DEEP DIVE

Dynamic Allocations Unveiled: Optimisation using Mean Reversion

Pablo Meijer
Quantitative Trading Associate
King's Capital

November 2023

Dynamic Allocations Unveiled: Optimisation using Mean Reversion

Pablo Meijer - Quantitative Trading Associate - King's Capital - Nov 2023

Introduction

In the realm of finance and microeconomics, mean reversion is a key concept that suggests that prices and returns eventually move back towards the mean or average, reflecting the tendency of a variable, such as a stock price, to converge on an average value over time. This concept, tied to mean reversion in wages and profits, plays a pivotal role in dynamic asset allocation strategies. It offers valuable insights for both seasoned investors and students of microeconomics, guiding the optimisation of investments and critical decisions within firms. Though not in the spotlight and rarely making headlines, its influence is prevalent in the realm of finance, especially in areas like value investing, making it indispensable for anyone navigating the complex landscape of financial decision-making. In this paper, we dive deep into the significance of mean reversion and its integration into dynamic asset allocation strategies.

Real-world scenarios

Warren Buffett's famous quotation, "Be fearful when others are greedy and greedy when others are fearful," (Warren Buffet, Investopedia [1]) is a practical expression of reversion in the investment world. It signifies that over time, extreme market behaviors tend to normalize. A parallel in the world of hedge funds is Jim Simons, the former chairman of Renaissance Technologies, renowned for managing the Medallion Fund. Under Simons' leadership, the Medallion Fund, known for its secrecy and quantified trading strategies, averaged a 66% return before fees from 1988 to 2018, significantly outperforming traditional investment benchmarks like Warren Buffet's returns (Oddmund Groette, Quantified Strategies). The fund's approach, rooted in collecting vast amounts of data to find statistical patterns and anomalies across various markets, embodies a practical application of mean reversion. They consistently exploit short-term market inefficiencies, often executing over 150,000 trades per day, without overriding their complex models. This strategy, while distinct from traditional value investing, aligns with the core principle of mean reversion, demonstrating its wide-ranging applicability in different investment philosophies.

Dynamic Asset Allocation (DAA)

Transitioning to the topic of Dynamic Asset Allocation (DAA), we move from the insights provided by influential figures in finance to a modern portfolio management approach. DAA extends far beyond traditional static strategies, such as the traditional 60/40 portfolio allocation. It involves the continuous adjustment of asset allocations in response to changing market conditions. To gain a deeper understanding of how DAA is applied in practice, we will explore Madhogaria & Lam's paper titled Dynamic Asset Allocation (Madhogaria & Lam 2015). The paper, written by Madhogria & Lam, investigates whether dynamically adjusting a portfolio with multiple asset classes can lead to superior returns. It utilises the mean-reverting behaviour of various asset classes and applies a relative valuation technique to dynamically allocate funds to six different asset classes. The question it aims to answer is if the DAA strategy can generate positive annualised geometric mean returns over extended horizons, with lower standard deviation and favourable risk-adjusted metrics compared to investing in individual asset classes.

A. The Strategy

The strategy of Dynamic Asset Allocation (DAA) is tailored for long-term investors, especially those managing retirement portfolios. Instead of fixed percentage allocations, DAA identifies undervalued and overvalued asset classes based on relative valuations. It involves overweighting underperforming asset classes, underweighting outperformers, and adjusting the portfolio over extended periods to enhance risk-adjusted returns. This approach prioritizes long-term value-based decisions over short-term market timing, aiming to leverage mean reversion trends.

a. Macroeconomics

A huge factor of the strategy is the notion of the impact macroeconomic events have on asset classes in the long run, which tend to cause asset classes to "overreact to both the upside and downside" (Madhoriga & Lam 2015). The DAA strategy capitalises on the tendency of asset classes to show strong responses to macroeconomic events, using these fluctuations to its advantage.

b. Do Value-Stocks really revert to the mean?

Poterba and Summers (1988) found that stock prices tend to bounce back to an average level over time. They observed that in the short term, stock prices are influenced by recent trends and tend to follow them, but in the long term, they tend to reverse those trends.

When a significant difference exists between the perceived and actual value of a stock, this gap typically narrows over time. For instance, during periods of pessimism, such as the 2008-2009 financial crisis, extensive selling often precedes a market recovery, as most sellers have already exited the market. Conversely, during periods of heightened optimism, like the dotcom bubble of 2000-2001, a wave of buyers at elevated prices can signal a market correction due to overvaluation.

In simple terms, stock prices often go back to their average values in the long run, but in the short term, they can be influenced by people's emotions and market trends.

c. Trying to time the market

Dynamic Asset Allocation (DAA) is a strategy that stands in contrast to trying to time the market, which has been proven to be highly challenging: "... no one can predict the market's ups and downs over a long period, and the risks of trying outweigh the rewards ..." (Jeffrey 1984) . Instead of attempting to predict short-term market movements, DAA focuses on leveraging mean reversion trends in asset classes over the long term.

B. Mean Reverting Behaviour

The DAA approach relies on the idea that investment prices tend to return to a normal level over time, a concept known as mean reversion. Geometric mean returns, which account for wealth accumulation over the investor's time horizon, play a key role in this approach. Understanding mean reversion plays a pivotal role in shaping investment decisions and risk management strategies.

Mathematically that can be explained as follows:

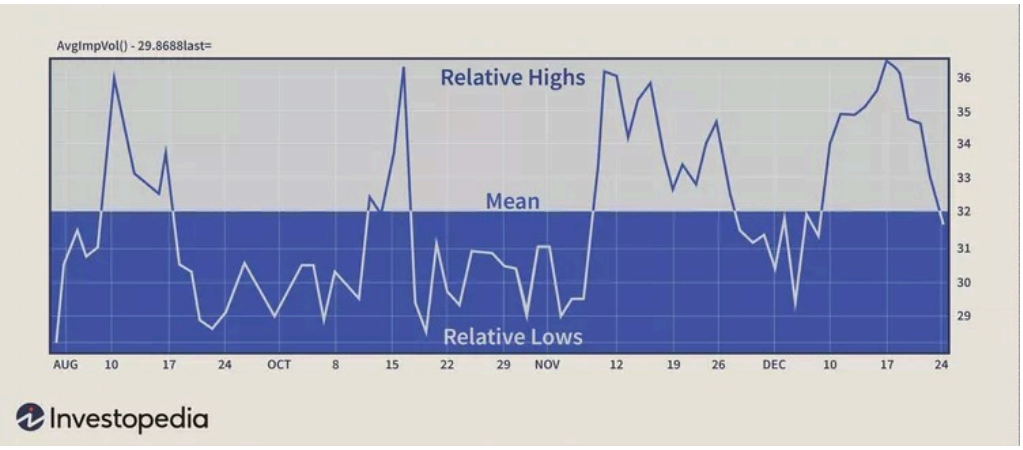
Let: Rt represent the return on an asset over time

μ represent the long-term mean or average return of the asset over a historical period

α represent the speed of mean reversion, indicating how quickly returns revert to the mean.

$$\frac{\mathrm{d}Rt}{\mathrm{d}t} = \alpha(\mu - Rt)$$

The LHS, in this case, represents the rate of change of the asset's return over time, while the RHS represents the force that pulls the assets return (Rt) back towards its long term mean (μ). This equation suggests that when the assets return (Rt) deviates from its long-term mean there is a force (RHS) that pushes it back toward that mean. α determines that speed/strength of the mean reversion effect.



[Figure 1: Mean reversion. Credit: Julie Bang © Investopedia 2023 [2]]

Above can you see a textbook example of mean-reversion, where a random stock price fluctuates above and below the central mean line. The light blue area above the mean line represents periods when the stock is trading above its historical average, indicating potential overvaluation, while the dark blue area below the mean line signifies undervaluation.

Findings from Research

Madhogria & Lam research on Dynamic Asset Allocation (DAA) provides valuable insights for long-term investors, particularly those planning for retirement.

1. Superior Returns and lower risk with DAA:

The results found that the DAA "provides higher returns than the six asset classes over long time horizons. (Madhorgaria & Lam, 2015 [3])." Even when compared to different asset classes, such as large capital stock, small capital stock, long-term corporate bonds, long-term government bonds, intermediate-term government bonds and Treasury bonds, the DAA approach generated higher returns and "also resulted in lower standard deviation", which is perceived as a measure of risk.

2. Investor Considerations:

In the broader context, it's essential to recognize that a 20-30 year investment strategy primarily appeals to individuals focused on long-term financial goals, often those saving for retirement. To cater to this demographic, the study examined an approach where future contributions are directed into the most undervalued asset class, eliminating the need for complete reallocation of accumulated wealth. This method enables investors to maintain portfolio diversification over time, alleviating the psychological stress associated with retirees having to shift their entire asset holdings.

Regardless of the slight change is strategy, the alternative DAA strategy still outperformed individual asset classes.

3. Equity Dominance:

Not only did the paper shine light on the positive outcomes of dynamically allocating your assets, but underscored that over the long term, equity portfolios are typically optimal for most long-term investors. This observation aligns with previous findings from Hanna and Chen (1998), emphasizing that equities tend to outperform fixed income investments.

Applications in Quant

Mean reversion has far-reaching applications beyond traditional investment strategies. A prime example is its use in algorithmic trading strategies, notably in pairs trading. Pairs trading is an algorithmic trading strategy that exploits the mean reversion principle in the price ratios of two historically correlated assets. This market-neutral strategy focuses on identifying and capitalising on temporary deviations from the long-term average price relationship between two assets. When one asset underperforms or overperforms relative to the other, traders buy the underperforming asset and sell the overperforming one, betting on the eventual convergence of their price ratio back to the historical average.

Innovative approaches to optimise pairs trading have emerged, as demonstrated in "Pairs trading with a mean-reverting jump-diffusion model on high-frequency data (Stübingera & Endresa, 2017 [4])." This paper, focusing on S&P 500 oil companies from 1998 to 2015, incorporates a mean-reverting jump-diffusion model into pairs trading. This method involves a detailed calibration process to identify the best asset pairs based on their mean-reversion speed and jump behaviour. Their strategy, tested on high-frequency data, has shown superior performance compared to traditional pairs trading methods, yielding significant returns and a higher Sharpe ratio. This advancement highlights the potential of combining mean reversion with advanced statistical models to enhance algorithmic trading strategies.

Relevance to Microeconomics

Mean reversion plays a crucial role not only in finance but also in microeconomics, particularly in labor economics. This concept is highlighted in Nominal and Real Wages: mean reversion, persistence and structural breaks, a study which examines UK nominal and real wages from 1750 to 2015 (Caporale & Gil-Alana, 2023 [5]). Their findings reveal a notable persistence in nominal wages, indicating slow adjustments to changes in inflation. This phenomenon has significant implications in microeconomics, which focuses on the behavior of individuals, firms, and markets.

For employees, understanding mean reversion is vital for wage negotiation and career planning. It indicates that wages tend to gradually align with economic shifts, providing a framework for making informed decisions. Employers, on the other hand, use this knowledge to develop sustainable compensation strategies and make informed hiring and retention choices. Policymakers also find value in recognising mean reversion in wages, as it aids in crafting labor market policies that consider wage pass-through effects and labor market flexibility. This interplay between macroeconomic trends and microeconomic decision-making highlights mean reversion's significant impact in shaping both financial markets and labor dynamics.

Conclusion

In conclusion, mean reversion plays a crucial role in both financial and labor markets. It informs investment strategies, wage negotiations, and labour market policies, bridging the gap between these two economic spheres and impacting overall economic well-being.

References

[1] Adam P. Brownlee, Investopedia "Warren Buffett: Be Fearful When Others Are Greedy" (2023)

[2] James Chen, Investopedia "What Is Mean Reversion, and How Do Investors Use It?" (2023) "What Is Mean Reversion, and How Do Investors Use It?" (2023)

[3] Madhogaria, S. and Lam, S. "Dynamic Asset Allocation". Journal of Asset Management, 16, 293–302 (2015)

[4] Stübingera, J., & Endresa, S. (2017). Pairs trading with a mean-reverting jump-diffusion model on high-frequency data. FAU Discussion Papers in Economics, No. 10/2017, Friedrich-Alexander-Universität Erlangen-Nürnberg, Institute for Economics, Nürnberg (2017)

[5] Caporale, G.M. and Gil-Alana, L.A. "Nominal and real wages in the UK, 1750–2015: mean reversion, persistence and structural breaks." SN Bus Econ 3, 135 (2023)