smoother than the other three MA.EMA and LWMA have similar behaviors in the horizontal direction. From the trend analysis, LWMA is closer to the actual price than the other three MA, with less lag and relatively accurate reflection of the market.

Figure 1 Four variations of a 15-cycle Moving Average at closing prices.

2.3. Application of Moving Average

Mobile average is widely used in quantitative trading and is very popular with investors. Therefore, the technical basis of many trading strategies and technical indicators is the average mobile line. Five kinds of buying and selling signals in the practical application of the Moving Average line are listed below [3].

2.3.1. Buying Point One

When the price is below the average line and the average line is going down, the price crosses the average line from bottom to top, making the average line show an upward sign. The intersection point formed at this time is called "golden intersection", which is an appropriate buying signal.

At this time, it should be noted that the price rise at this time may only be a rebound. Only when the price rises all the way through the average, and the support or resistance of the average does not interfere with the price rise, the signal is relatively effective. At this point, the signal will be more competitive if the volume increases and the price rises.

2.3.2. Buying Point Two

The price rises ceaselessly in average upper part, fell to the bottom very quickly however, but soon the price will be pulled up and break through the average line, while continuing to rise above, this is a false breakthrough, is a good buy signal.

2.3.3. Buying Point Three

Recently, prices have been above the Moving Average and far from the Moving Average. After that, prices have continued to fall to the Moving Average and are strongly supported by the Moving Average. At this point, if the price rises again, it is a suitable buy signal.

2.3.4. Selling Point One

The price is above the Moving Average, the Moving Average trend does not fall; the price falls and breaks the Moving Average from top to bottom. At the same time, the Moving Average constitutes a strong pressure on the price, and the Moving Average trend shows a downward trend. The intersection formed at this time is called the death cross which is a suitable sell signal.

2.3.5. Selling Point Two

The price is below the Moving Average and the Moving Average continues to decline. If the price rises and breaks above the Moving Average, but then rises above the Moving Average and then quickly falls back below the Moving Average, the Moving Average is still falling. This situation is a false breakthrough. It is to sell the signal[4].

3. Moving Average Cycle

There are many cycle for the Moving Average to choose from, investors use it from three days to hundreds of days, However, only the accurate cycle average to judge the market can achieve the highest return, which has been the confusion of most investors.

The choice of the Moving Average Cycle should represent three trends, short, medium and long, the following three trends can be consulted:

Short-term trend: Usually, the trend of price fluctuation within one month is called short-term trend. In the trading market, the 5-day Moving Average represents price fluctuations in a week, and the 10-day Moving Average represents price fluctuations in two weeks or half a month, so the average of the above two length cycles is generally used to represent short-term trends, and it is

precisely because The cycle is short, and the trend is characterized by large fluctuations and is very sensitive to price.

Medium-term trend: Generally defined, the trend of price fluctuations of more than one month and less than half a year is called a medium-term trend. In the trading market, the 20th represents four-week, that is, the price fluctuation within one month, the 40th represents the price fluctuation within two months, and the 60th represents the price fluctuation within three months, that is, one quarter, so generally the above three lengths are used. The Moving Average of the cycle represents the medium-term trend, and because the medium-term trend is longer than the short-term, and the longer-term trend is shorter, the trend has a certain vitality and stability.

Long-term trend: The trend of price volatility in the market for more than half a year is usually referred to as a long-term trend. In the trading market, the 120-day line represents the half-year volatility trend, and the 240-day line represents the one-year volatility trend. Therefore, the average of the above two length cycles represents a long-term trend, and the trend is generally presented because of the long-term trend cycle. It is a smooth choice and has little ups and downs, making it the best choice for long-term investors.

4. Main Content of Strategy

The trading strategy is to use technical indicators, summarize trading experience and organize a set of effective trading steps. According to different trading varieties, the parameters of technical indicators are adjusted and quantified into different trading models.

4.1. Strategy Design

This strategy is based on the quantitative trading indicators of the Moving Average.

The Linear Weighted Moving Average (LWMA) in the Moving Average model is used to complete the long cycle stable profit strategy model by combining the most popular combination of MA cross of gold and MA cross of death in the trading market and constantly adjusting the cycle parameters.

Quantitative models of MA cross of gold or MA cross of death judged by Moving Average are as follows:

$$\text{BUY} = (\text{gMAlong} > gMAshort) \wedge (\text{MAlong} < MAshort) \quad (5)$$

$$\text{SELL} = (\text{gMAlong} < gMAshort) \wedge (\text{MAlong} > MAshort) \quad (6)$$

BUY is a variable to judge whether it is a buying point, and SELL is a variable to judge whether it is a selling point.

gMAlong denotes the long cycle mean value of a candle node before two mean lines intersect, gMAshort denotes the short cycle mean value of a candle node before two mean lines intersect, MAlong denotes the long cycle mean value of a candle node after two mean lines intersect, and MAshort denotes the short cycle mean value of a candle node after two mean lines intersect.

Only when gMAlong is greater than gMAshort and MAlong is smaller than MAshort, the value of the whole logic and the value of the variable BUY will be true, and then the value of the variable BUY will be assigned true by the default false value. The assignment process of variable SELL is consistent with BUY.

4.2. Strategy Process

The following is a brief description of the study of quantitative models.

1) Get the total number of orders currently held, and records them as Count, so as to facilitate subsequent identification as entry or exit operations.

2) If the short cycle Moving Average crosses the long cycle average from bottom to top, there will be a Moving Average cross of gold. When Count is 0, close the last order and establish a new order immediately; when Count is not 0, establish a new order immediately. In both cases, the order type is BUY.

3) If the short cycle Moving Average crosses the long cycle average from top to bottom, there will be Moving Average cross of death. When Count is 0, close the last order and establish a new order immediately. When Count is not 0, establish a new order immediately. In both cases, the order type is SELL.

4) If none of the above happens, wait and see, and wait for the next change.

The process design of this strategy is shown in Figure 2.

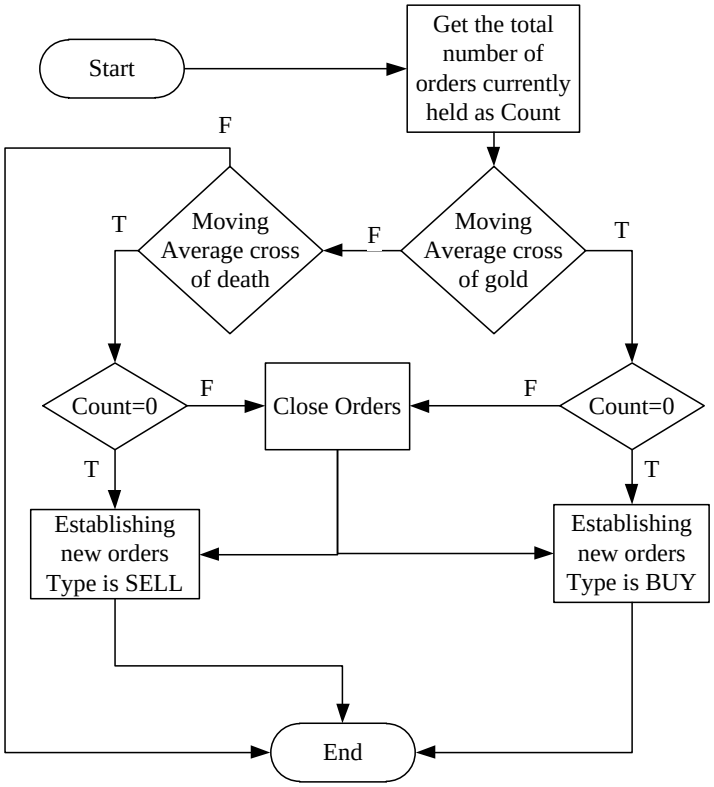

Figure 2 Quantitative strategy flow chart.

5. Test Data

In order to verify the validity of the Quantitative trading strategy based on the Moving Average indicators, Aiming at this strategy, a simulation experiment and comparative analysis are carried out on a simulated account trading process in *MetaTrader*, a foreign exchange trading platform.

5.1. Simulation Experiment

Initial condition:

Establish a simulated account with Initial funds of $10,000

Testing time: 3 January 2017 to 29 December 2017

The trading varieties is XAUUSD

The cycle time of the strategy is 1 hour.

5.2. Data Source

The exchange rate data of XAUUSD in 2017, due to the excessive data, the data sources used in the simulation exchange will be extracted in table form, and only a part of them will be cited as reference.

As shown in Table 1, the opening price of the first data record in the table is 1151.67 at 2017.01.03 1:00, in US dollars, i.e. the equivalent of 1 ounce of gold is 1151.67 US dollars.

Table 1 XAUUSD exchange rate change in 2017.

date	time	Opening price	Highest price	Minimum price	Closing price	volume
2017.01.03	1:00	1151.67	1151.68	1149.39	1150.29	3850
2017.01.17	1:00	1202.54	1203.76	1202.49	1203.15	1371
2017.02.01	1:00	1210.43	1213.14	1210.38	1211.54	1862
2017.02.17	1:00	1239.28	1239.33	1237.43	1238.42	1692
2017.03.01	1:00	1247.92	1249.15	1245.66	1245.93	3809
2017.03.16	1:00	1219.13	1220.79	1218.54	1220.38	2048
2017.04.03	1:00	1248.43	1249.49	1247.48	1249.24	1381
2017.04.17	1:00	1292.14	1294.29	1290.39	1293.42	2874
2017.05.01	1:00	1268.36	1271.15	1268.21	1270.63	816
2017.05.15	1:00	1229.53	1230.45	1228.48	1229.15	1177
2017.06.01	1:00	1268.75	1269.00	1268.16	1269.00	1155
2017.06.16	1:00	1254.17	1254.93	1253.94	1254.60	625
2017.07.03	1:00	1241.47	1242.63	1241.42	1241.62	565
2017.07.17	1:00	1228.70	1230.58	1228.19	1230.05	1366
2017.08.01	1:00	1269.19	1269.85	1268.79	1269.26	1739
2017.08.16	1:00	1271.87	1271.98	1271.20	1271.61	729
2017.09.04	1:00	1334.13	1336.67	1333.53	1334.92	3555
2017.09.18	1:00	1319.45	1319.46	1317.35	1317.36	1014
2017.10.02	1:00	1279.74	1279.74	1276.82	1277.93	726
2017.10.17	1:00	1295.56	1296.11	1295.24	1295.58	1917
2017.11.01	1:00	1270.70	1271.03	1270.30	1270.32	1455
2017.11.15	1:00	1279.93	1280.92	1279.12	1280.77	1610
2017.12.01	1:00	1274.69	1275.78	1274.51	1274.82	2652
2017.12.18	1:00	1254.28	1254.38	1253.53	1253.71	2231

Figure 3 shows the variation of gold against the dollar in 2017, with 5,387 records. The graph is based on the time abscissa and the exchange rate as the ordinate.

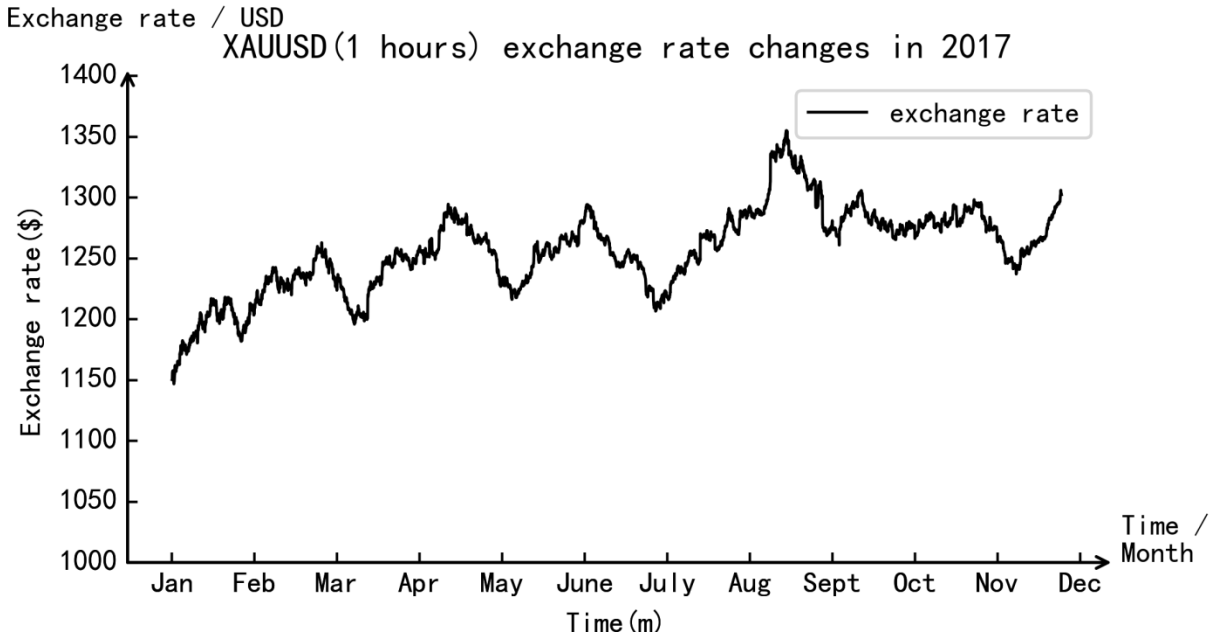

Figure 3 One hour line change chart of XAUUSD in 2017.

6. Test Result

The simulation test results show that there are 6 kinds of combinations, including 3 hours and 30

hours, 3 hours and 40 hours, 5 hours and 30 hours, 5 hours and 40 hours, 7 hours and 30 hours, 7 hours and 40 hours.

6.1. Contrast Test

There are two parameters in the quantitative trading strategy based on the Moving Average indicators, namely the short-term average period and the long-term average period. Different combination will affect the transaction to a great extent, and different portfolio will have different benefits[5].

In order to study the effects of different combination strategies, choose the short period is 3 hours, 5 hours or 7 hours, and the long period is 30 hours or 40 hours in testing. That is, the comparative analysis method of reference 5 is adopted.

6.2. Comparative Analysis

The test results show that, compared with six kinds of average combination, the final net profit of the combination with short average cycle of 5 hours and long average cycle of 30 hours is the highest value of $11256.00, that is, the strategic return is as high as 112.56%. The remaining cycle portfolios net profits of $8899.00, $7226.50, $3321.00, $2630.50 and $1690.00, respectively. As shown in Table 2.

Table 2 Test results by six modes of mean-line cyclic combination.

Trading varieties	Short MA cycle	Long EMA cycle	Total number of Orders	Total number of BUY	Total number of SELL	Net profit
XAUUSD	3 hours	30 hours	148	78	70	8899.00
XAUUSD	3 hours	40 hours	127	64	63	3321.00
XAUUSD	5 hours	30 hours	124	57	67	11256.00
XAUUSD	5 hours	40 hours	109	46	63	7226.50
XAUUSD	7 hours	30 hours	117	55	62	1690.00
XAUUSD	7 hours	40 hours	98	38	60	2630.50

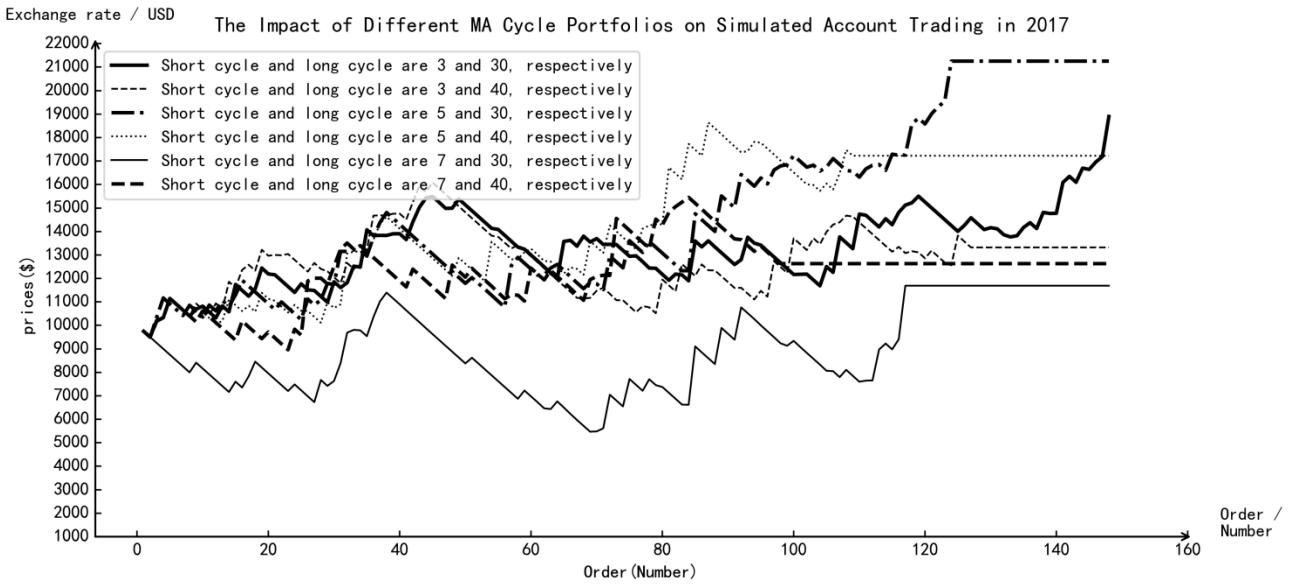

Figure 4 The impact of six cycle combinations on trading.

In Figure 4, this paper uses a line chart to show the change of funds in the trading account of XAUUSD. It can be seen that the larger the cycle, the more can reflect the operation failure caused by the lag of the average line. Compared with short-term, the cycle of medium-term trend can balance the lag of long-term and the fluctuation short-term, and bring better stability. It is the recommended combination to judge the golden cross and death cross.

7. Conclusions

When researcher construct a trading model and study the Moving Average model, find that the linear weighted Moving Average model is closer to the real price and has less lag, which can accurately reflect the market.

And based on the linear weighted mobile model, a quantitative trading strategy based on the Moving Average indicators is proposed. The efficiency of this strategy is verified in the simulation environment with a quantitative trading strategy. In the case of linear weighted moving mode, the combination of Moving Average is analyzed and compared. In the Simulation Environment, the quantification strategy is tested. The comparison and analysis of the test results show that the combination of 5 hours and 30 hours as short and long cycles respectively is the relatively excellent average of XAUUSD in 2017. Line cycle group, the final calculation of the strategic return is 112.56%, that is, to achieve stable profits.

At present, the strategy also needs to make a suitable stop-loss location experiment for a single variety, which is expected to reduce excessive losses under large market fluctuations, and further verify the quantitative trading strategy based on the Moving Average.

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