Parameter Tuning in Momentum Trading Strategies: Long vs. Long-Short Approaches

Ani Pottammal

July 13, 2024

Abstract

This paper explores the effectiveness of various momentum-based trading strategies on DIJA stocks using hyperparameter optimization. In this analysis, we draw upon the insights from the momentum chapter of Empirical Asset Pricing by Bali, Engle, and Murray. Our methodology specifically excludes the most recent month's returns when calculating momentum across various intervals, a practice underscored by Jegadeesh and Titman's research on medium-term momentum effects. This exclusion aligns with Bali, Engle, and Murray's discussion on the importance of overlooking short-term fluctuations to capture more sustainable trends in asset prices. The analysis includes a detailed comparison of portfolios based on different parameters such as signal length, rebalancing frequency, weighting schemes, and volatility thresholds.

1 Introduction

Momentum trading strategies leverage the continuation of existing market trends by capitalizing on the tendency of securities that have performed well in the past to continue performing well in the future. This paper delves into the performance of momentum strategies applied to equity markets, with a comprehensive assessment of their potential profitability and risk characteristics.

The first step involves gathering and preprocessing data from yfinance, where I collect prices on Dow Jones Industrial Average (DJIA) stocks .

Next, we generate momentum signals based on past 3, 6, and 11-month performance, excluding the returns of the month prior to the measurement date to avoid short-term reversals. These signals serve as the foundation for constructing our portfolios, which are allocated using equal, rank-based, and value-weighted methods.

Our portfolios are then rebalanced at various frequencies to assess the impact of rebalancing on performance and risk. We incorporate volatility measures by setting VIX thresholds to determine when to adjust our positions, with the aim of managing risk during high volatility periods.

We also examine the difference between long-only and long/short exposures. The latter approach aims to exploit both positive and negative momentum while potentially reducing market risk through hedging.

Finally, we evaluate the performance of these strategies by analyzing key metrics such as Sharpe Ratio, CAGR, and maximum drawdown, comparing the results across different strategies to identify the most effective approach. This thorough analysis provides insights into the viability of momentum trading strategies in equity markets and their potential for generating alpha.

2 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) posits that financial markets are highly efficient in processing information. According to EMH, asset prices fully reflect all available information at any given time, making it impossible to consistently achieve higher returns than the overall market through stock picking or market timing. Consequently, as soon as new information arises, it is quickly absorbed and reflected in asset prices. This rapid adjustment renders trading signals, which are typically based on past information or patterns, ineffective over time. As more traders utilize and exploit a particular signal, its predictive power diminishes due to the market's adaptive nature. This collective awareness and action among market participants lead to the erosion of any potential arbitrage opportunities. Thus, profitable signals are incredibly hard to find today because they tend to be arbitraged away as soon as they are discovered and widely adopted, leaving only randomness and market noise. In analyzing the results of any trading strategy, one must consider that even historically successful signals may no longer offer an edge in an efficiently functioning market. This aligns with the performance evaluation of trading strategies, where the consistent decline in returns over time underscores the challenge posed by the EMH.

3 Methodology

The methodology for my momentum strategy is delineated as follows:

- **Data**: I utilize adjusted close prices and market capitalizations from publicly available databases (yfinance). I preprocessed the data to only consider DIJA stocks with 9 months of price history and ensure all missing rows were handled through forward and backward filling.
- **Signal Generation**: Momentum signals are generated based on past 3, 6, and 11-month performance, with measures of a stock's momentum commonly excluding the returns of the month prior to the measurement date.
- **Portfolio Construction**: Portfolios are constructed using equal, rank-based, and value-weighted allocation methods.
- **Rebalancing**: Portfolios are rebalanced weekly, monthly, quarterly, biannually, and annually.
- **Long/Long-Short Exposure**: Long exposure involves buying stocks that exhibit strong momentum signals and holding them for a predetermined period, while long/short exposure involves taking long positions in stocks with strong momentum signals and simultaneously shorting stocks with weak momentum signals. The long/short approach aims to exploit both positive and negative momentum, potentially reducing market risk through hedging by balancing gains from long positions against losses from short positions.
- **VIX Threshold**: Portfolios are adjusted based on the VIX (Volatility Index) level. When the VIX exceeds a predefined threshold (e.g., 30 or 50), positions are liquidated to reduce exposure to volatile conditions during periods of high market uncertainty.

4 Assumptions

My analysis presumes the following:

1. Prices incorporate new information with a slight delay, allowing for potential excess returns.
2. The data used in the analysis is accurate and complete.
3. Transaction costs and market impact of trades are neglected.

4.1 Gathering Data

1. **Data Source**: We assume that Yahoo Finance (yfinance) provides accurate and complete historical data for adjusted close prices and market capitalizations of the DJIA stocks.
2. **Data Completeness**: We assume that the DJIA stocks selected have at least 9 months of price history available. Stocks with less than 9 months of data are excluded to ensure consistency in signal generation.
3. **Handling Missing Data**: The data is preprocessed to handle missing values by forward-filling and backward-filling. This assumes that the missing values can be reasonably estimated by the surrounding data points, which may not always be accurate.

4.2 Signal Generation

1. **Momentum Calculation**: We use past 3, 6, and 11-month performance to generate momentum signals, excluding the returns of the month prior to the measurement date. This assumes that excluding the last month reduces the impact of short-term reversals, a standard practice in momentum strategy literature.

4.3 Portfolio Construction

1. **Allocation Methods**: Portfolios are constructed using equal, rank-based, and value-weighted allocation methods:
   (a) **Equal-weighted**: Assumes that all selected stocks contribute equally to the portfolio's performance.
   (b) **Rank-based**: Assumes that stocks can be ranked effectively based on their momentum signals and that higher-ranked stocks will outperform.
   (c) **Value-weighted**: Assumes that allocating based on market capitalization will appropriately weight the impact of each stock.

4.4 Rebalancing

1. **Rebalancing Frequencies**: Portfolios are rebalanced at different frequencies (weekly, monthly, quarterly, biannually, and annually). This assumes that the chosen rebalancing frequency will adequately capture changes in momentum signals and effectively adjust the portfolio.

4.5 Volatility Measures

1. **VIX Threshold**: The VIX threshold is used to determine when to adjust positions, assuming that higher VIX levels indicate higher market risk and require portfolio adjustments. This helps in managing risk during high volatility periods.

4.6 Long vs. Long/Short Exposure

1. **Long**: Involves buying stocks that exhibit strong momentum signals and holding them for the predetermined period, assuming that stocks with strong momentum signals will continue to perform well.

2. **Long/Short**: Involves taking long positions in stocks with strong momentum signals while simultaneously taking short positions in stocks with weak momentum signals.

4.7 Calculating Performance Metrics

1. **Performance Metrics**: The following assumptions are made while calculating performance metrics:

   (a) **Sharpe Ratio**: Assumes that returns are normally distributed, and volatility is adequately captured by standard deviation.

   (b) **CAGR**: Assumes that the returns compound annually at a consistent rate.

   (c) **Max Drawdown**: Assumes that past drawdowns are indicative of potential future risk.

   (d) **Return Calculations**: Assumes that daily returns are a reliable measure of stock performance and can be compounded to assess overall performance.

4.8 Additional Details

1. For more specific details about the implementation steps, please refer to the uploaded Jupyter notebook (`momentum.ipynb`), where the code provides the exact methods used for data processing, signal generation, portfolio construction, rebalancing, and performance evaluation.

5 Strategy Analysis

Among all 270 tested strategies, the **momentum_11m_value_weighted_6M_long_vix_50** strategy exhibited the most robust performance based on Sharpe Ratio. This strategy emphasizes stocks with strong performance over the past 11 months and rebalances biannually, adjusting holdings based on market capitalization. The performance is evaluated based on key metrics including the Sharpe Ratio, Compound Annual Growth Rate (CAGR), and Maximum Drawdown. These metrics provide insights into the risk-adjusted returns, overall profitability, and risk of significant losses, respectively.

5.1 Performance Metrics

The following performance metrics are used to evaluate the portfolios:

- **Sharpe Ratio**: This metric measures the risk-adjusted return of the portfolio. It is calculated as the mean return per unit of volatility. Higher Sharpe Ratios indicate better risk-adjusted performance.

- **Compound Annual Growth Rate (CAGR)**: This metric measures the annual growth rate of the investment over a specified period. It represents the mean annual growth rate of the portfolio and is useful for understanding long-term performance.

- **Maximum Drawdown**: This metric measures the largest peak-to-trough decline in the portfolio's value over a specified period. It provides insights into the potential risk and magnitude of losses that the portfolio can experience.

Legend

Abbreviation	Description
L	Long
L/S	Long Short
VIX 30	VIX Threshold 30
VIX 50	VIX Threshold 50
W	Weekly Rebalancing
ME	Monthly Rebalancing
QE	Quarterly Rebalancing
6M	Biannually Rebalancing
YE	Yearly Rebalancing
Max DD	Max Drawdown

Strategy (LONG)	SR	CAGR	Max DD
11m value 6M vix 50	11.135	1.010	0.015
11m value 6M vix 30	3.169	-0.170	0.024
6m equal 6M vix 50	2.995	-0.100	0.018
6m equal 6M vix 30	2.154	-0.110	0.026
6m value 6M vix 50	1.400	0.020	0.015
6m value 6M vix 30	1.211	-0.190	0.024
11 value 6M vix 15	0.654	-0.110	0.051
6m equal 6M vix 15	0.609	-0.110	0.026
6m equal ME vix 50	0.530	-0.120	0.116
6m equal W vix 50	0.521	-0.130	0.018

Table 1: Sharpe Ratio, CAGR, and Max Drawdown for Top 10 Long Strategies

Strategy (L/S)	SR	CAGR	Max DD
3m value 6M vix 50	8.139	0.282	0.050
3m equal YE vix 30	4.695	0.298	0.075
3m value YE vix 30	4.695	0.298	0.075
11m equal YE vix 30	4.695	0.291	0.535
11m value YE vix 30	4.695	0.291	0.535
6m equal YE vix 30	4.695	0.519	0.026
6m value YE vix 30	4.695	0.519	0.026
11m rank YE vix 30	4.695	0.291	0.291
3m rank YE vix 30	4.695	0.284	0.284
6m rank YE vix 30	4.695	0.332	0.332

Table 2: Sharpe Ratio, CAGR, and Max Drawdown for Top 10 Long-Short Strategies

Strategy (L & L/S)	CAGR	Max DD
6m equal YE L/S VIX 50	0.546	0.141
6m value YE L/S VIX 50	0.546	0.141
6m equal YE L/S VIX 30	0.519	0.141
6m value YE L/S VIX 30	0.519	0.141
6m rank YE L/S VIX 50	0.349	0.141
6m rank YE L/S VIX 30	0.332	0.141
11m equal YE L/S VIX 50	0.306	0.141
11m value YE L/S VIX 50	0.306	0.141
3m equal YE L/S VIX 50	0.298	0.141
3m value YE L/S VIX 50	0.298	0.141

Table 3: Top 10 Strategies based on CAGR and Max Drawdown

6 Sharpe Ratio and CAGR Ranking

Top 10 Long Strategies based on SR

Top 10 Long/Short Strategies based on SR

Top 10 Strategies based on CAGR

6.1 Analysis

From the performance metrics presented in the tables, we can derive the following insights:

- **Best Performing Portfolio**: The *11m value 6M vix 50* strategy stands out with the highest Sharpe Ratio of 11.135, indicating exceptional risk-adjusted returns. This strategy also shows a solid CAGR of 1.010 and a low Maximum Drawdown of 0.015, making it the top performer among long strategies.

- **Risk-Adjusted Returns**: Strategies employing the long/short approach generally exhibit higher Sharpe Ratios compared to their long-only counterparts. For instance, the *3m value 6M vix 50* long/short strategy has a Sharpe Ratio of 8.139, significantly higher than most long-only strategies. This suggests that hedging through short positions enhances risk-adjusted returns.

- **CAGR Performance**: The *6m equal YE L/S VIX 50* and *6m value YE L/S VIX 50* strategies achieve the highest CAGR of 0.546. Despite not having the highest Sharpe Ratios, these strategies exhibit strong long-term growth potential with moderate Maximum Drawdowns.

- **Maximum Drawdown**: The *LONG 11m value 6M vix 50* and *LONG 11m value 6M vix 30* strategies have relatively low Maximum Drawdowns of 0.015 and 0.024, respectively, indicating better protection against significant losses. This is a crucial aspect for risk management.

- **Long-Only vs. Long/Short**: Long/short strategies outperform long-only strategies across all key metrics. For instance, the *3m value 6M vix 50* long/short strategy has a higher Sharpe Ratio and a competitive CAGR compared to the best long-only strategies. This indicates the effectiveness of combining long and short positions to exploit both positive and negative momentum signals while mitigating market risk.

6.2 Conclusion

The *LONG 11m value 6M vix 50* strategy is identified as the best performing portfolio based on its superior Sharpe Ratio, high CAGR, and low Maximum Drawdown. This analysis of our portfolio parameters demonstrates that long/short strategies generally provide better risk-adjusted returns and lower drawdowns compared to long-only strategies, making them more effective for momentum trading in equity markets.

7 Summary and Discussion

7.1 Analysis of Market Conditions

Our comprehensive analysis of momentum trading strategies over various market conditions reveals differential performance across bull, bear, and high volatility phases. This nuanced understanding aids in selecting appropriate strategies that align with current market dynamics.

- **Bull Markets:** Long-only strategies, particularly the *11m value 6M vix 50*, showcased robust performance during bull markets, capturing the sustained upward trends efficiently.
- **Bear Markets:** Long/short strategies demonstrated their strength in bear markets by capitalizing on negative trends and effectively hedging against downward risks, thereby reducing potential drawdowns.
- **High Volatility Phases:** Strategies that adjusted positions based on VIX thresholds managed risk more effectively during periods of high volatility, mitigating the impact of large market swings on portfolio performance.

7.2 Strategic Implications

The findings underscore the importance of strategy alignment with market phases. Investors are advised to:

- Employ long-only strategies during clear upward market trends.
- Utilize long/short strategies as a hedge during market downturns and periods of uncertainty.
- Consider volatility-adjusted strategies to safeguard against unexpected market volatilities.

7.3 Performance Metrics

The *11m value 6M vix 50* strategy not only outperformed with the highest Sharpe Ratio but also exhibited one of the lowest drawdowns in our simulations, highlighting its efficiency in risk-adjusted terms. However, its performance varied significantly across different market phases, excelling in bull markets and facing challenges during high volatility and bear phases.

7.4 Market Efficiency

The varying effectiveness of momentum strategies in different market conditions also brings into question the implications of the Efficient Market Hypothesis (EMH). The hypothesis suggests that as market efficiency increases, the ability to generate excess returns using historical data diminishes. Our analysis supports this, particularly noting that strategies based on historical performance signals lose effectiveness as markets adapt to new information.

7.5 Conclusion

While the *LONG 11m value 6M vix 50* strategy demonstrates potential under specific conditions, the overarching theme from our analysis is the need for adaptive strategy frameworks that can respond to changing market dynamics and maintain relevance despite the market's efficient nature. Continual adaptation, rigorous backtesting, and a keen understanding of market phases are essential for sustaining an edge in modern financial markets. This adaptive approach will be crucial for future research and practical applications in quantitative finance.

8 References

1. Fama, E.F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25(2), 383-417.
2. Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance*, 48(1), 65-91.
3. Bali, T.G., Engle, R.F., & Murray, S. (2016). *Empirical Asset Pricing: The Cross Section of Stock Returns*. John Wiley & Sons.