Research on the momentum effect in the US stock market based on S&P 500

Jinlong Shi *

School of finance, Zhejiang University of economic finance, Hangzhou, China

* Corresponding Author Email: sjl672701@icloud.com

Abstract. Momentum effect refers to the tendency of stock returns to continue the original direction of motion. On the basis of momentum effect, this paper proposes a trading strategy targeting S&P 500 stocks using a quantitative trading strategy as the underlying architecture, conduct historical backtesting to test its predictive ability, use several metrics such as the Sharpe Ratio to conduct a risk measurement, and review the implemented improvements to the strategy and unimplemented ideas that may be able to complement the strategy, with the final results confirming the soundness of our ideas and actually investing them in the stock market to obtain alpha that exceeds the average of the market.

Keywords: Momentum effect, High-values; S&P 500.

1. Introduction

As computer technology and mathematical models began to be introduced into the financial markets, the germ of quantitative trading took initial shape. In the 1960s, with the development of game theory, modern portfolio theory and other financial theories, as well as advances in computer science and technology, quantitative trading has been further developed, and more and more people choose to use quantitative trading to obtain excess alpha and achieve excess returns. Quantitative trading strategy stands out among them, with its easy to understand and the underlying logic of simple attributes, to obtain more and more traders to adopt trading strategies or penetrate its ideas in the trading behavior.

Momentum effect, which was developed by Jegadeesh and Titman (1993), refers to the tendency of stock returns to continue the original direction of motion, i.e., stocks with higher returns in past periods will still earn higher returns in the future than stocks with lower returns in the past. It can be explained by behavioral finance, which has emerged in recent years. The phenomenon can be caused by people's high emotions of chasing the market and investors' less-than-sensible frenzy. Based on the stock momentum effect, investors can profit by buying stocks with high past returns and selling stocks with low past returns, and this kind of investment strategy constructed by utilizing the stock price momentum effect is called momentum investment strategy.

While the underlying logic of momentum trading is clear, the details of its implementation require a variety of conditions to be considered. In order to have a good comparison effect to verify the reasonableness of the strategy, I changed the target trading stocks to S&P Midcap 400 as well as S&P Smallcap 600 stocks randomly selecting 50 stocks for the same trades, and in order to prove the reasonableness, we repeated the sampling of the 50 stocks 3 times to calculate their arithmetic average return, and got a total return of 12,809, with an average rate of return of 2%, which failed to beat the market average interest rate. Thus, proving that, other things being equal, the capacity of the momentum effect is greater for large value stocks. That’s why we choose to select big value stocks. Here is the comparison (table1)

Table 1. Midcap small cap and big value stocks.

	total revenue	average return
Midcap&small cap	12809	2%
Big value stocks	47706.15	9%

In this paper, we focus on the use of momentum strategies on some high-value stocks in the S&P 500 to find out whether our specific details and ideas about momentum strategies can be confirmed in practice.

From<<Momentum Trading by Institutions>> [1], they recorded the stock trading behavior of about 1,200 institutions from the third quarter of 1987 through the third quarter of 1995. Using a trade decomposition approach, we find that institutions enter trading positions with a predominantly momentum effect.

From<<Price Momentum and Trading Volume>>[2]They do this by constructing past trading volume as a link between momentum and value strategies, using high and low past trading volume as a measure of their future earnings. It is argued that past trading volume helps to reconcile the medium-term "underreaction" effect with the long-term "overreaction" effect.

From<<Momentum Trading, Return Chasing, and Predictable Crashes>>[3]They combined historical data collected from 1867 to 1907 with CRSP data from 1926 to 2012, they examined one of the most popular mechanical trading strategies in use today, the momentum strategy. The results indicated that momentum strategies earned unusually high risk-adjusted returns - a three-factor alpha of 1% per month between 1927 and 2012 - but also made considerations about the risk of momentum strategies over specific different time periods.

From<<An effective application of decision tree to stock trading>> [4] some trading strategies also choose to utilize strategies such as decision trees to aid in decision making.

From<<Value and Growth Investing: Review and Update>> [5] they focuses on some theories of value investing as well as growth investing. It is argued that value investment returns are higher than growth investment in a long time dimension. It also suggests that high value stocks.

We find that many institutions, including individual investors will be in the trading strategy to penetrate more and more quantitative trading thinking, and the momentum effect with its simple underlying logic is very popular, the investment in this paper will be the momentum effect as the underlying logic to start, aiming to get more than the market average market yield, and to validate the investment in the investment trading ideas.

2. Data and Method

2.1. Data

“The momentum strategy works, in general, but is particularly strong among low-value (expensive) stocks.”[6]Having received his inspiration as well as his own reflections, it is reasonable to believe that there is more room for momentum from large value stocks. Unlike more mainstream multi-factor models, we are inspired by Mr. Clifford Asness to look at the big value stocks in the S&P 500. In the current stock market, we use a liquid stock pooling strategy, which selects the top 60 stocks in the S&P 500 index constituents on the upside and downside rankings.

However, in order to verify the validity of our own stock picking views, we specifically chose mid-cap vs. small micro-cap market capitalization stocks to test against each other.

Due to considerations of regression to the mean and decreasing momentum effects over time, we use one month (recognized as 30 days) as the period for remaking our trading configurations.

Then we backtest our strategy using the 2012-2017 data for the S&P 500 as a new dataset to test how well our strategy works out of sample.

2.2. Method

(1)Momentum strategy,

Also known as trend-following strategy, refers to the investor to follow the general trend of the market, according to the upward or downward trend of the investment products to make the corresponding long, short transactions

(2) backtesting

Backtesting refers to testing whether different trading strategies have been profitable in the past by simulating historical stock prices and trading data, and analyzing their profit/loss and risk/reward ratios.

(3) Exponentially Weighted Moving-Average (EWMA)

$$weights = np.exp(np.linspace(-1, 0, 22))$$
$$\mathrm{EWMA(t)} = \lambda \mathrm{Y(t)} + (1-\lambda)\ \mathrm{EWMA(t-1)} \text{ for } t = 1, 2, \ldots, n. \quad (1)$$

3. Results and discussion

3.1. Discussion and results of momentum strategy

3.1.1. Deataled presentation

Considering the time effect of the momentum strategy, we use the exponential decay method for weighting (EWMA), i.e., the closer to the day's return, the greater the weight in front of the parameter.

"In addition to equal- and value-weighted momentum strategies, we derive a liquidity-weighted strategy designed to reduce the cost of trades. Equal-weighted strategies perform the best before trading costs and the worst after trading costs."[7]This was inspired by and is the reason why we used flow weighting for sorting.

Immediately after that, we sort the stocks according to their momentum metric scores to get a preliminary ranking. Since we are a liquid pool of stocks, we re-adjust the metrics every month to get a new ranking. We set up to buy and sell stocks on the first day of each month. Regarding buying stocks, we decided to buy stocks in the top 10% of the momentum indicator. As for selling stocks, we intend to lock in a specific stock we bought and track its performance afterward, set a stop-loss line whose value is the gain the stock has given us, and sell the stock if it drops more than $500.

Combination momentum-contrarian strategies, used to select from among 18 developed equity markets at a monthly frequency, outperform both pure momentum and pure contrarian strategies. The results continue to hold after corrections for factor sensitivities and transaction costs. They reveal the importance of controlling for mean reversion in exploiting momentum and vice versa [8].

We do not only consider momentum strategies, we understand the critical impact of mean reversion on the stock market, so we strictly control our momentum effect interval to 30 days, which we consider to be the optimal solution after weighing the maximization of momentum returns and the reasonableness of mean reversion, to avoid the appearance of too extreme and unrealistic situations, which will affect the objectivity of the results.

3.1.2. Results of momentum strategy

Maintaining great confidence in our strategy, the following demonstrates our results: Total return of 47,706.15 over 5 years, with an average annual rate of return of 9%. The average annualized return on U.S. stocks over the last two hundred years has been 6.9% the average annualized return over the last 50 years has been 7.2% the real annualized return on equity assets over the period 2000-2021 has still reached 5.2%. One can then look at the U.S. 10-year Treasury yield which generally fluctuates between 2% and 8%. With the U.S. Federal Funds Rate at 4.83% as of April 11, 2023, it is safe to say that our strategy is outperforming the average market level of return and is a quality investment option (tabel2).

Table 2. Strategy results.

total revenue(5years) /Average return	Federal Funds Rate (April11,2023)	last 50 years (USstock)	last 20 years(US stock)	10-year US treasury
47706.15/9%	4.83%	7.2%	5.2%	2%-8%

3.2. Results of backtesting

The results of the test were better and met our mental expectations for the strategy with the sharp ratio1.51&average annual rate of return18% (table3).

Table 3. Backtesting.

Sharp ratio	average return
1.51	18%

As can be seen from the data, committing our strategy to an earlier time dimension delivers better total returns as well as Sharpe ratio performance.

We have the following reflections on the even better performance of the backtested data:

(1)The data is over fitted and the model may have been over-optimized on the training set.

(2)Changes in market conditions, the 2012-2017 data chosen for backtesting, may have been more favorable and in a bull market at the time, which would have resulted in superior backtesting data.

(3)Possible under-improvement in data pre-processing.

(4)Impact of external factors: External macro-factors such as policies may lead to rapid changes in the market.

3.3. Risk assesment

3.3.1. Three risk metrics: standard deviation, Sharpe ratio, and maximum retracement.

(1)Standard deviation

Standard deviation measures the degree of volatility or variability in the return or price of a portfolio or asset. The higher the standard deviation, the higher the volatility of the portfolio or asset, and the higher the risk. In our portfolio, the standard deviation is 0.0058931.

(2)Sharpe Ratio:

In general, a higher Sharpe Ratio indicates a higher excess return per unit of risk taken. As such, it is seen as a measure of how well an investment balances return against risk, and a higher Sharpe Ratio generally means a better performing investment.

In our portfolio, we assume a risk-free rate of 2%. Our Sharpe Ratio is 0.727133, a value that implies an investment's excess return is positive relative to the risk it takes, but less than 1% for each unit of risk taken. While this is not the highest risk-adjusted return, it shows that investments can still generate positive excess returns when risk is taken into account.

(3)Maximum Drawdown

The maximum amount by which a portfolio or net asset value can fall from its highest point to its lowest point over a period of time. It is used to measure the extent to which a portfolio or asset may lose money over a period of time. In our portfolio, the maximum Drawdown is 40525.804.

As shown in table 2, ,the standard deviation is 0.0058931, Sharpe Ratio is 0.727133,the maximum Drawdown is 40525.804.The portfolio has performed well in terms of returns, but there is still some risk that it may incur large losses, particularly in times of high market volatility.(tabel4)

Table 4. Risk assessment.

Standard deviation	Sharp ratio	Maximum drawdown
0.0068931	0.727133	40525.804

3.3.2. More macro risk indicators

(1) Financial indicators

Check the company's financial statements, including the income statement, balance sheet and cash flow statement, to assess the company's profitability, financial position and cash flow position can be used as a reference basis for stock selection, but also for secondary screening after the conditions for sale have been met.

(2) Industry and market risk

Understand the overall risk level of the industry in which you are investing and the impact of the macroeconomic environment on the industry and the market. For example, in 2023, the pharmaceutical industry as a whole showed a shocking downward trend, which was affected by a variety of factors. On the one hand, factors such as post-epidemic recovery expectations, leading cutbacks, and industry policies have had a large impact on the market trend. On the other hand, the medical anti-corruption action unfolded, and the pharmaceutical industry sectors continued to be under pressure.

(3) More specialized evaluation criteria

Evaluate the company's governance structure, the quality of the management team, and the company's ethical and moral risks; understand the competitive environment in which the company operates, including the strength of competitors, market share, and competitive strategies.

3.4. Improvements in the production strategy process

3.4.1. Improvements realized

(1)Change in weights of momentum indicators

From the previous averaging with the returns of the last 5 days first, followed by custom weights to weight them. Improved to a normalized weighting method, where the more recent data has a greater weight, with the following code:

$$weights = np.exp(np.linspace(-1, 0, 22)) \tag{2}$$

$$\text{weights} = \text{weights} / \text{np.sum}(\text{weights}) \tag{3}$$

$$\text{EWMA(t)} = \lambda \text{Y(t)} + (1 - \lambda)\,\text{EWMA(t} - 1) \text{ for t} = 1, 2, \ldots, \text{n.} \tag{4}$$

(2)Adjustments to the selling policy

Originally we used to simply sell the stock when we encountered a negative return, but now we have adapted this to lock in a specific stock we bought and track its subsequent performance by setting a stop-loss line and selling the stock if it falls beyond the value of the stop-loss line.

(3)Time Screening

Improved from taking historical data for the past year to selecting data for the past 5 years

(4)Liquid Stock Pool

Originally using a strategy of obtaining the day's top performing stocks in the S&P 500 and locking them in, we are now focusing on the entire S&P 500 data and adopting a liquid stock pooling strategy by selecting the top 60 stocks on the list of top gainers and losers among the constituents of the S&P 500 on the first or early trading day of each month as the stock pool.

3.4.2. Some strategic outlook to be realized

(1)The parameters of the momentum indicator can be further improved, such as adding a market size factor, the stock's P/B ratio, P/E ratio, and whether it is a growth stock to further assess its momentum performance.

(2)The consideration of the timing of the buy is underdeveloped and overly simplistic.

(3)For the sell strategy: our stop-loss conditions are relatively simple. We have used the consideration of the stop-loss line, choosing a maximum tolerable loss value of 20% of the gain, but the results are not as good as before, but we believe that there is a choice that would be more sensible, but the difficulty of going to find that threshold is exponentially higher!

(4)The frequency of evaluation for the Sharpe ratio still needs to be considered.[9]To address this question, Andrew W. Lo is Harris & Harris Group derive explicit expressions for the statistical distribution of the Sharpe ratio using standard asymptotic theory under several sets of assumptions for the return-generating process—independently and identically distributed returns, stationary returns, and with time aggregation. We find that updating the Sharpe ratio and other risk measurement indicators over time is preferable. This article provides us with a reference.

4. Conclusion

High-values does hold more momentum However, momentum strategies should not just be momentum strategies, but should consider mean reversion as well as factor in fundamentals in order to maximize their momentum balances. Large-value stocks have more momentum space than small- and medium-value stocks, but they also need to adopt the above strategies in order to maximize their benefits.

But the results indicated that the trading strategy constructed under the guidance of our trading ideology was a quality strategy that broadly outperformed the market's returns bringing additional alpha.

However, there are several limitations in this paper. For transaction costs the metric is relatively simple. Transaction costs for momentum effects are supposed to be the least negligible and should not be estimated so simply here. It will be better to introduce more variables that reflect consideration of macro factors [10].

References

[1] Badrinath, Swaminathan G., and Sunil Wahal. "Momentum trading by institutions." The Journal of Finance 57.6 (2002): 2449-2478.

[2] Lee, Charles MC, and Bhaskaran Swaminathan. "Price momentum and trading volume." the Journal of Finance 55.5 (2000): 2017-2069.

[3] Chabot, Benjamin, Eric Ghysels, and Ravi Jagannathan. Momentum trading, return chasing, and predictable crashes. No. w20660. National Bureau of Economic Research, 2014.

[4] Wu, Muh-Cherng, Sheng-Yu Lin, and Chia-Hsin Lin. "An effective application of decision tree to stock trading." Expert Systems with applications 31.2 (2006): 270-274.

[5] Mehmet Umutlu, Pelin Bengitöz & Adam Zaremba. (2021) Decomposing the earnings-to-price ratio and the cross-section of international equity-index returns. Applied Economics 53:54, pages 6213-6230.

[6] Asness, Clifford S. "The interaction of value and momentum strategies." Financial Analysts Journal 53.2 (1997): 29-36.

[7] Korajczyk, Robert A., and Ronnie Sadka. "Are momentum profits robust to trading costs?" The Journal of Finance 59.3 (2004): 1039-1082.

[8] Balvers, Ronald J., and Yangru Wu. "Momentum and mean reversion across national equity markets." Journal of Empirical Finance 13.1 (2006): 24-48.

[9] Munki Chung, Yongjae Lee, Jang Ho Kim, Woo Chang Kim & Frank J. Fabozzi. (2022) the effects of errors in means, variances, and correlations on the mean-variance framework. Quantitative Finance 22:10, pages 1893-1903.

[10] Amenc, Noël, et al. "Macroeconomic risks in equity factor investing." The Journal of Portfolio Management (2019).