

Back-Testing of Various Basic Strategies of Quantitative Investment in Python – and Comparative Analysis of Specific Strategies

Wu Junlin

High School Affiliated to Renmin University of China, Beijing, China

Keywords: Quantitative investment, Stock and bond, Mathematical modelling, Linear programming, Programming

Abstract: In this article, we back-test some strategies of quantitative trading in the secondary market and get the key parameter such as yield, maximum drawdown, Sharpe ratio, Alpha and Beta, providing accurate and explicit references for the quantitative investors.

1. Introduction

1.1 Introduction to Moving Average

Moving average refers to a statistics-based technical indicator that averages the price of bond in a certain period and links the average values of different periods to form an average line, and use the line to observe the changing trend of the bond price.

1.2 Moving Average Strategy

Content of the strategy: Buy the stock when the ten-day moving average crosses the stock price line upwards; sell the stock if ten-day moving average crosses the stock price line downwards.

1.3 Double Moving Average Strategy

Content of the Strategy: Buy the stock when the five-day moving average crosses the ten-day moving average upwards (golden crossing); sell the stock if the five-day moving average crosses the ten-day moving average downwards (dead crossing).

2. Data Source

Tushare is an open-source financial data interface package for Python. I can use it to collect, process and store financial data to provide fast, neat, diversified and easily analytical data for the financial analyst and reduce their workload greatly.

2.1 Related Concept

2.1.1 Basic Parameter

A. Annual yield

The yield refers to the rate of return of investment, usually represented as an annual percentage based on the current market price, face value, coupon interest rate, and the time left to the due date. For a company, the yield refers to net profit as a percentage of the average capital occupied.

Annual yield is calculated by turning the current yield (daily yield, weekly yield, monthly yield) into the annual yield. It is a rate of return in theory, not the actual yield.

I assume an investor spends C (amount) as capital; the amount turns to V after T (the days), then in this investment:

B. The formula for the return is $P=V-C$

C. The formula for the yield is $K=P/C=(V-C)/C=V/C-1$

D. The formula for the annual yield is:

(1) $Y=(1+K)^N-1=(1+K)^{(D/T)}-1$ or

(2) $Y=(V/C)^N-1=(V/C)^{(D/T)}-1$

In the calculation of the yield of stocks, the D in the formula refers to the number of trading days in the whole year (about 250 days).

2.1.2 Maximum Drawdown

A maximum drawdown is the maximum observed loss from a peak to a trough of a portfolio over a specified period before a new peak is attained. It is used to describe the worse situation after buying a product. As a significant indicator of downside risk, maximum drawdown is more important than volatility for hedge fund trading and strategy trading.

2.1.3 Benchmark Yield

The benchmark yield, also known benchmark discount rate, is the lowest acceptable yield determined by the enterprise or industry from a dynamic point of view.

Usually, I compare the benchmark yield of the strategy with the stock market indexes, e.g. Shanghai securities index, Hushen 300 index, China securities 500 index, China securities 50 index, etc.

The strategy is considered outperformed the benchmark yield, or the market if it is higher than the Shanghai securities index.

The strategy is considered underperformed the benchmark yield if it is lower than the Shanghai securities index. A good strategy should at least be higher than the benchmark yield.

If the profit of a strategy is 20% a year, while the Shanghai securities index increases 30% in the same year, then the strategy should be considered bad.

2.1.4 Beta

Beta (β) reflexes the volatility of the yield comparing to the performance evaluation of bench yield. It is a relative index used to indicate the sensitivity of strategies to changes in the market. The higher the β , the higher the volatility of the fund to the performance evaluation of bench yield. When the Beta is 1.5, the strategy might increase by 1.5% when the market rises to 1%, and vice versa.

2.1.5 Alpha

Alpha is the excess yield, which has nothing to do with market volatility, meaning that it does not depend on the systematical increase to get profit. For example, an investor gains 15% of yield, and there is 10% of the yield from the benchmark, the Alpha or the value-added portion is therefore 5%.

2.1.6 Sharpe Ratio

(Strategy yield – risk-free interest rate) / Volatility of the strategy yield

The Sharpe ratio is the average return earned in excess of the risk-free rate per unit of volatility or total risk. It means that the return would be higher than the volatility risk if the Sharpe ratio is a positive value; the volatility risk would be higher than the return if the Sharpe ratios is a negative value. Generally, the greater the value of the Sharpe ratio, the more attractive the risk-adjusted return.

Calculation:

Annual yield: by multiplicative function

Alpha and Beta: x =accumulative yield; y =strategy yield; carry on linear regression analysis of x and y - the coefficient is Alpha, and the constant term is Beta.

The formula of the Sharpe ratio: Sharpe ratio = (Strategy yield – risk-free interest rate)/Volatility rate of the strategy yield, assume the risk-free interest rate to be 0.04 (bank savings rate)

2.2 Market Timing

The mock trading began one year ago and ended today.

2.3 Evaluation of the Strategy

Moving average strategy

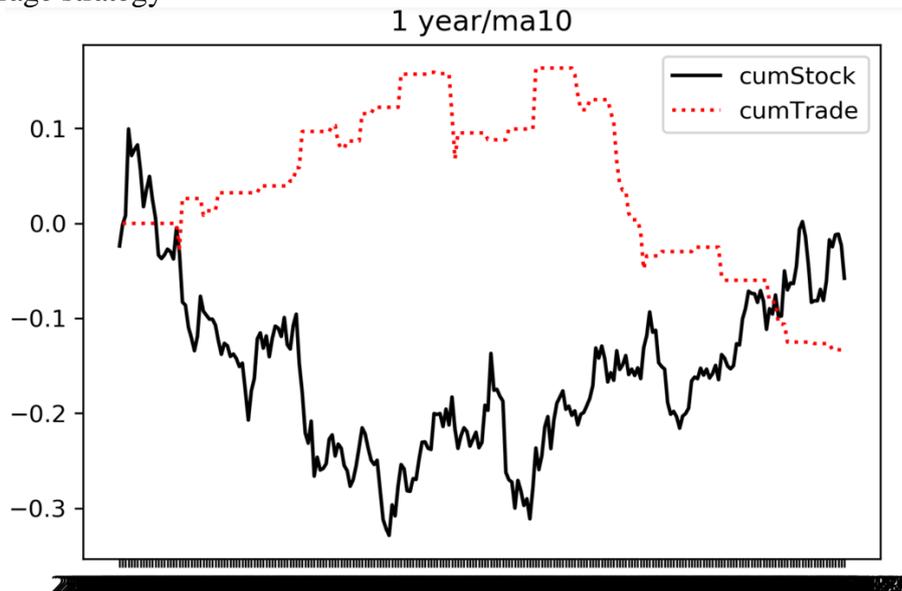


Fig.1 Moving Average Strategy

Black full curve: Accumulative yield (benchmark)

Red dashed curve: Strategy yield

Index: Annual yield-0.13694068560024494; Sharpe ratio-2.036448843269852;

Alpha-0.06780326590750368; Beta-0.6848351121652825

Double moving average strategy:

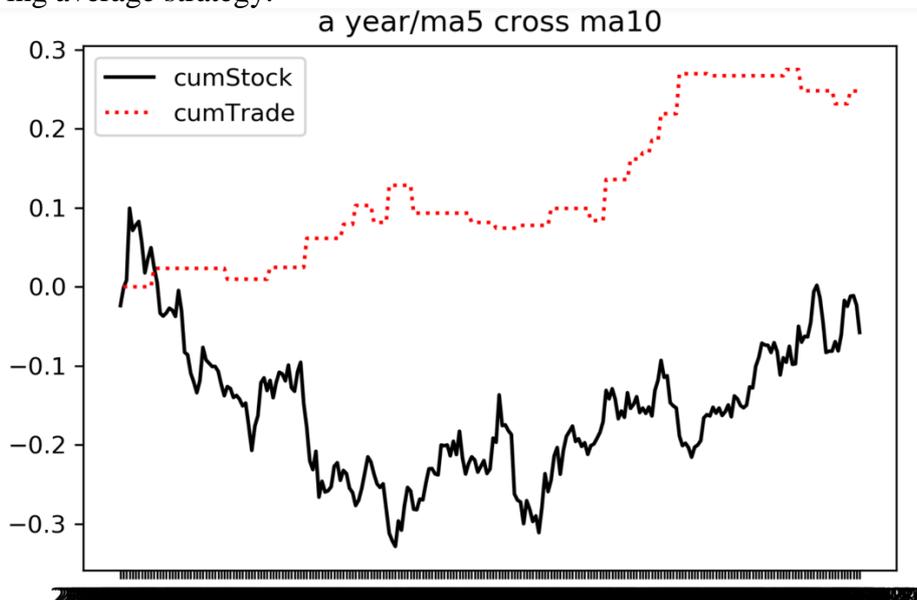


Fig.2 Double Moving Average Strategy

Index: Annual yield-0.25483771126056504; Sharpe ratio-2.4726139559318767;

Alpha-0.13378664325948442; Beta-0.08125390410177907

3. Analysis of the Result

Comment: I can see from the above result that this strategy helps avoid the sharp decline in the middle of the year effectively. Meanwhile, I can see from the parameters and charts that there was no response to the rise of stock price since the second half of the year. Hence the yields decreased gradually and were exceeded by the benchmark at the end. The reason is that the ten-day moving average strategy is too simple to judge the complicated factors effectively. Therefore, the double

moving average strategy is introduced. After improvement, the yield increases significantly, indicating that the double moving average strategy is better than the average strategy. Double moving average strategy is more sensitive to the development trend, and its parameters are relatively good. It is considered as a good strategy.

4. Conclusion and Prospect

The moving average strategy and double moving average strategy are welcomed and widely used by the investors because they are useful, easy to understand, and the operation is simple. However, more researches are needed because investors need more data and more in-depth theories to create better strategies.

The moving average strategy and double moving average strategy are more suitable for the public because of their universality. They will have a better future if I combine them with artificial intelligence.

5. Security Selection

There are many stocks to choose from in the market, and the selection of stocks is always difficult. I can pick out a stock rapidly using the quantization platform Zhi Kuan. The selection criteria are as follows:

- 1). P/B ratio should be less than 2;
- 2). The debt ratio should be higher than the average market value;
- 3). The current assets should be at least 1.2 times more than current liabilities;
- 4). Date of start: 2018-3-26

Following are the selected stocks

Table 1 Selected Stocks

OCT A (000069.XSHE)
Weichai Power (000338.XSHE)
Jinrongjie (000402.XSHE)
Yango (000671.XSHE)
BOE A (000725.XSHE)
Zhongnan Construction (000961.XSHE)
RiseSun Real Estate Development (002146.XSHE)
Poly Real Estate (600048.XSHG)
SDIC (600061.XSHG)
Gezhouba (600068.XSHG)
TBEA (600089.XSHG)
Shanghai Construction (600170.XSHG)

Manually selected Weichai Power (000338.XSHE) to carry out the back-test.

Period: 2018-3-26 to 2019-3-25; one year

Back-test result:

- 1). Ten-day moving average

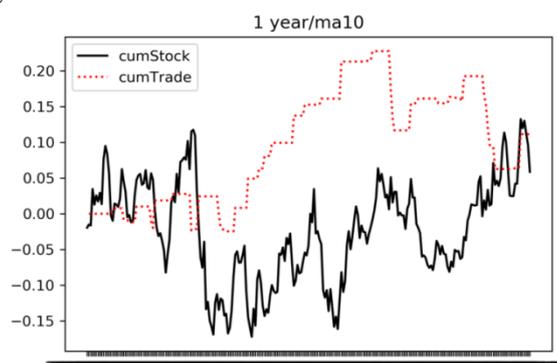


Fig.3 Ten-Day Moving Average

Key parameters:

Annual rate: 0.1147

Alpha: 0.0923

Beta: -0.0818

Sharpe ratio: 1.0594

Maximum drawback from 2018-11-14 to 2019-02-26: -0.1402

2).20-day moving average

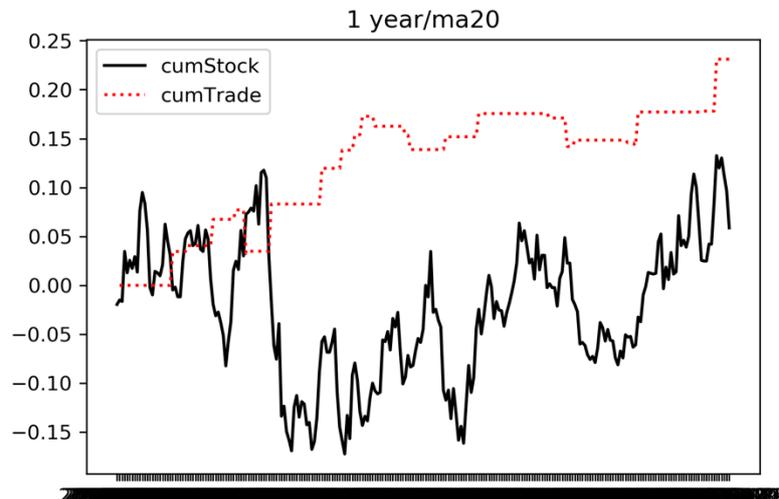


Fig.4 20-Day Moving Average

Key parameters:

Annual yield: 0.2377

Alpha: 0.1207

Beta: -0.1024

Sharpe ratio: 2.8039

Maximum drawback from 2018-11-14 to 2019-02-26: -0.0413

6. Analysis of the Result

Table 2 Comparison between Ten-Day Moving Average and 20-Day Moving Average

	Annual yield	Alpha	Beta	Sharp ratio	Maximum drawback
Ten-day moving average	0.1147	0.0923	-0.0818	1.0594	-0.1402
20-day moving average	0.2377	0.1207	-0.1024	2.8039	-0.0413

Analysis: The 20-day moving average method gains more yield, higher Alpha, higher Sharpe ratio and lower maximum drawback (here I refer to the absolute value for the maximum drawback is a negative value) than the ten-day moving average. I can conclude that the 20-day moving average method is better than the ten-day moving average method in the one-year test.

7. Conclusion and Prospction

7.1 Conclusion

Python is an easy and practical programming language, which is very suitable for ordinary people. Quantitative investment refers to the trading which gains profit by sending buying and selling orders using quantitative and computer programming. The use of python for relatively unintelligible quantitative investments helps democratize investments, lowering the barriers for people to enter the financial market, and allowing people without rich business knowledge to profit from investments. In the research, a large amount of data was used to prove that this model is simple but very practical. At the same time, a lot of professional theoretical knowledge is used to

ensure the authority of this model. The selection of stocks further guarantees the yields of the model.

Table 3 Comparison Table of All Strategies

	Advantage	Disadvantage
Moving average strategy	Simple operation, easy to tell the selling point and buying point	Very slow in response, resulting in high risks
Double average strategy	High yield, stable in the long-term	Slow in response
MACD strategy	Sensitive and accurate to the trend	Low yield

7.2 Prospect

I hope that the programming can be more intelligent to help investors learn investment techniques quickly. I can expect a software which helps investors buy and sell stocks automatically in the future.

References

- [1] Shu Jiaxian, Yi Miaomiao, Tang Jingyi. Research on the optimization of quantitative investment talent training mode in the era of big data -- Taking Anhui University of Finance and economics as an example. *Journal of Chifeng University (Chinese philosophy and Social Sciences Edition)*, 2019 (10): 1-7.
- [2] Wang Wang, Cai Yang, Huang Jinping. Quantitative investment research based on alpha strategy. *Science, education, culture and culture (mid ten issue)*, 2019 (08): 99-100.
- [3] he Baoguo. Quantitative investment strategy and risk control measures in capital market. *China business theory*, 2019 (08): 51-52.
- [4] Zheng Shaozhi, Liu Manshan, Huang Jiyan, Li Haifang, Zhao Zhenwei. Quantitative investment strategy based on big data . *Taxation*, 2019,13 (13): 187-189.