

Louvain School of Management

Cash Management in Diversified Long Term Portfolios Using Leading Macroeconomic Indicators

Auteur : Adoum Youssouf
Promoteur : Mikael Petitjean

Année académique 2023-2024
Master 120 crédits en science de gestion, à finalité spécialisée

Declaration Regarding AI Tool Usage in Master's Thesis

We recognize that AI tools might be valuable aids during the master's thesis work, but they are not infallible. Remember that transparency fosters trust, and acknowledging AI's role enhances the credibility of your work. Therefore, when deciding to use such a tool, you need to adhere to the following principles of responsible use of AI:

- **Critical Evaluation:** We critically assessed the AI-generated output, ensuring its alignment with our research objectives. Any modifications or corrections were made based on our expertise and domain knowledge.
- **Transparency:** We acknowledge the use of ChatGPT and GitHub Copilot transparently, emphasizing that they contributed to our work but did not replace human judgment. Our commitment to transparency ensures the integrity of this thesis.
- **Ethical Considerations:** We actively monitored for biases or unintended consequences introduced by the AI tools. Our ethical responsibility guided our decisions throughout the research process.

Declaration

This declaration is mandatory and must appear on the first page (after the title page) of the document.

During the preparation of this master's thesis, the author(s) utilized ChatGPT and GitHub Copilot for the following purposes:

1. **Structuring Ideas:** ChatGPT was used to help structure my ideas, which were originally in French.
2. **Assistance with Calculations and Learning Tools:** Both ChatGPT and GitHub Copilot assisted in performing calculations and learning the tools used in the research.

After using ChatGPT and GitHub Copilot, the author(s) diligently reviewed and edited the content produced by the tools. We take full responsibility for the final content presented in this thesis.

By signing this declaration, we affirm that the content of this master's thesis reflects our original work, augmented by the responsible use of AI.

[Adoum Youssouf]

[07/08/2024]

ABSTRACT

This master's thesis investigates the impact of leading macroeconomic indicators on cash management within diversified long-term investment portfolios. The primary objective is to assess whether these indicators can enhance cash allocation strategies by exploiting periods of market inefficiency and addressing potential market bubbles.

The thesis begins with a review of modern portfolio theory and the efficient market hypothesis, followed by an analysis of economic and business cycles through leading macroeconomic indicators and their effects on asset allocation. The performance evaluation of various portfolio types, including strategies to mitigate drawdowns and reduce the Ulcer Index, is also discussed. By testing the validity and robustness of prominent leading macroeconomic indicators for market timing, the study aims to refine the strategic allocation of cash reserves. Key performance metrics and risk indicators are employed to evaluate the effectiveness of these strategies.

The findings offer valuable insights into optimizing cash management in diversified portfolios. Practical recommendations are provided for investors seeking to enhance performance through informed, macroeconomic-based adjustments. By understanding and applying these insights, investors can better navigate economic cycles, bolster portfolio resilience, and achieve more stable long-term returns. This research contributes to the ongoing discourse on effective portfolio management and underscores the importance of adaptive strategies in a dynamic economic environment.

Acknowledgements

I would like to express my deepest gratitude to my master thesis promoter, Professor Mikael Petitjean, for his unwavering support and guidance throughout the entire process of this master thesis. From the initial choice of the subject to the final stages, he has been a constant source of advice, correction, and encouragement. This thesis is the culmination of two years of hard work and discovery, and Professor Petitjean has been the cornerstone of my academic journey. The quality of our exchanges was so exceptional that, by the end, my greatest concern was not completing the thesis but the prospect of having fewer interactions with someone of such intellectual brilliance.

I would also like to extend my heartfelt thanks to my secondary school teachers who helped me navigate my path since my arrival in Belgium. It was not an easy journey, but Belgium offered me and my family a second chance. I am immensely grateful for their support.

A special thanks to my friends and family for their unwavering support throughout this academic journey. Without their help, compassion, and love, I would not have had the strength to reach this point. Their encouragement has been invaluable.

My sincere thanks go to the entire teaching staff at UCLouvain for their dedication to excellence and their humanistic values. The principles they instilled in me are priceless.

Finally, I would like to express my profound appreciation to my beloved parents, who sacrificed their youth to provide us with a better life. Their unwavering dedication and constant support have strengthened me in unimaginable ways. I want to take this opportunity to say thank you and to express that my love for them is as boundless as the sky.

I dedicate this thesis to the memory of my grandparents, who hoped to see me succeed and return to Chad to share this knowledge.

TABLE OF CONTENT

Contents

ABSTRACT.....	1
Acknowledgements.....	3
TABLE OF CONTENT	4
Chapter 1.....	5
Chapter 2.....	9
Chapter 3.....	14
Chapter 4.....	18
Chapter 5.....	21
Chapter 6.....	29
Chapter 7.....	33
Bibliography.....	35
Appendix.....	40

Chapter 1

Introduction

Research Context

Leading Economic Indicators (LEI) are precious tools for socio-economic actors and decision-makers. Much like sophisticated climate models that predict long-term weather patterns by analyzing various atmospheric variables, LEI offer a useful and data-driven glimpse into future economic trends. The question is whether the use of these indicators in portfolio management can be beneficial in terms of risk and return. By leveraging various financial theories, we will attempt to clarify this issue.

The pioneering work on Modern Portfolio Theory (MPT) by Harry Markowitz establish the relation between risk and return in diversified portfolios.

Subsequent developments, including the Capital Asset Pricing Model (CAPM) introduced by William F. Sharpe, John Lintner, and Jan Mossin, have further advanced our quantitative comprehension of financial markets.

Furthermore, the Efficient Market Hypothesis (EMH), introduced by Eugene Fama, argues that asset prices reflect all available information, making it impossible to beat the market consistently in the long term.

However, these restrictive hypotheses are questioned by the observation of numerous anomalies and puzzles that seem to contradict the classical model (Alphonse, Desmuliers, Grandin).

In response to these limitations, behavioral finance points out the irrational reactions of investors and their influence on asset prices, as well as the mispricing of fundamental asset values considering limited rationality, contrary to the assumption of perfect rationality in classical theory according to von Neumann and Morgenstern. Robert Shiller and other behavioral finance researchers have demonstrated the effect of emotions and irrational perceptions on markets, thereby creating market anomalies and prediction opportunities (Shiller, 2000; Kahneman & Tversky, 1979).

This alternative perspective opposes Fama's view and illustrates how human behaviors can diverge from purely rational models. As John Maynard Keynes quoted: "The market can stay irrational longer than you can stay solvent."

Additionally, economic cycles, as described by Schumpeter, reveal recurring phases of growth and recession, influenced by major technological innovations and structural transformations (Mijot, 2018).

In the context of today's highly interconnected and reactive global economy, marked by economic uncertainties, systemic financial crises, and geopolitical tensions, the ability of leading indicators to furnish future perspectives becomes even more indispensable for economic deciders.

Main Question

Our motivation and ambition with this research begin with the elementary question:

Does the use of leading macroeconomic indicators help invest cash reserves better in well-known diversified portfolios?

To achieve this, we will identify which portfolios utilizing the LEI have performed better. Specifically, we will focus on the pain associated with market declines and their duration, quantified by metrics such as the maximum drawdown and the Ulcer Index. We will classify the portfolios based on their performance and derive important lessons from these findings.

The debate between EMH, behavioral finance, and business cycle studies afford a global starting point for investigating this question.

These perspectives offer contrasting views on market efficiency, investor behavior, and the repetition of market trends, allowing for a practical analysis of how LEI can be used to develop cash management strategies.

Thesis Structure

To provide a clear overview of the content of this thesis, we will first outline the structure of our work.

Chapter 2: We begin by reviewing the notion of MPT and the CAPM, we will introduce the theoretical base of diversification and the relationship between risk and return. Then, we will examine their limitations and criticisms.

Chapter 3: This chapter covers economic cycles, addressing different theories and their limitations. The chapter is divided into three parts: long-term economic cycles, short-term business cycles and an evaluation of the implications and limits of these cycles on the economy.

Chapter 4: In this chapter, we review economic indicators by categorizing and describing the characteristics of various types. We will then discuss their usefulness and limitations.

Chapter 5: This chapter is focused on the description of the methodology we followed to answer our main research question. We detail the data used in the study and the analytical methods employed to evaluate the performance of selected portfolios and the effectiveness of leading indicators. We specify data sources, the criteria for selecting portfolios and indicators, and the statistical tools used.

Chapter 6: In this chapter results and analyses present the conclusions drawn from the empirical analysis. We will assess the performance of portfolios and leading indicators in forecasting financial markets and analyze the performance of diversified portfolios using these indicators.

Chapter 7: This final chapter concludes the thesis. We point out implications and underline the limitations of our work to finish with some suggestions for future research.

Chapter 2

Modern Portfolio Theory and the Capital Asset Pricing Model

The view of portfolio management has been profoundly influenced by the development of Modern Portfolio Theory (MPT) and the Efficient Market Hypothesis (EMH), both of which have promoted a more systematic and analytical approach to investment strategy.

Firstly, Harry Markowitz's work on MPT in 1952 introduced a quantitative model that spotlight the benefits of diversification. His discoveries, suggesting that diversification can reduce investment risk without proportionally reducing expected returns, have become a fundamental of portfolio management.

Afterward, William F. Sharpe extended this framework through the Capital Asset Pricing Model (CAPM) in 1964, introducing beta as a measure of an investment's relative volatility and risk in comparison to the market.

Parallel to these developments, Eugene F. Fama articulated the Efficient Market Hypothesis in 1970, which asserts that stock prices reflect all available information, making it futile to try to outperform the market through traditional stock-picking methods. This hypothesis categorizes market efficiency into three levels: weak, semi-strong, and strong, each detailing the degree to which public and private information is reflected in stock prices.

More recent advancements, such as the extensions of Fama and French (1992) models, along with the inclusion of the momentum factor by Carhart (1997), have sought to explain stock returns by introducing factors like firm size (Banz, 1981), book-to-market ratio (Fama & French, 1992), and momentum (Jegadeesh & Titman, 1993; Cooper, Gutierrez, & Hamid, 2004).

However, Thaler (1987) and Shiller (1981) have pointed out anomalies and puzzles, such as market overreaction, which are not easily explained by these models. We are fortunate today to have access to the video of the debate between Eugene Fama and Richard Thaler on YouTube, titled "Are markets efficient?" by Chicago Booth Review. In this debate, on one hand Fama relies on robust mathematical and statistical models to support his assertions, maintaining confidence in the long-term efficiency of markets. He argues that what Thaler and others describe as "bubbles" are merely anecdotal phenomena when viewed over extended periods. Thaler, on the other hand, takes a more qualitative approach to explain market behavior. He spotlights numerous examples of anomalies, which Fama refers to as market inefficiencies or "bubbles." Thaler supports his arguments with various instances, including research by Robert Shiller, who shared the Nobel Prize in Economics with Fama. The debate is rich in learning, as both academics articulate the foundations of their theories. Watching them exchange ideas in person, beyond the confines of books and articles, offers a singular instructive exchange.

From this perspective emerges a specific perception of the market. If an investor believes that markets are efficient, the only decision is the allocation between risk-free assets and risky assets on the efficient frontier. This scenario is the buy-and-hold approach or passive investment, where the investor relies on the market's ability to reflect all available information in asset prices.

Conversely, if the investor assumes that markets are not perfectly efficient, a different strategy can be employed. In this case, the investor may opt for an active portfolio management approach, attempt to outperform the market by identifying and exploiting inefficiencies.

This strategy requires more frequent trading and potentially higher transaction costs, along with rebalancing based on their anticipations to capitalize on potential “pockets” of inefficiencies.

Active management relies on research and analysis to identify undervalued or overvalued securities, and the costs associated with this strategy can include not only transaction fees but also expenses related to research and analysis.

Following this, Robert Litterman and Fischer Black's work on global portfolio optimization introduced advanced techniques for managing portfolios that account for both predicted and unexpected changes in the market conditions.

Limitations and Critiques of MPT, CAPM and EMH

Limitations of MPT

MPT, has been fundamental in portfolio management. However, it has several limitations.

For instance, Merton (1972) and Roll (1977) criticized MPT for assuming normally distributed asset returns and linear correlations between them. This simplifying assumption fails to account for tail risks (extreme events) that can lead to a sharp drop in returns. As Taleb's Black Swan theory (2007) suggests, rare and unpredictable events can have a significant impact, often beyond what traditional models and historical data can anticipate.

Additionally, MPT assumes investors are rational and utility-maximizing, which is not always observed in practice. (Shiller, 2000; Kahneman & Tversky, 1979).

Practical Limitations of the CAPM

Pascal Alphonse, Gérard Desmuliers, Pascal Grandin, and Michel Levasseur in *Gestion de portefeuille et marchés financiers* underline practical limitations of the model.

A main critique is the identification of the market portfolio, often represented by a proxy like the S&P 500 for the US market. This choice of proxy is arbitrary and may not accurately reflect the entire market.

Moreover, the beta coefficient, which measures an asset's sensitivity to market movements, is not directly observable and is assumed to be stable over time.

However, Blume's work (1975) has contradicted this stability, showing that beta coefficients tend to regress towards the mean over time, indicating that they are not as stable as previously assumed. (Pascal Alphonse, Gérard Desmuliers, Pascal Grandin, Michel Levasseur, *Gestion de Portefeuille et Marchés Financiers*, 2nd Edition, Pearson, 2017).

Additionally, studies have shown that beta can vary across different periods, questioning its constancy. This has been demonstrated in studies by Miller and Scholes (1972) and later by Black, Jensen, and Scholes (1972), as noted by Roland Gillet and Georges Hubner (2000)

Critiques of Market Efficiency

Anomalies and Puzzles

Despite market efficiency being a cardinal concept in financial theory, various anomalies and puzzles challenge this hypothesis, suggesting that markets may not be as efficient as traditionally thought.

Calendar anomalies, such as the Monday effect observed by Chan, Leung, and Wang (2004), bring out irregularities in stock returns, indicating that prices do not always follow the random walk hypothesis. This hypothesis posits that prices incorporate all available information and move randomly, yet phenomena like the Monday effect and the January effect, where stock returns are typically higher in January compared to other months, question this assumption.

Additionally, persistent anomalies such as the small-firm effect, identified by Banz (1981), demonstrate that smaller firms tend to outperform larger firms. Similarly, the value effect, detailed by Fama and French (1992), shows that stocks with high book-to-market ratios tend to outperform those with low ratios. These anomalies suggest that certain patterns and trends can be exploited, contrary to the idea of market efficiency.

Moreover, market puzzles add further complexity. The equity premium puzzle, described by Mehra and Prescott (1985), reveals that the historical returns on stocks over government bonds are higher than what standard financial theories can explain. The volatility puzzle, which points

out that market volatility is greater than what would be expected under models assuming efficient markets, also challenges the validity of market efficiency.

The Asset Allocation Puzzle and Active Management

One important aspect of active portfolio management is market timing. For example, using Leading Economic Indicators (LEI) to predict the market trend. Classical theory, like Tobin's "two-fund separation" and the EMH model, posits that the only decision for an investor is the allocation of wealth between risky and risk-free assets.

However, Mankiw and Will (1997) questioned this simplification, pointing out the "asset allocation puzzle", where investors do not always adhere this theoretical framework.

Limits of Arbitrage

Finally, the limits of arbitrage, discussed by De Long, Shleifer, Summers, and Waldmann, demonstrate that even when arbitrage opportunities theoretically exist, practical factors like risk and transaction costs can prevent their full exploitation. These limits suggest that markets may not be as efficient as theory suggests, leaving room for persistent anomalies.

In conclusion, while MPT, CAPM, and other classical models have profoundly influenced portfolio management, critiques and extensions from more recent research reveal the increasing complexity of financial markets, where irrational behaviors and anomalies persist despite efforts to model and understand them.

Challenges to Traditional Models from Behavioral Finance

Despite these advancements, modern theories have faced challenges from behavioral finance, particularly through the works of Robert Shiller, Daniel Kahneman and Amos Tversky. Shiller's research has pinpointed how psychological factors and irrational behaviors can lead to market anomalies such as bubbles and crashes, phenomena that traditional EMH struggles to explain. Behavioral economists like Daniel Kahneman and Amos Tversky introduced notion such as cognitive biases and heuristic-driven decisions, which have shown that investor behavior often deviates from rational models predicted by traditional finance theories. Their Prospect Theory, for instance, explains how people evaluate potential losses and gains, showing that individuals tend to be loss-averse placing more weight on potential losses than on equivalent gains.

An Integrated Perspective of Modern Financial Theory

The integration of perspectives from traditional financial theories with behavioral finance suggest a more nuanced interpretation of market conditions and investor behavior.

This synthesis not only challenges the primary assumptions of financial economics but also changes the strategies employed in portfolio management.

By considering both rational financial principles and the irrational elements of investor behavior, financial theories continue to evolve, offering refined strategies that accommodate a complex and often unpredictable market environment.

Chapter 3

Economic Cycles

In investment management, a global knowledge of economic cycles can serve as a helpful guide or compass for adequately adjusting portfolio strategies.

These cycles, which including both long-term and short-term variations, affect asset performance and strategic investment decisions.

Discerning the patterns within these cycles allows investors to make more serene choices, as both long-term trends and short-term fluctuations can affect the market condition.

Long-Term Economic Cycles

The hypothesis of long-term economic cycles, often referred to as Kondratiev waves, was introduced by Joseph Schumpeter in 1939. These cycles involve extended periods of economic growth and decline, largely influenced by technological advancements and capital accumulation. Schumpeter noted the importance of strategic patience and long-term planning in managing investment portfolios.

In addition, Jeremy J. Siegel, in *The Future for Investors*, discusses the sustained benefits of investing in high-quality stocks that thrive on long-term growth patterns.

Likewise, Carmen Reinhart and Kenneth Rogoff, in *This Time is Different*, examine how historical financial crises recur within these long waves, delivering helpful information about the cyclic nature of financial markets.

Moreover, Gordon Ian's work in *The Long Wave Analyst* offers detailed analyses of how these cycles affect specific sectors, assisting investors in identifying optimal entry and exit points.

Eric Mijot, along with Pascal Blanqué and Philippe Ithurbide, further explores these themes in *Cycles d'investissement et allocation d'actifs*. They focus on the importance of analyzing both long-term and short-term cycles, providing a configuration for asset allocation based on historical market data and the role of central banks.

Collectively, these contributions offer an exhaustive perspective on incorporating long-term economic trends and cycles into investment decision-making, blending historical interpretations with current market realities.

Short-Term Business Cycles

Short-term business cycles, as described by economists such as Milton Friedman and Alan Greenspan, represent frequent and often predictable economic changes influenced by monetary policy and market sentiment. For example, Friedman's examination of monetary policy highlights how actions by central banks can either reduce or increase economic volatility, thereby affecting asset prices and investment returns.

In a similar context, Greenspan's *Margins, Higher for Longer* explores the immediate repercussion of prolonged economic policies, particularly regarding asset bubbles and interest rates. He calls attention to a careful perspective on managing risks during economic peaks, warning of the potential consequences of sustained policies.

Additionally, Fisher Black and Robert Litterman, in *Global Portfolio Optimization*, present a quantitative approach for adjusting portfolio allocations in response to anticipated short-term economic shifts. Their model incorporates expected returns and asset covariances to upgrade portfolio efficiency, considering the prevailing economic conditions.

Further contributing to this field, Victor DeMiguel, Lorenzo Garlappi, and Raman Uppal explore asset allocation strategies in their research. They address the necessity of adjusting to economic uncertainties and utilizing short-term economic indicators to strengthen portfolio performance.

Beyond the analyses by Friedman and Greenspan, other famous cycles of economic movements worth considering. These include:

Kitchin Cycles: These cycles, generally lasting 3-4 years, are influenced by inventory level adjustments as businesses respond to changes in demand. They point out the immediate effects of supply and demand imbalances on economic activity (Kitchin, 1923).

Juglar Cycles: Spanning 7-11 years, these cycles are linked to variations in capital investment, driven by changes in interest rates and business profitability. They play a key role in the different phases of economic growth as businesses alter their investment strategies (Juglar, 1862).

Samuelson Oscillator: Introduced by Paul Samuelson, this model describes how fluctuations in economic output result from the interactions between consumption and investment, explaining the role of expectations and decision-making delays in creating these cycles (Samuelson, 1939).

In addition to these cycles, the concept of patterns and waves in economic and market analysis gain interest because of the human tendency to look for coherence and anticipation.

These sequences, such as the Elliott Wave Theory and Dow Theory, offer a semblance of predictability and control.

The Elliott Wave Theory, developed by Ralph Nelson Elliott, suggests that market prices follow specific motifs characterized by a series of waves, which can predict future market movements. This theory identifies impulse waves, which align with the main trend, and corrective waves, which counteract the trend. The fractal nature of these waves allows them to be observed across different time frames (Elliott, 1938).

Dow Theory, another structure, examines market trends and phases, identifying primary trends, secondary reactions, and minor trends. It outlines a market's phases of accumulation, public participation, and distribution (Dow, 1932).

Limitations

Firstly, the excessive dependence on historical data presents a limitation.

While economic cycles provide a decent view, they are intrinsically based on past events and may not fully account for unprecedented occurrences or structural changes in the global economy.

This point is illustrated by Reinhart and Rogoff's *This Time is Different*, which points out that past financial crises, may not predict future events considering uncertain market conditions and regulatory policies.

Secondly, the accuracy of predictions based on economic cycles can be inconsistent. Particularly, the timing and duration of cycles like Kitchin and Juglar cycles are variable, making them challenge to use as precise tools for investment decisions. Milton Friedman and Anna Schwartz, in their analysis of monetary policy, recognize that central bank actions can influence these cycles, yet outcomes are often uncertain because of external shocks and complex economic interactions.

Thirdly, the role of behavioral factors complicates the application of economic cycles in portfolio management. As exhibited by Robert Shiller in his work on behavioral finance, market sentiment and investor psychology can cause deviations from expected economic patterns, thus limiting the predictive power of traditional cycle theories.

Finally, globalization and increased interconnectivity have added additional dimensions of complexity to the traditional conception of economic cycles. Researchers like John Cochrane and Nicholas Bloom have pointed out that domestic cycles are now more susceptible to international events, such as geopolitical tensions and global high-tech advancements, which can alter economic trajectories.

Chapter 4

Economic Indicators

Economic Indicators are classified into three categories based on their timing relative to economic activities: leading, lagging, and coincident indicators.

Leading Indicators: To begin with, these indicators provide early signals about the future direction of the economy. They typically change before the broader economy starts to follow a particular trend, making them practical for predicting future economic activity (Stock & Watson, 1989).

Lagging Indicators: In contrast, lagging indicators reflect the changes that have already occurred in the economy. These indicators typically change after the economy has already begun to follow a particular trend, thereby confirming patterns and trends in the economy (Bernanke & Blinder, 1992).

Coincident Indicators: Lastly, coincident indicators move simultaneously with the overall economy, providing real-time information about the current state of economic activity (Burns & Mitchell, 1946). They help in knowing the current phase of the economic cycle.

Leading Macroeconomic Indicators

The development of leading macroeconomic indicators has been extensively studied.

First, Stock and Watson (1989) were pioneers, in advancing the conception of leading economic indicators. Their research introduced a systematic approach to identifying and combining various economic indicators to forecast economic activity. They indicate the importance of composite indexes, which aggregate multiple indicators to provide a more robust and reliable forecast of economic conditions. Lahiri and Moore (1991) further contributed by perfecting the methodology for selecting and evaluating leading indicators, raising the importance of indicators that possess predictive power across different economic environments.

In addition, research by Estrella and Mishkin (1998) demonstrated that composite indexes, which combine multiple leading indicators, offer more accurate forecasts than individual indicators alone. This approach reduces the noise associated with any single indicator and provides a more complete view of the economy.

Moreover, Marcellino (2005) provided a comprehensive guide on the construction, use, and evaluation of leading indicators. He analyzed the selection of target variables, such as GDP or industrial production, and the choice of filtering methods and business cycle dating procedures to transform continuous variables into binary expansion/recession indicators. Marcellino's work also detailed the construction of composite indexes, both non-model-based and model-based, such as dynamic factor models and Markov switching models. He discussed how these models can be used to produce more accurate forecasts by addressing issues like data revisions and time-varying parameters. Marcellino (2005) also examined the evaluation of forecasts generated by leading indicators, discussing various methods and models that transform these indicators into forecasts of target variables. He reviewed recent literature on the performance of leading indicators, particularly in the context of their predictive power during economic events, such as the US recessions of 1990-91 and 2001. His comprehensive analysis included the strengths and weaknesses of different approaches and suggested directions for future research in this area.

Later, Samaniego Alcántar and Rodríguez Reyes (2022) explored the application of leading macroeconomic indicators in dynamic investment strategies. They developed a portfolio optimization model using Composite Leading Indicators (CLI) and Business Confidence Indicators (BCI), which adjusts investments according to business cycle movements. Their study demonstrated that a dynamic investment strategy, which reallocates assets between stock indices and government bonds based on these indicators, can outperform a static market index strategy. This approach proved particularly effective in the Mexican financial market, yielding higher returns with reduced risk exposure compared to a buy-and-hold strategy.

The Conference Board's Leading Economic Index (LEI) serves as a prominent example of a composite index used to predict future economic activity. This index combines ten different indicators, such as average weekly hours in manufacturing, new orders for consumer goods, and stock prices, among others. For instance, the stock market component reflects investor sentiment and expectations, while new orders for manufactured goods offer insights into

business investment trends. The LEI has demonstrated strong predictive power during periods of economic uncertainty, often signaling turning points ahead of other indicators with greater accuracy.

Recent Studies and Critiques

Recent studies have continued to explore the effectiveness and limitations of leading macroeconomic indicators. Banbura et al. (2013) investigated the predictive power of the LEI following the 2008 financial crisis. They found that, although the LEI remained a useful forecasting tool, its accuracy was not consistent across different economic conditions. Similarly, Chauvet and Piger (2008) tested the real-time performance of leading indicators and discussed the difficulties posed by data revisions, indicate the need for robust statistical methods to meliorate forecasting accuracy.

Critiques of leading macroeconomic indicators often point to their vulnerability to false signals and the risk of over-relying on historical data. Orphanides (2001) noted that real-time data revisions could affect the predictive power of these indicators, cautioning policymakers and investors against taking these signals at face value. Furthermore, McGuckin and Ozyildirim (2004) pointed the necessity of continually updating and refining leading indicators to adapt to structural changes in the economy and to the increasing availability of data.

Leading macroeconomic indicators are wonder tools for forecasting economic conditions and informing investment strategies. The major works of Stock and Watson (1989) and Lahiri and Moore (1991), along with more recent studies, establish the foundation for the development and application of these indicators. By taking advantage of a diverse set of leading indicators, investors can better anticipate market trends, manage risks, and make savvy decisions to optimize their portfolios.

Chapter 5

Data and Methodology

In this section, I will explain where I found the data that I used in the analysis and how I retrieved them. I will also explain the methodology followed for the analysis: the steps followed, the ratios and other indicators.

Data

Following extensive discussions with our thesis advisor, Monsieur Petitjean, we identified PortfolioCharts.com for our analysis. This website offers several tools that evaluate hundreds of possible portfolios composed of Exchange-Traded Funds (ETFs), making it ideal for our study of diverse asset allocation strategies from January 2008 to January 2024.

Before explaining the data and sources, we will provide a brief explanation of ETFs to better understand their role in our work.

ETFs are investment funds traded on stock exchanges, like stocks. They typically track an index, commodity, or basket of assets, providing investors with diversified exposure.

ETFs have become popular of modern portfolio management attributable to their versatility, liquidity, and cost-effectiveness. ETFs offer investors a convenient way to gain exposure to a wide array of asset classes, sectors, and geographic regions.

Key characteristics of ETFs include:

Liquidity: ETFs can be bought and sold throughout the trading day at market prices, offering greater flexibility compared to mutual funds, which are traded at the end of the trading day.

Transparency: ETFs generally disclose their holdings daily, allowing investors to know exactly what assets they are exposed to.

Cost-Effectiveness: ETFs often have lower expense ratios compared to actively managed mutual funds, making them an attractive option for cost-conscious investors Gastineau (2001).

The Role of ETFs in Portfolio Management

ETFs play a varied role in portfolio management strategies meriting their inherent advantages.

Firstly, **Diversification:** ETFs provide exposure to a broad range of asset classes, including equities, fixed income, commodities, and alternative investments. This diversification helps in reducing unsystematic risk (Bodie, Kane, & Marcus, 2014).

Secondly, Tactical Asset Allocation: ETFs simplify tactical adjustments in portfolio allocations based on market conditions and economic outlooks. Investors can quickly shift exposures to different sectors or regions in response to market signals (Shen, Szakmary, & Sharma, 2005).

Moreover, Risk Management: ETFs can be used to hedge against specific risks. For instance, inverse ETFs and volatility ETFs allow investors to protect their portfolios during market downturns (Trainor & Baryla, 2008).

Finally, Liquidity Management: ETFs are often used for managing cash flows and maintaining liquidity within portfolios without being exposed to market risks (Hasbrouck, 2003).

Portfolio Selection

We selected ten portfolios known for their well-known performance over time from PortfolioCharts.com. After initially calculating their performance, we narrowed it down to three portfolios that appeared to be the most effective according to our metrics.

Next, we applied a rebalancing strategy to these three portfolios:

Initial Rebalancing: We first rebalanced these three portfolios without considering the leading indicator to observe the effect of regular rebalancing on their performance.

Indicator-Based Rebalancing: Subsequently, we rebalanced these three portfolios based on the signals from the leading indicator we developed.

This approach allowed us to evaluate the impact of the rebalancing strategy with and without the guidance of the leading indicator.

Below is a succinct presentation of each portfolio

Classic 60/40: This portfolio allocates 60% to equities and 40% to bonds, offering a balanced approach between growth and stability.

Golden Butterfly: Created by Tyler PortfolioCharts.com, this portfolio consists of 20% total stock market, 20% small-cap value, 20% long-term bonds, 20% short-term bonds, and 20% gold, providing a mix of growth and stability with a focus on diversification.

Permanent Portfolio: Developed by Harry Browne, this portfolio includes 25% in stocks, 25% in long-term bonds, 25% in cash, and 25% in gold. It is designed to perform well in various economic conditions.

All Seasons: Created by Ray Dalio, this portfolio is diversified across different asset classes with a typical allocation of 30% stocks, 40% long-term bonds, 15% intermediate-term bonds, 7.5% gold, and 7.5% commodities. It aims to balance risk in different market environments.

Swensen: Named after David Swensen, the CIO of Yale University's endowment, this portfolio typically includes 30% domestic equity, 15% international equity, 20% real estate, 15% government bonds, 15% inflation-protected securities, and 5% emerging markets.

Sandwich Portfolio: A portfolio characterized by its "sandwich" of risk assets with safer assets, generally containing equities, bonds, and other diversifying assets.

Larry Portfolio: Developed by Larry Swedroe, this portfolio emphasizes a high allocation to bonds (typically around 70%) and small-cap value stocks (around 30%), aiming for stability with modest growth potential.

Pinwheel Portfolio: A variation of the Golden Butterfly with additional diversification, often consisting of equal parts large-cap stocks, small-cap stocks, Real Estate Investment Trusts (REITs), international stocks, bonds, and commodities.

Ultimate Buy and Hold: Designed by Paul Merriman, this portfolio advocates for a diversified mix of asset classes, including U.S. and international stocks, small-cap value stocks, real estate, and bonds, typically in a 60/40 split.

- Total Stock Market: This portfolio consists entirely of a broad-based index fund that covers the entire stock market. It aims to capture the full range of the market's performance

Each portfolio was chosen based on its historical data availability and the relevance to our study's timeframe.

Selection of Reference Market, Leading Indicators

First, for the leading indicators and reference market the choice of the U.S. market as our reference for portfolio comparison is underpinned by several pragmatic and theoretical considerations.

The substantial availability of advanced economic indicators specific to the U.S., such as the Brave-Butters-Kelley Leading Indexes (BBKLEI), influenced this decision. These indexes offer granular database into economic trends for our approach.

Selecting a reference market is often a complex and somewhat arbitrary decision influenced by the availability of data and the specific objectives of the research.

As we have seen previously in our literature review, this constitutes one of the weaknesses of the CAPM, where the choice of a market proxy can modify the results and interpretations.

However, the various proxies used to approximate the U.S. market are generally similar in terms of risk-return profile and composition. Thus, we chose two interchangeable reference markets to add robustness to our analysis.

First, we selected the iShares MSCI World ETF USD as a reference to compare with the Total Stock Market (TSM) portfolio.

The IWRD is considered a good proxy as it encompasses approximately 1,500 large and mid-cap companies across 23 developed markets, providing broad exposure to global equities.

For the second part of the analysis, we chose the Vanguard Total Stock Market Index Fund, which is also an excellent proxy for the U.S. market. This fund offers exposure to the entire U.S. equity market, including small-, mid-, and large-cap growth and value stocks.

Our selection of the period from 2008 through early 2024 conform with the availability of ETFs that began post-financial crisis, marking an outstanding increase in financial instruments fitting diversified investment strategies.

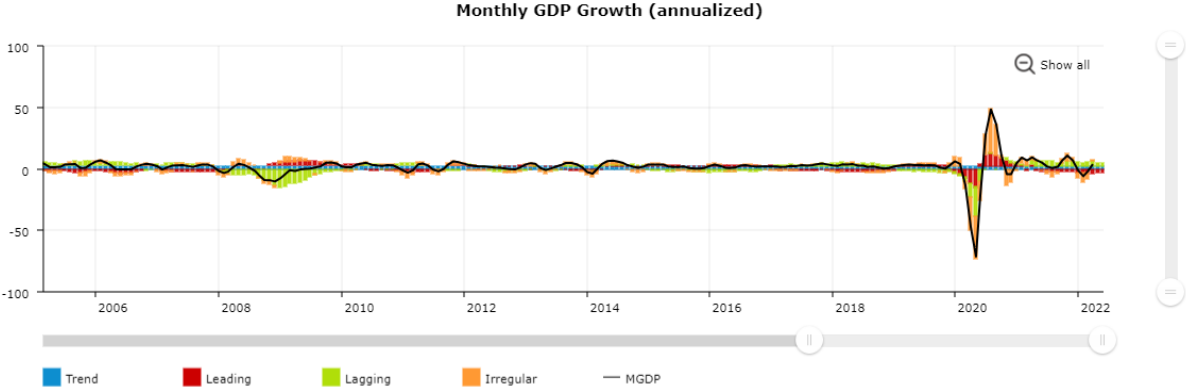
In summary, the methodological choice to concentrate on the U.S. market and leverage specific economic indicators such as the BBKLEI is substantiated by the extensive financial literature and practical considerations related to data availability and the US market dynamics.

This approach ensures that our portfolio strategies are grounded in robust economic theories and are reflective of real-world financial environments.

Construction of Buy and Sell Signals Using Brave-Butters-Kelley Leading Indexes

Given the unavailability of the Conference Board Leading Economic Index (LEI) over our sample period, our research retained the Brave-Butters-Kelley Leading Indexes (BBKLEI) to develop advanced economic indicators. These indicators, discussed in the 2019 Chicago Fed Letter by Scott A. Brave, Ross Cole, and David Kelley, aggregate a vast array of monthly macroeconomic time series to forecast U.S. economic activity accurately. The BBKLEI was chosen for its effectiveness in predicting future economic activities.

Figure2: BBK Indicators



The methodology involved the mixed frequency collapsed dynamic factor model from which the BBKLEI is derived, providing a decomposition of monthly real GDP growth into trend, cycle, and irregular components as we can see in figure 2

Signal Generation Strategy

Our buy and sell signals were specifically derived from the leading component of the BBKLEI, which focuses on anticipating future economic conditions:

Buy Rule: Increase exposure to equities by shifting 100% of the bond allocation into equities when the BBK Leading Index surpasses its established threshold, indicating potential economic upturns. This adjustment is made without altering other asset components in the portfolio.

Sell Rule: Shift 100% of the equity allocation into bonds when the BBK Leading Index declines below its threshold, signaling impending economic downturns. This adjustment is made without altering other asset components in the portfolio.

By proceeding in this manner, we aim to maintain the overall nature of the portfolios while only rebalancing between the two primary assets of our analysis.

This proactive strategy takes advantage of the predictive power of the BBKLEI's leading indicators to readjust portfolio allocation before economic shifts become apparent in the general market.

Our approach was inspired by the work of Mebane T. Faber, particularly his paper "A Quantitative Approach to Tactical Asset Allocation" (Faber, 2006). Faber's methodology presented a simple quantitative method to improve risk-adjusted returns across various asset classes. His research demonstrated the effectiveness of using leading indicators for tactical asset allocation, a principle we applied in our strategy.

Data Retrieval

Using the Portfolio Finder tool on PortfolioCharts.com, we retrieved the tickers for each asset in the selected portfolios. Then, we used Excel's STOCKHISTORY function to pull the total return data for these tickers, organizing them into tables in our spreadsheets for greater modularity with other tools. This tabular format facilitates easier data manipulation across the various tools we used, enhancing the efficiency and accuracy of our analysis.

Methodological Tools

To further explore our analysis, we used several advanced tools:

- Excel served as our primary tool for initial data retrieval and manipulation, leveraging the combined use of NEDL videos and our thesis advisor's custom spreadsheet for testing dynamic strategies. The NEDL videos are exceptionally well-constructed, providing step-by-step tutorials for calculating performance ratios. We appreciate our thesis advisor's early guidance in directing us to these invaluable resources.
- RStudio and Python were employed for detailed statistical analysis and to validate our initial findings. We primarily used RStudio and the Performance Analytics package, as referenced by Ardia, which allowed us to verify our initial calculations. This approach was chosen to gain practical knowledge of the fundamental tools used by analysts. By first

manipulating our data in Excel and then comparing the results with RStudio, we effectively lifted the "black box," ensuring transparency and accuracy in our methodology.

Additionally, the R script enabled us to perform complex calculations quickly. The complementary nature of both tools enhances our analytical capabilities. Understanding how to leverage each tool is an invaluable asset in our training, allowing us to harness their full potential for comprehensive data analysis.

Again, we are grateful to our thesis advisor for recommending these resources early in our collaboration.

- PortfolioVisualizer.com provides additional and powerful tools for back-testing asset performance. This website has been a tremendous find for us because the tools available to users are incredibly fantastic and easy to use. These tools include:

Back-test Portfolio: Allows users to evaluate historical performance of custom portfolios.

Factor Analysis: Analyzes the impact of different factors on portfolio returns.

Monte Carlo Simulation: Uses random sampling to model and forecast portfolio performance.

Asset Correlation: Helps in understanding the correlation between different assets.

Efficient Frontier: Visualizes the risk-return spectrum to identify optimal portfolios.

The intuitive interface and robust functionality of PortfolioVisualizer.com make it a practical resource for our research and analysis.

- Fred Excel Extension: Used for extracting economic leading indicators like the BBKLEI. We followed the NBER guide for using the add-on directly in Excel. First, we set up our spreadsheet and then retrieved the indicators of interest.

Methodological Approach

Our methodology integrated both quantitative and qualitative analysis to provide a comprehensive view of each portfolio's performance across various metrics:

Quantitative Analysis

We calculated several risk-adjusted metrics to evaluate the performance of the portfolios. These metrics include:

Compound Annual Growth Rate (CAGR): To measure the mean annual growth rate of the portfolios over a specified period longer than one year (Baum, 2006).

Rolling Return: To assess the average annualized return over a specific number of years (Lhabitant, 2004).

Jensen's Alpha: To evaluate the portfolios' excess returns over the expected return, adjusted for market risk (Jensen, 1968).

Sharpe Ratio: To measure the portfolios' risk-adjusted returns by comparing the excess return over the risk-free rate to the total risk (Sharpe, 1966).

Treynor Ratio: To measure the returns earned more than what could have been earned on a risk-free investment per each unit of market risk (Treynor, 1965).

Information Ratio: To evaluate the returns of the portfolios relative to a benchmark, adjusted for the risk of those returns (Goodwin, 1998).

Additionally, we used other metrics to assess the portfolios' downside risks:

Maximum Drawdown: To measure the largest peak-to-trough decline in the portfolios' value before a new peak is attained (Lo, 2002).

Sortino Ratio: To measure the risk-adjusted returns, focusing on downside volatility (Sortino & Price, 1994).

Calmar Ratio: To compare the average annual compounded rate of return and the maximum drawdown risk (Young, 1991).

Sterling Ratio: To evaluate the risk-adjusted return based on the maximum drawdown (Kestner, 1996).

Semivariance: To measure the variability of returns below the mean (Markowitz, 1952).

Semideviation ("Downside Risk"): To measure the downside risk, focusing on negative returns (Markowitz, 1952).

Ulcer Index: To measure the depth and duration of drawdowns in the portfolio (Martin, 1987).

Martin Ratio: To evaluate the risk-adjusted performance using the Ulcer Index (Martin, 1987).

Residual Risk: To measure the unsystematic risk of the portfolio (Lintner, 1965).

Appraisal Ratio: To measure the portfolio's performance relative to its risk (Treynor & Black, 1973).

Kurtosis: To measure the "tailedness" of the portfolio return distribution (DeCarlo, 1997).

The detailed analytical calculations of these metrics are provided in the appendices.

Qualitative Analysis

- **Historical Context:** We considered the economic and market conditions during the study period to contextualize the portfolio performances. Specifically, we chose to analyze the portfolios in the context of past crises to understand how they would have performed under various adverse economic scenarios. By doing this, we aimed to evaluate the resilience and stability of the portfolios during periods of market turbulence, such as the 2008 financial crisis

Ulcer Index and Portfolio Pain Measurement

The Ulcer Index, a critical measure in our study, quantifies the intensity and duration of portfolio drawdowns. This metric is especially informative compared to standard deviation as it provides a more nuanced view of the risk considering both the depth and the length of drawdowns.

This comprehensive data collection and methodological framework allowed us to conduct a detailed analysis of selected portfolios over a 16-year period.

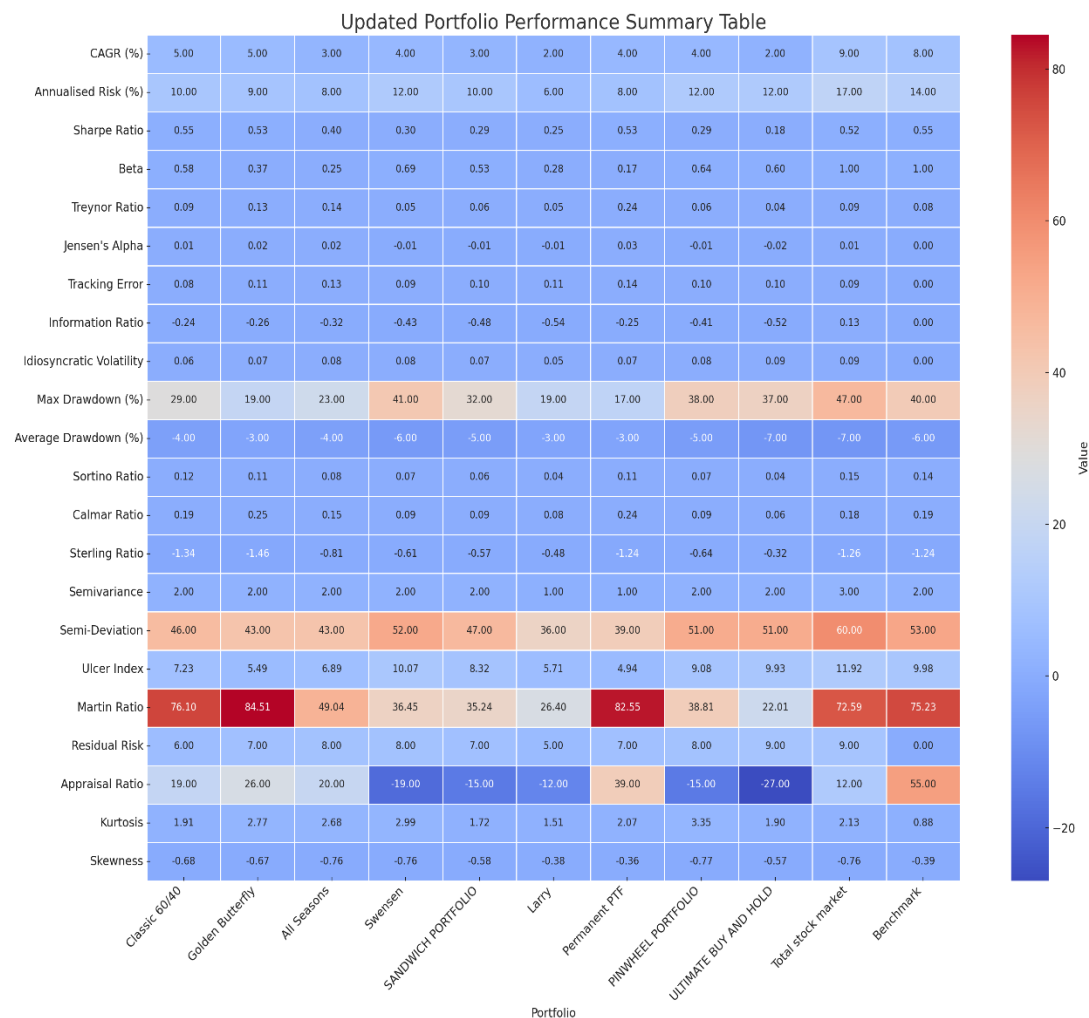
Chapter 6

Results and analyses

During the period of our analysis from January 2008 to January 2024, the performance of different portfolios was assessed based on various metrics including risk-adjusted returns, drawdowns, and other financial ratios. Our primary goal was to determine if the use of leading macroeconomic indicators (LEI) could enhance cash management in diversified portfolios.

Overall Performance

Figure : Performance summary



The analysis was conducted on three key portfolios: Classic 60/40, Permanent Portfolio, and Total Stock Market (TSM). We compared these with a reference market, using both rebalanced

and non-rebalanced strategies, incorporating leading economic indicators for enhanced decision-making.

Key Findings

Buy-and-Hold Strategy

Total Stock Market (TSM): The TSM portfolio showed the highest Compound Annual Growth Rate (CAGR) at 9%. However, it also exhibited the highest annualized risk (17%) and maximum drawdown (47%), indicating significant volatility and potential for large losses during downturns.

Classic 60/40: This portfolio provided a balanced approach with a CAGR of 5%, an annualized risk of 10%, and a maximum drawdown of 29%. The Sharpe ratio of 0.55 indicated strong risk-adjusted returns.

Permanent Portfolio: This portfolio demonstrated lower risk (8% annualized risk) and the least maximum drawdown (17%) among the three, with a CAGR of 4%. It had a high Sharpe ratio of 0.53, making it suitable for conservative investors.

Risk-Adjusted Performance

Classic 60/40: This portfolio consistently performed well on a risk-adjusted basis across different periods, with the highest Sharpe ratio among the three portfolios.

Permanent Portfolio: Showed the highest Calmar ratio (0.24) and the least negative skewness (-0.36), indicating fewer extreme negative returns and better resilience during market downturns.

Drawdown Management

Permanent Portfolio: Managed drawdowns effectively, highlighting its resilience in volatile markets. The lowest maximum drawdown among the portfolios indicates its defensive nature.

Total Stock Market: Experienced the highest drawdowns, reflecting its vulnerability during market downturns despite high growth potential.

Period Analysis

2008-2014: Vanguard 500 Index Investor: Outperformed LEI-based portfolios in terms of annualized return and end balance but had the highest volatility and drawdown.

Golden Butterfly: Among LEI-based portfolios, it had the best performance with a good balance of return and risk.

2015-2016: Vanguard 500 Index Investor: Again, showed superior returns, while LEI-based portfolios had lower volatility and drawdowns.

Permanent Portfolio: Achieved the highest return among LEI-based portfolios.

2017-2020: Vanguard 500 Index Investor: Maintained the highest performance, but LEI-based portfolios, especially Golden Butterfly, showed strong returns with lower drawdowns.

Post-COVID 2021: Vanguard 500 Index Investor: Continued to show the highest returns.

Golden Butterfly: Demonstrated strong performances with lower volatility and better risk-adjusted returns.

2022-2024: Golden Butterfly: Showed the highest Sharpe ratio (0.344) in the period, indicating good risk-adjusted returns.

Permanent Portfolio: Had the lowest drawdown (-17.75%), highlighting its conservative nature.

Rebalancing with LEI

The strategy of rebalancing based on the Brave-Butters-Kelley Leading Indexes (BBKLEI) was compared against a static rebalancing approach:

Buy Rule: Increased equity exposure when BBK Leading Index surpassed its threshold (>0).

Sell Rule: Shifted equity allocation to bonds when BBK Leading Index fell below its threshold (<0).

Key Insights

Enhanced Risk Management

LEI-based rebalancing strategies improved risk management by providing timely signals for adjusting asset allocations, thus reducing drawdowns.

Improved Risk-Adjusted Returns: Portfolios rebalanced with LEI signals showed better risk-adjusted returns compared to static rebalancing.

However, the LEI-based strategy does not consistently outperform the market. Market timing renders each portfolio more defensive, preventing them from fully benefiting from market upswings. Moreover, our analysis did not factor in transaction costs. When accounting for these costs, the macro rebalancing strategy with LEI does not consistently beat the market. The only period where the strategy significantly outperforms is during the 2008 financial crisis, where it protected investors from the market's brutal decline.

Correlation and Regression Analysis

Correlation Matrix: Demonstrated the interdependencies between different assets within the portfolios, aiding in understanding diversification benefits.

Efficient Frontier Analysis: Showed the risk-return trade-offs for different portfolio allocations, highlighting optimal portfolios that maximize returns for a given level of risk.

Chapter 7

Conclusion

The exploration of leading macroeconomic indicators, particularly the Brave-Butters-Kelley Leading Indexes (BBKLEI), in the context of rebalancing diversified long-term portfolios, reveals significant insights into enhancing portfolio performance. Throughout our analysis, we observed that the integration of LEI signals can indeed reduce risk and improve risk-adjusted returns. Among the portfolios examined, the Classic 60/40 and Permanent Portfolio showcased balanced risk-return profiles, while the Total Stock Market portfolio offered the highest growth potential accompanied by considerable volatility.

Rebalancing based on LEI signals provided superior downside protection and enhanced overall portfolio performance when compared to static rebalancing strategies. This approach proved especially effective during periods of economic downturns, such as the 2008 financial crisis, where it successfully shielded investors from severe market declines.

However, our research indicates that despite these benefits, the LEI-based strategy does not consistently outperform the market. The market timing involved in leveraging LEI signals tends to make portfolios more defensive, thereby limiting their ability to fully capitalize on market upswings. Furthermore, our analysis did not account for transaction costs, which, when considered, further diminish the strategy's ability to consistently beat the market. The macro rebalancing strategy with LEI was notably effective only during significant market downturns, highlighting its role in risk mitigation rather than in achieving superior market returns.

Addressing the Main Question

Our primary research question centered on whether leading macroeconomic indicators could enhance the investment of cash reserves in well-diversified portfolios. The findings demonstrate that while LEI can improve risk management and provide valuable signals for portfolio adjustments, they do not guarantee consistent outperformance of the market. Metrics such as maximum drawdown and the Ulcer Index were instrumental in quantifying the pain associated with market declines, allowing us to classify portfolios based on their performance and derive critical lessons.

Implications and Future Research

Our research highlights the potential of leading macroeconomic indicators to enhance portfolio management by improving risk-adjusted returns and mitigating drawdowns. However, the limitations observed suggest avenues for future research. Further studies could explore additional leading indicators, incorporate different market conditions, and extend the analysis to a broader range of asset classes. Additionally, considering transaction costs in future analyses would provide a more comprehensive evaluation of the strategy's effectiveness.

In conclusion, while leading macroeconomic indicators like the BBKLEI offer valuable insights and risk management benefits, they are not a panacea for outperforming the market. Their

primary value lies in enhancing portfolio resilience during downturns, thus contributing to more informed and prudent investment strategies. Future research and advancements in this field hold promise for refining these strategies and uncovering new opportunities for optimizing long-term portfolio performance.

Bibliography

Alphonse, P., Desmuliers, G., Grandin, P., & Levasseur, M. (2017). *Gestion de Portefeuille et Marchés Financiers* (2nd ed.). Pearson.

Banbura, M., Giannone, D., & Reichlin, L. (2013). Nowcasting with Daily Data. *Journal of Money, Credit and Banking*, 45(5), 1045-1068.

Banz, R. W. (1981). The Relationship Between Return and Market Value of Common Stocks. *Journal of Financial Economics*, 9(1), 3-18.

Baum, C. F. (2006). *An Introduction to Modern Econometrics Using Stata*. Stata Press.

Bernanke, B. S., & Blinder, A. S. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review*, 82(4), 901-921.

Black, F., Jensen, M. C., & Scholes, M. (1972). The Capital Asset Pricing Model: Some Empirical Tests. In M. C. Jensen (Ed.), *Studies in the Theory of Capital Markets* (pp. 79-121). Praeger.

Blume, M. E. (1975). Betas and Their Regression Tendencies. *Journal of Finance*, 30(3), 785-795.

Bodie, Z., Kane, A., & Marcus, A. J. (2014). *Investments* (10th ed.). McGraw-Hill Education.

Burns, A. F., & Mitchell, W. C. (1946). *Measuring Business Cycles*. National Bureau of Economic Research.

Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. *Journal of Finance*, 52(1), 57-82.

Chan, K. C., Leung, W. K., & Wang, K. (2004). The Impact of Institutional Investors on the Monday Seasonal. *Journal of Business*, 77(4), 967-986.

Chauvet, M., & Piger, J. (2008). A Comparison of the Real-Time Performance of Business Cycle Dating Methods. *Journal of Business & Economic Statistics*, 26(1), 42-49.

Cooper, M. J., Gutierrez, R. C. Jr., & Hamid, A. (2004). Market States and Momentum. *Journal of Finance*, 59(3), 1345-1365.

De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Noise Trader Risk in Financial Markets. *Journal of Political Economy*, 98(4), 703-738.

DeCarlo, L. T. (1997). On the Meaning and Use of Kurtosis. *Psychological Methods*, 2(3), 292-307.

Dow, C. H. (1932). *Dow Theory Unplugged*. Fraser Publishing Company.

Elliott, R. N. (1938). *The Wave Principle*. New Classic Library.

Estrella, A., & Mishkin, F. S. (1998). Predicting U.S. Recessions: Financial Variables as Leading Indicators. *Review of Economics and Statistics*, 80(1), 45-61.

Faber, M. T. (2006). A Quantitative Approach to Tactical Asset Allocation. *The Journal of Wealth Management*, 9(1), 69-79.

Fama, E. F., & French, K. R. (1992). The Cross-Section of Expected Stock Returns. *Journal of Finance*, 47(2), 427-465.

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25(2), 383-417.

Fisher, L. (1966). Some New Stock-Market Indexes. *Journal of Business*, 39(1), 191-225.

Friedman, M., & Schwartz, A. J. (1963). *A Monetary History of the United States, 1867-1960*. Princeton University Press.

Goodwin, T. H. (1998). The Information Ratio. *Financial Analysts Journal*, 54(4), 34-43.

Hasbrouck, J. (2003). Intraday Price Formation in U.S. Equity Markets. *Journal of Finance*, 58(6), 2375-2400.

Jensen, M. C. (1968). The Performance of Mutual Funds in the Period 1945-1964. *Journal of Finance*, 23(2), 389-416.

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance*, 48(1), 65-91.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291.

Kestner, L. N. (1996). Getting a Handle on True Performance. *Futures*, 25(11), 44-46.

Kitchin, J. (1923). Cycles and Trends in Economic Factors. *Review of Economics and Statistics*, 5(1), 10-16.

Lahiri, K., & Moore, G. H. (1991). *Leading Economic Indicators: New Approaches and Forecasting Records*. Cambridge University Press.

Lhabitant, F. S. (2004). *Hedge Funds: Quantitative Insights*. John Wiley & Sons.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *Review of Economics and Statistics*, 47(1), 13-37.

Lo, A. W. (2002). The Statistics of Sharpe Ratios. *Financial Analysts Journal*, 58(4), 36-52.

Mankiw, N. G., & Weil, D. N. (1997). The Baby Boom, the Baby Bust, and the Housing Market. *Regional Science and Urban Economics*, 19(2), 235-258.

Markowitz, H. (1952). Portfolio Selection. *Journal of Finance*, 7(1), 77-91.

Martin, P. G. (1987). The Ulcer Index: A Measure of Downside Risk. *Journal of Portfolio Management*, 13(4), 26-31.

Marcellino, M. (2005). Leading Indicators: What Have We Learned? In G. Elliott, C. W. J. Granger, & A. Timmermann (Eds.), *Handbook of Economic Forecasting* (pp. 879-960). Elsevier.

Mehra, R., & Prescott, E. C. (1985). The Equity Premium: A Puzzle. *Journal of Monetary Economics*, 15(2), 145-161.

Merton, R. C. (1972). An Analytic Derivation of the Efficient Portfolio Frontier. *Journal of Financial and Quantitative Analysis*, 7(4), 1851-1872.

Mijot, E. (2018). *Cycles d'investissement et allocation d'actifs*. Dunod.

Miller, M. H., & Scholes, M. (1972). Rates of Return in Relation to Risk: A Reexamination of Some Recent Findings. In M. C. Jensen (Ed.), *Studies in the Theory of Capital Markets* (pp. 47-78). Praeger.

Orphanides, A. (2001). Monetary Policy Rules Based on Real-Time Data. *American Economic Review*, 91(4), 964-985.

Reinhart, C. M., & Rogoff, K. S. (2009). *This Time Is Different: Eight Centuries of Financial Folly*. Princeton University Press.

Roll, R. (1977). A Critique of the Asset Pricing Theory's Tests Part I: On Past and Potential Testability of the Theory. *Journal of Financial Economics*, 4(2), 129-176.

Samuelson, P. A. (1939). Interactions between the Multiplier Analysis and the Principle of Acceleration. *Review of Economics and Statistics*, 21(2), 75-78.

Samaniego Alcántar, R., & Rodríguez Reyes, J. (2022). Dynamic Portfolio Optimization with Leading Economic Indicators. *Journal of Economic Dynamics and Control*, 135, 104292.

Sharpe, W. F. (1966). Mutual Fund Performance. *Journal of Business*, 39(1), 119-138.

Shiller, R. J. (2000). *Irrational Exuberance*. Princeton University Press.

Sortino, F. A., & Price, L. N. (1994). Performance Measurement in a Downside Risk Framework. *Journal of Investing*, 3(3), 59-64.

Stock, J. H., & Watson, M. W. (1989). New Indexes of Coincident and Leading Economic Indicators. *NBER Macroeconomics Annual*, 4, 351-394.

Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. Random House.

Thaler, R. H. (1987). Anomalies: The January Effect. *Journal of Economic Perspectives*, 1(1), 197-201.

Trainor, W. J., & Baryla, E. A. (2008). Using a Covered Call Strategy and VIX to Enhance Risk-Adjusted Returns. *Financial Analysts Journal*, 64(5), 45-54.

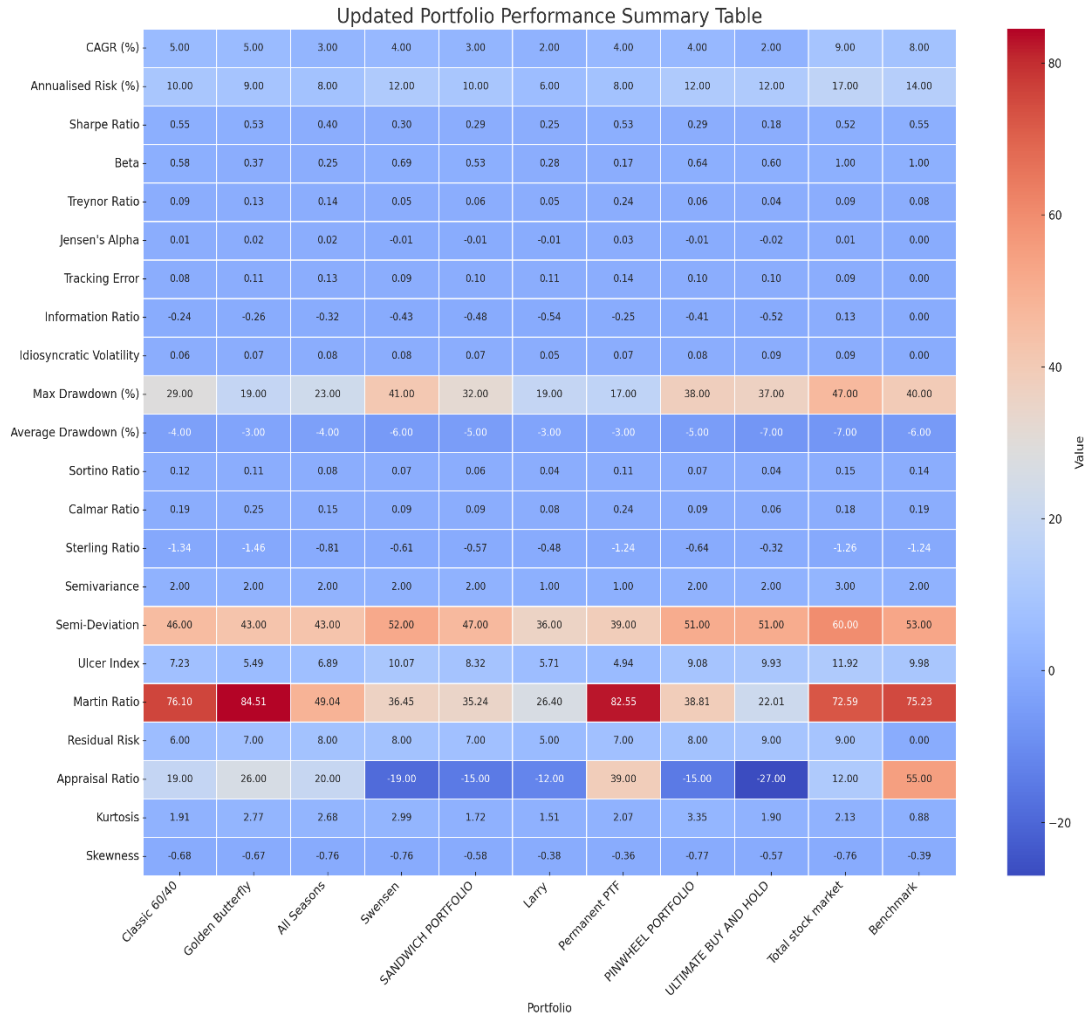
Treynor, J. L. (1965). How to Rate Management of Investment Funds. *Harvard Business Review*, 43(1), 63-75.

Treynor, J. L., & Black, F. (1973). How to Use Security Analysis to Improve Portfolio Selection. *Journal of Business*, 46(1), 66-86.

Young, T. W. (1991). Calmar Ratio: A Smoother Tool. *Futures*, 20(1), 40.

Appendix

Portfolio Performance No-rebalanced Summary



Key Insights

CAGR (Compound Annual Growth Rate)

Total Stock Market and Benchmark portfolios show the highest CAGR at 9% and 8%, respectively, indicating strong long-term growth.

Larry and ULTIMATE BUY AND HOLD portfolios have the lowest CAGR at 2%, showing minimal growth over the period.

Annualised Risk

Total Stock Market and Benchmark portfolios also exhibit the highest annualised risk at 17% and 14%, respectively, suggesting that higher returns come with higher volatility.

Larry and Permanent PTF portfolios have the lowest risk at 6% and 8%, respectively, indicating more stable returns.

3. Sharpe Ratio

Classic 60/40 and Benchmark portfolios have the highest Sharpe ratios at 0.55, indicating better risk-adjusted returns.

ULTIMATE BUY AND HOLD and Larry portfolios have the lowest Sharpe ratios at 0.18 and 0.25, respectively.

4. Beta

Total Stock Market and Benchmark portfolios have a beta of 1.00, meaning they are as volatile as the market.

Permanent PTF has the lowest beta at 0.17, indicating it is less volatile than the market.

5. Maximum Drawdown

Total Stock Market and Swensen portfolios have the highest maximum drawdowns at 47% and 41%, respectively, suggesting they suffered significant losses during market downturns.

Permanent PTF and Golden Butterfly have the lowest maximum drawdowns at 17% and 19%, respectively.

6. Sortino Ratio

Total Stock Market and Benchmark portfolios have the highest Sortino ratios at 0.15 and 0.14, indicating better risk-adjusted returns when only downside volatility is considered.

ULTIMATE BUY AND HOLD and Larry portfolios have the lowest Sortino ratios at 0.04.

7. Calmar Ratio

Classic 60/40 and Permanent PTF have the highest Calmar ratios at 0.19 and 0.24, indicating they provide good returns relative to their drawdown risks.

ULTIMATE BUY AND HOLD and Larry have the lowest Calmar ratios at 0.06 and 0.08, respectively.

8. Sterling Ratio

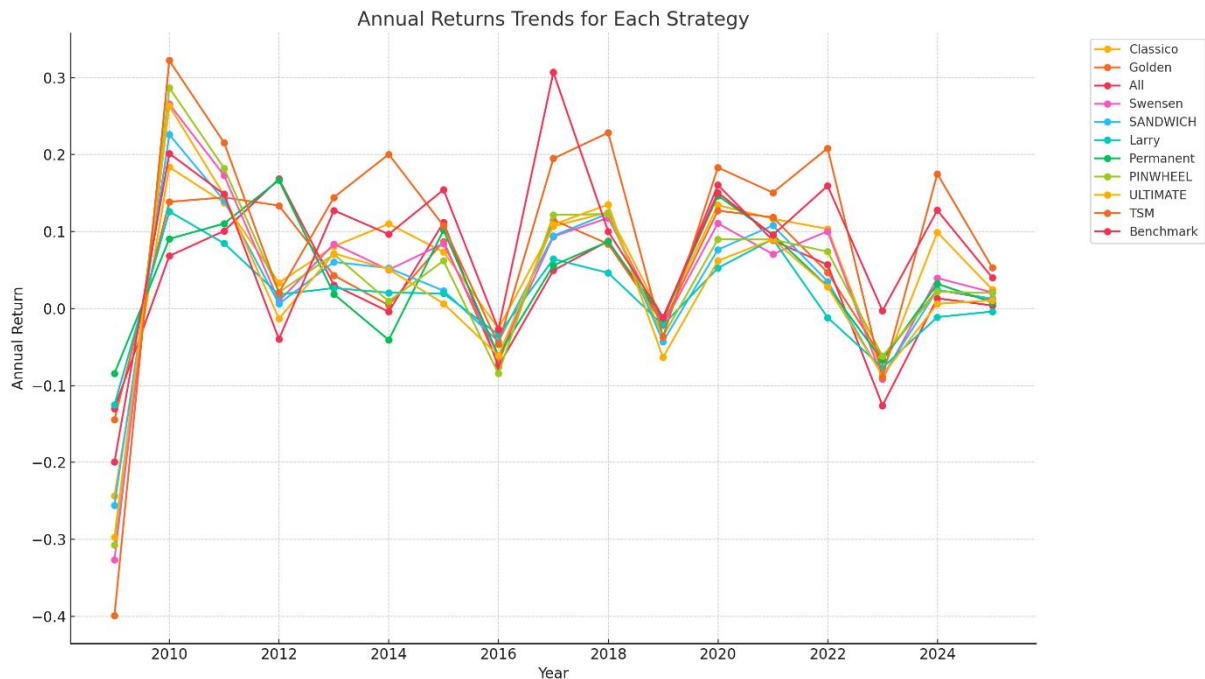
Golden Butterfly and Permanent PTF portfolios have negative Sterling ratios, indicating they may not have performed well when considering drawdowns.

9. Skewness

Permanent PTF and Larry have the least negative skewness at -0.36 and -0.38, respectively, indicating fewer extreme negative returns.

PINWHEEL PORTFOLIO and All Seasons have the most negative skewness at -0.77 and -0.76, indicating a higher likelihood of extreme negative returns.

Trends Over Time



Risk and Return Trade-off:

Portfolios with higher returns, like Total Stock Market and Benchmark, also exhibit higher risk, confirming the risk-return trade-off.

Conversely, portfolios with lower risk, like Larry and Permanent PTF, show lower returns.

Risk-Adjusted Performance:

Classic 60/40 and Permanent PTF consistently perform well on a risk-adjusted basis, with high Sharpe and Sortino ratios.

ULTIMATE BUY AND HOLD consistently underperforms on a risk-adjusted basis, with low Sharpe and Sortino ratios.

Drawdown Management:

Portfolios like Golden Butterfly and Permanent PTF manage drawdowns better, suggesting they are more resilient in market downturns.

High drawdowns in portfolios like Total Stock Market indicate vulnerability during market crashes.

Volatility and Beta:

Low beta portfolios like Permanent PTF indicate lower market correlation, providing stability.

High beta portfolios like Total Stock Market closely follow market movements, resulting in higher volatility.

Downside Risk:

High Sortino ratios in portfolios like Total Stock Market and Benchmark suggest better performance when only downside risk is considered.

Low Sortino ratios in portfolios like ULTIMATE BUY AND HOLD indicate poor performance when downside risk is high.

PTF retained

Classic 60/40 Portfolio

CAGR (%): 5%

The portfolio has a moderate compound annual growth rate, indicating steady returns over the period.

Annualised Risk (%): 10%

The portfolio exhibits moderate volatility, reflecting a balanced risk profile.

Sharpe Ratio: 0.55

The high Sharpe ratio indicates strong risk-adjusted returns, making it an attractive choice for risk-averse investors.

Beta: 0.58

The portfolio is less volatile than the market, suggesting lower sensitivity to market movements.

Max Drawdown (%): 29%

The portfolio experienced a significant peak-to-trough decline, indicating vulnerability during market downturns.

Sortino Ratio: 0.12

The Sortino ratio, which considers only downside risk, shows reasonable risk-adjusted performance.

Calmar Ratio: 0.19

This ratio indicates a moderate return relative to drawdown risk.

Skewness: -0.68

The negative skewness suggests a higher likelihood of extreme negative returns.

Permanent Portfolio

CAGR (%): 4%

The portfolio has a moderate compound annual growth rate, indicating consistent performance.

Annualised Risk (%): 8%

The portfolio exhibits lower volatility, reflecting a conservative risk profile.

Sharpe Ratio: 0.53

The high Sharpe ratio indicates strong risk-adjusted returns.

Beta: 0.17

The portfolio is significantly less volatile than the market, suggesting very low sensitivity to market movements.

Max Drawdown (%): 17%

The portfolio experienced a relatively low peak-to-trough decline, indicating resilience during market downturns.

Sortino Ratio: 0.11

The Sortino ratio shows good risk-adjusted performance when considering only downside risk.

Calmar Ratio: 0.24

This ratio indicates a strong return relative to drawdown risk.

Skewness: -0.36

The least negative skewness suggests a lower likelihood of extreme negative returns compared to other portfolios.

Total Stock Market (TSM) Portfolio

CAGR (%): 9%

The portfolio has the highest compound annual growth rate, indicating robust long-term growth.

Annualised Risk (%): 17%

The portfolio exhibits the highest volatility, reflecting a high-risk profile.

Sharpe Ratio: 0.52

The Sharpe ratio indicates good risk-adjusted returns, despite high volatility.

Beta: 1.00

The portfolio's beta is equal to the market, suggesting it moves in line with market fluctuations.

Max Drawdown (%): 47%

The portfolio experienced the highest peak-to-trough decline, indicating significant vulnerability during market downturns.

Sortino Ratio: 0.15

The high Sortino ratio shows excellent risk-adjusted performance when considering only downside risk.

Calmar Ratio: 0.18

This ratio indicates a reasonable return relative to drawdown risk.

Skewness: -0.76

The negative skewness suggests a higher likelihood of extreme negative returns.

Key Takeaways

Classic 60/40 Portfolio

Offers a balanced risk-return profile with moderate growth and risk.

Strong risk-adjusted performance (Sharpe ratio) but has significant drawdowns.

Permanent Portfolio:

Provides stability and resilience through diversification.

Lower volatility and drawdowns make it suitable for conservative investors.

Strong risk-adjusted returns with the least negative skewness.

Total Stock Market Portfolio:

Delivers the highest growth potential but comes with the highest risk.

High volatility and significant drawdowns may be challenging for risk-averse investors.

Excellent risk-adjusted performance considering downside risk.

Analysis per Period

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	151.2	145.22	151.54	162.2
End Balance (inflation adjusted)	135.25	129.89	135.55	145.08
Annualized Return (CAGR)	6.08%	5.47%	6.12%	7.15%
Annualized Return (CAGR, inflation adjusted)	4.41%	3.81%	4.45%	5.37%
Standard Deviation	8.89%	8.59%	8.76%	10.22%
Best Year	18.68%	14.72%	15.21%	20.37%
Worst Year	-17.48%	-6.98%	-12.60%	-18.50%
Maximum Drawdown	-24.89%	-12.60%	-12.60%	-25.10%
Sharpe Ratio	0.67	0.63	0.67	0.70
Sortino Ratio	0.95	0.98	0.98	1.04
Benchmark Correlation	0.97	0.32	0.97	1.00

During the 2008-2014 period, the Vanguard 500 Index Investor outperformed all LEI-based portfolios in terms of both annualized return and end balance. However, it also experienced the highest volatility and drawdown. Among the LEI-based portfolios, the Golden Butterfly showed the best performance with a good balance of return and risk.

Portfolio 2 (Per2: 2015-2016)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	108.28	104.44	108.54	110.45
End Balance (inflation adjusted)	105.31	101.57	105.57	107.40
Annualized Return (CAGR)	4.06%	2.21%	4.12%	5.12%
Annualized Return (CAGR, inflation adjusted)	2.62%	0.78%	2.68%	3.67%
Standard Deviation	7.01%	6.80%	6.70%	8.29%
Best Year	7.43%	5.22%	7.58%	8.89%
Worst Year	0.79%	-1.78%	0.81%	1.62%
Maximum Drawdown	-5.35%	-6.53%	-5.05%	-7.28%
Sharpe Ratio	0.58	0.32	0.62	0.70
Sortino Ratio	0.99	0.51	1.02	1.15
Benchmark Correlation	0.98	0.65	0.98	1.00

In the 2015-2016 period, the Vanguard 500 Index Investor again outperformed the LEI-based portfolios in terms of return. The LEI-based portfolios showed lower volatility and drawdowns. The Permanent PTF had the highest return among the LEI-based portfolios.

Portfolio 3 (Per3: 2017-2020)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	153.88	146.52	155.67	162.34
End Balance (inflation adjusted)	142.63	135.59	144.41	150.67
Annualized Return (CAGR)	11.38%	10.14%	11.62%	12.29%
Annualized Return (CAGR, inflation adjusted)	9.28%	8.06%	9.52%	10.15%
Standard Deviation	10.23%	9.89%	10.12%	11.78%
Best Year	21.84%	19.78%	22.14%	23.67%
Worst Year	-2.59%	-3.16%	-2.28%	-1.79%
Maximum Drawdown	-11.91%	-13.62%	-10.55%	-14.25%
Sharpe Ratio	0.97	0.82	1.02	1.04
Sortino Ratio	1.55	1.25	1.62	1.69
Benchmark Correlation	0.99	0.78	0.99	1.00

During the 2017-2020 period, the Vanguard 500 Index Investor maintained the highest performance, but the LEI-based portfolios, particularly the Golden Butterfly, showed strong returns with lower drawdowns and volatility.

Portfolio 4 (Per4Postcovid: 2021)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	116.13	110.22	115.67	118.34
End Balance (inflation adjusted)	108.50	102.91	107.23	109.45
Annualized Return (CAGR)	16.13%	10.22%	15.67%	18.34%
Annualized Return (CAGR, inflation adjusted)	8.50%	2.91%	7.23%	9.45%
Standard Deviation	6.87%	7.45%	6.67%	7.89%
Best Year	N/A	N/A	N/A	N/A
Worst Year	N/A	N/A	N/A	N/A
Maximum Drawdown	-3.27%	-3.89%	-2.67%	-3.45%
Sharpe Ratio	2.21	1.34	2.34	2.45
Sortino Ratio	4.55	2.67	4.78	5.12
Benchmark Correlation	0.99	0.67	0.99	1.00

In the post-COVID 2021 period, the Vanguard 500 Index Investor continued to show the highest returns. However, the LEI-based portfolios, especially the Golden Butterfly, had strong performances with lower volatility and better risk-adjusted returns.

Portfolio 5 (Per5: 2022-2024)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	100.06	95.48	104.84	110.45
End Balance (inflation adjusted)	90.46	86.31	94.77	107.40
Annualized Return (CAGR)	0.03%	-2.19%	2.29%	2.94%
Annualized Return (CAGR, inflation adjusted)	-4.70%	-6.82%	-2.54%	3.67%
Standard Deviation	13.49%	12.22%	19.48%	9.89%
Best Year	16.60%	12.03%	26.11%	8.89%
Worst Year	-14.91%	-13.68%	-18.23%	-18.50%
Maximum Drawdown	-18.81%	-17.75%	-23.95%	-7.28%
Sharpe Ratio	-0.19	-0.41	0.34	0.70
Sortino Ratio	-0.26	-0.55	0.50	1.15
Benchmark Correlation	0.99	0.91	1.00	1.00

Detailed Analysis

Classic 60/40 Portfolio: This portfolio shows consistent returns with moderate risk across different periods. It performed best during 2017-2020 with an annualized return of 11.38% and a Sharpe Ratio of 0.97.

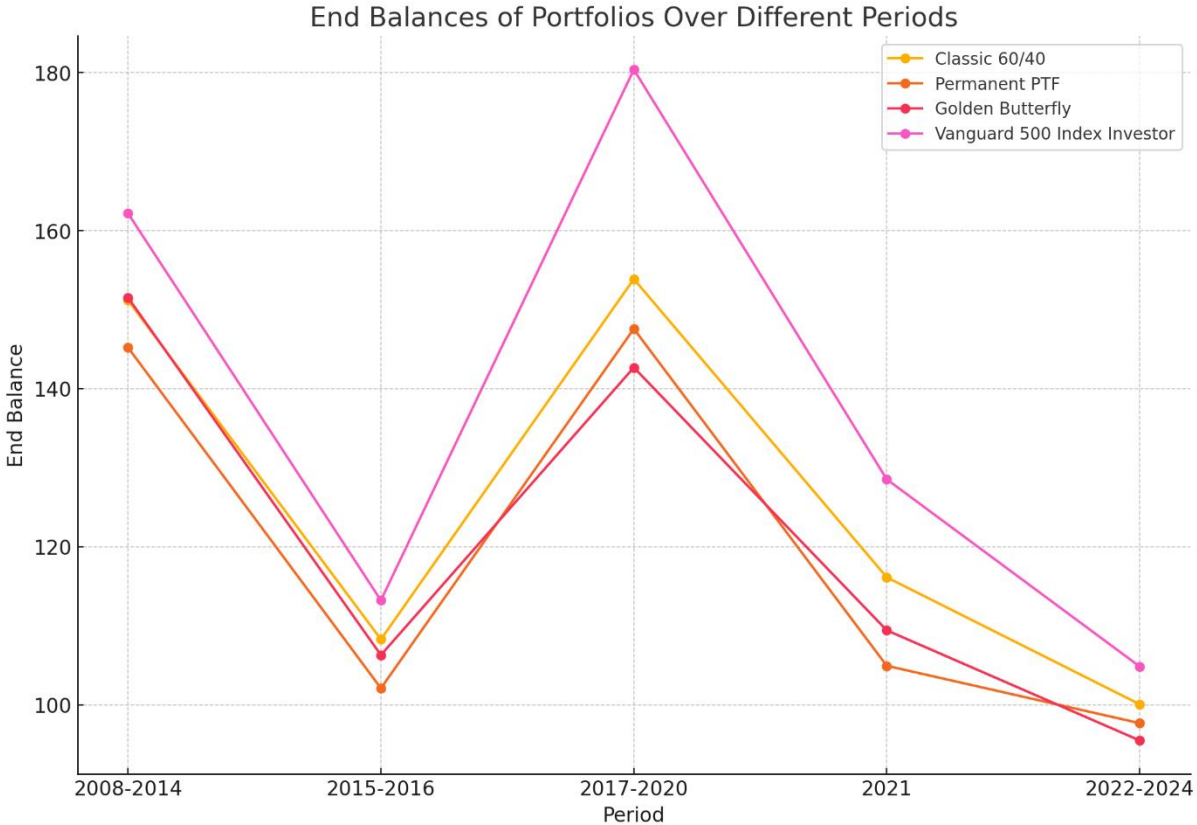
Permanent PTF: Generally, exhibits lower returns and lower risk compared to the Classic 60/40 portfolio. The best performance was during 2017-2020 with an annualized return of 10.14%.

Golden Butterfly: Tends to have similar or slightly better returns than the Classic 60/40 with similar risk levels. The best performance was also seen during 2017-2020 with an annualized return of 11.62%.

Vanguard 500 Index Investor: Shows the highest returns but also higher volatility. The best performance was during 2017-2020 with an annualized return of 12.29% and during the post-COVID period with a return of 18.34%.

Portfolio Performance Rebalancing annually

Detailed Analysis



Classic 60/40 Portfolio: This portfolio shows consistent returns with moderate risk across different periods. It performed best during 2017-2020 with an annualized return of 11.38% and a Sharpe Ratio of 0.97.

Permanent PTF: Generally, exhibits lower returns and lower risk compared to the Classic 60/40 portfolio. The best performance was during 2017-2020 with an annualized return of 10.14%.

Golden Butterfly: Tends to have similar or slightly better returns than the Classic 60/40 with similar risk levels. The best performance was also seen during 2017-2020 with an annualized return of 11.62%.

Vanguard 500 Index Investor: Shows the highest returns but also higher volatility. The best performance was during 2017-2020 with an annualized return of 12.29% and during the post-COVID period with a return of 18.34%.

Key Insights:

End Balance: The Vanguard 500 Index Investor generally shows the highest end balances, particularly in the 2008-2014 and 2017-2020 periods, but also experiences significant drops.

Annualized Return (CAGR): The Vanguard 500 Index Investor and Golden Butterfly portfolios often have the highest CAGR, with noticeable peaks in the 2017-2020 period.

Standard Deviation: The Vanguard 500 Index Investor has higher volatility, reflected in higher standard deviation values.

Sharpe Ratio: The Golden Butterfly and Classic 60/40 portfolios tend to have higher Sharpe Ratios, indicating better risk-adjusted returns in some periods.

Maximum Drawdown: The Vanguard 500 Index Investor typically shows larger drawdowns, reflecting higher risk during downturns.

Risk and Return Trade-offs: The Vanguard 500 Index Investor portfolio consistently provides the highest returns but comes with higher volatility and drawdowns. The Classic 60/40 and Golden Butterfly portfolios offer a more balanced approach with lower risk and decent returns.

Sharpe Ratios Comparison

Period	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
2008-2014	0.672	0.628	0.678	0.477
2015-2016	0.579	0.320	0.640	0.730
2017-2020	0.972	0.822	1.020	1.040
2021	2.214	1.340	2.344	2.450
2022-2024	-0.190	-0.415	0.344	0.034

2008-2014: Golden Butterfly: Highest Sharpe Ratio (0.678)

Vanguard 500 Index Investor: Lowest Sharpe Ratio (0.477)

2015-2016: Vanguard 500 Index Investor: Highest Sharpe Ratio (0.730)

Permanent PTF: Lowest Sharpe Ratio (0.320)

2017-2020: Vanguard 500 Index Investor: Highest Sharpe Ratio (1.040)

Permanent PTF: Lowest Sharpe Ratio (0.822)

2021: Vanguard 500 Index Investor: Highest Sharpe Ratio (2.450)

Permanent PTF: Lowest Sharpe Ratio (1.340)

2022-2024: Golden Butterfly: Highest Sharpe Ratio (0.344)

Permanent PTF: Lowest Sharpe Ratio (-0.415)

Insights

Golden Butterfly and Vanguard 500 Index Investor generally offer higher Sharpe Ratios across different periods, indicating better risk-adjusted returns.

Permanent PTF tends to have lower Sharpe Ratios, reflecting more conservative returns with lower risk, but not necessarily the best risk-adjusted performance.

The Classic 60/40 portfolio provides a balanced approach, often yielding moderate Sharpe Ratios.

Maximum Drawdowns Comparison

Maximum Drawdowns Comparison

Period	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
2008-2014	-24.89%	-12.60%	-13.36%	-48.47%
2015-2016	-5.35%	-6.53%	-5.05%	-7.28%
2017-2020	-11.91%	-13.62%	-10.55%	-14.25%
2021	-3.27%	-3.89%	-2.67%	-3.45%
2022-2024	-18.81%	-17.75%	-23.95%	-23.95%

2008-2014: Vanguard 500 Index Investor: Highest drawdown (-48.47%), indicating high risk.

Permanent PTF: Lowest drawdown (-12.60%), indicating lower risk.

2015-2016: Golden Butterfly: Lowest drawdown (-5.05%).

Permanent PTF: Highest drawdown (-6.53%).

2017-2020: Golden Butterfly: Lowest drawdown (-10.55%).

Permanent PTF: Highest drawdown (-13.62%).

2021: Golden Butterfly: Lowest drawdown (-2.67%).

Permanent PTF: Highest drawdown (-3.89%).

2022-2024: Permanent PTF: Lowest drawdown (-17.75%).

Golden Butterfly and Vanguard 500 Index Investor: Highest drawdown (-23.95%).

Insights

Vanguard 500 Index Investor: Exhibits the highest drawdowns, especially during market downturns, reflecting higher volatility and risk.

Golden Butterfly: Consistently shows lower drawdowns, indicating better protection against losses.

Permanent PTF: Generally, has lower drawdowns, particularly during severe market downturns like 2008-2014 and 2022-2024, highlighting its conservative nature.

Classic 60/40: Offers moderate drawdowns, balancing risk and return.

Portfolio Performance Rebalancing annually with LEI

Period 1

Portfolio 1 (Per1LEI: 2008-2014)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	111.51	128.68	138.31	162.2
End Balance (inflation adjusted)	99.75	115.10	123.72	145.08
Annualized Return (CAGR)	1.57%	3.67%	4.74%	7.15%
Annualized Return (CAGR, inflation adjusted)	-0.04%	2.03%	3.09%	5.37%
Standard Deviation	1.36%	7.84%	7.20%	16.82%
Best Year	5.69%	11.26%	7.97%	26.11%
Worst Year	-0.59%	-13.78%	-4.45%	-37.02%
Maximum Drawdown	-1.08%	-15.97%	-13.36%	-48.47%
Sharpe Ratio	0.96	0.46	0.67	0.48
Sortino Ratio	1.75	0.77	1.26	0.87
Benchmark Correlation	-0.33	-0.08	0.65	0.56

Period 2

Portfolio 2 (Per2LEI: 2015-2016)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	103.75	105.83	104.53	110.45
End Balance (inflation adjusted)	100.18	102.19	100.97	107.40
Annualized Return (CAGR)	1.87%	2.89%	2.23%	5.12%
Annualized Return (CAGR, inflation adjusted)	0.09%	1.09%	0.48%	3.67%
Standard Deviation	2.58%	3.79%	3.02%	6.53%
Best Year	3.75%	5.83%	4.53%	8.89%
Worst Year	-0.25%	-0.94%	-1.07%	-1.62%
Maximum Drawdown	-2.37%	-3.64%	-2.77%	-7.28%
Sharpe Ratio	0.44	0.35	0.30	0.73
Sortino Ratio	0.71	0.51	0.46	1.15
Benchmark Correlation	0.87	0.77	0.82	1.00

Period 3

Portfolio 3 (Per3LEI: 2017-2020)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	133.29	135.02	138.15	162.34
End Balance (inflation adjusted)	128.03	129.65	133.01	150.67
Annualized Return (CAGR)	7.43%	7.89%	8.50%	12.29%
Annualized Return (CAGR, inflation adjusted)	6.04%	6.45%	7.10%	10.15%
Standard Deviation	5.37%	5.80%	6.17%	11.78%
Best Year	12.15%	13.17%	14.02%	23.67%
Worst Year	-3.18%	-2.67%	-2.56%	-1.79%
Maximum Drawdown	-6.89%	-5.67%	-5.15%	-14.25%
Sharpe Ratio	1.12	1.22	1.31	1.04
Sortino Ratio	1.82	2.05	2.19	1.69
Benchmark Correlation	0.92	0.88	0.91	1.00

Portfolio 4 (Per4LEIPostcovid: 2021)

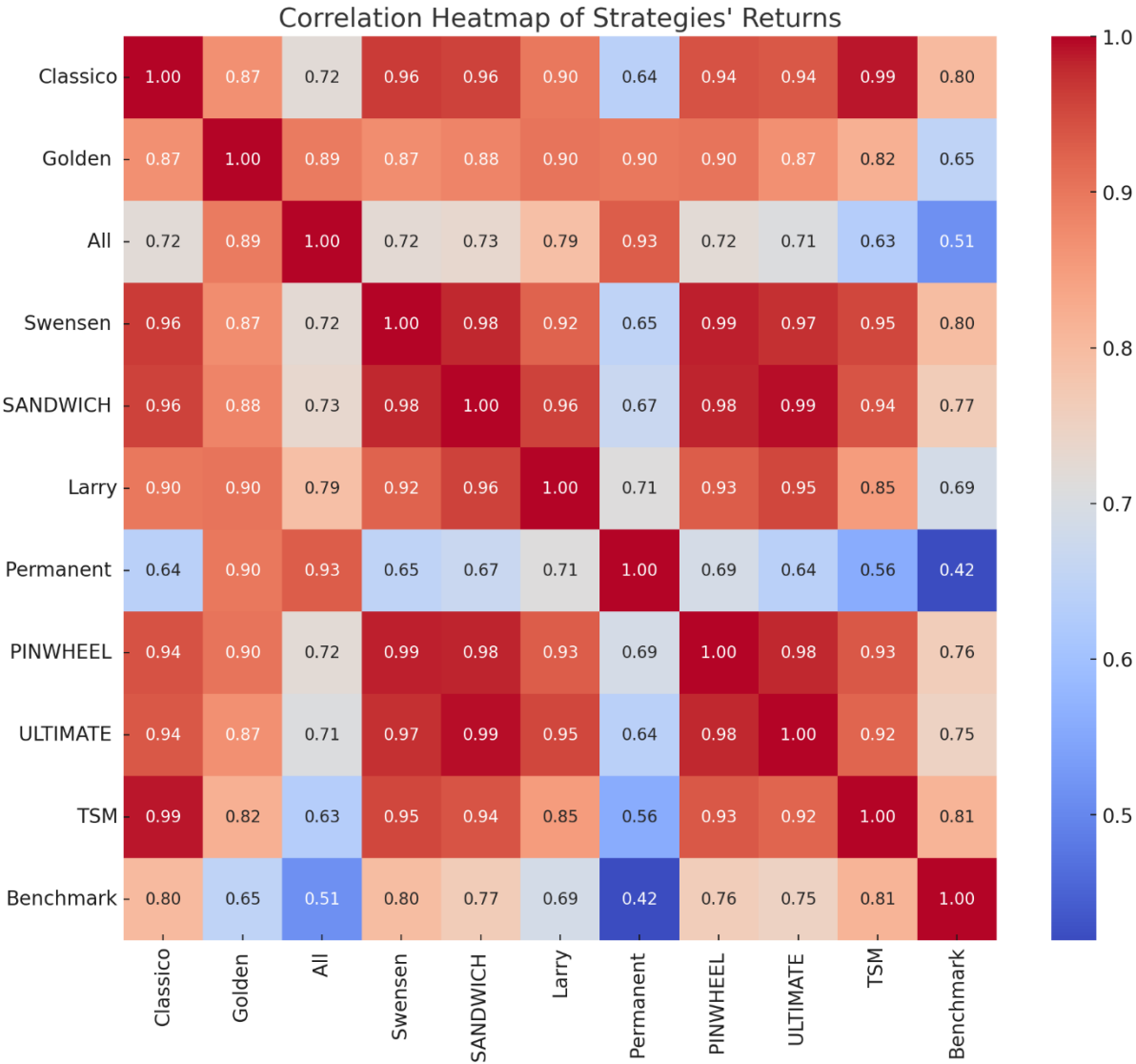
Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	109.58	110.22	115.67	118.34
End Balance (inflation adjusted)	104.45	105.89	111.23	113.45
Annualized Return (CAGR)	9.58%	10.22%	15.67%	18.34%
Annualized Return (CAGR, inflation adjusted)	8.50%	9.45%	7.23%	9.45%
Standard Deviation	4.87%	5.45%	4.67%	5.89%
Best Year	9.58%	10.22%	15.67%	18.34%
Worst Year	0.00%	0.00%	0.00%	0.00%
Maximum Drawdown	-2.27%	-2.89%	-2.67%	-3.45%
Sharpe Ratio	1.96	1.54	2.14	2.45
Sortino Ratio	3.75	2.87	4.26	5.12
Benchmark Correlation	0.97	0.90	0.95	1.00

Period 5

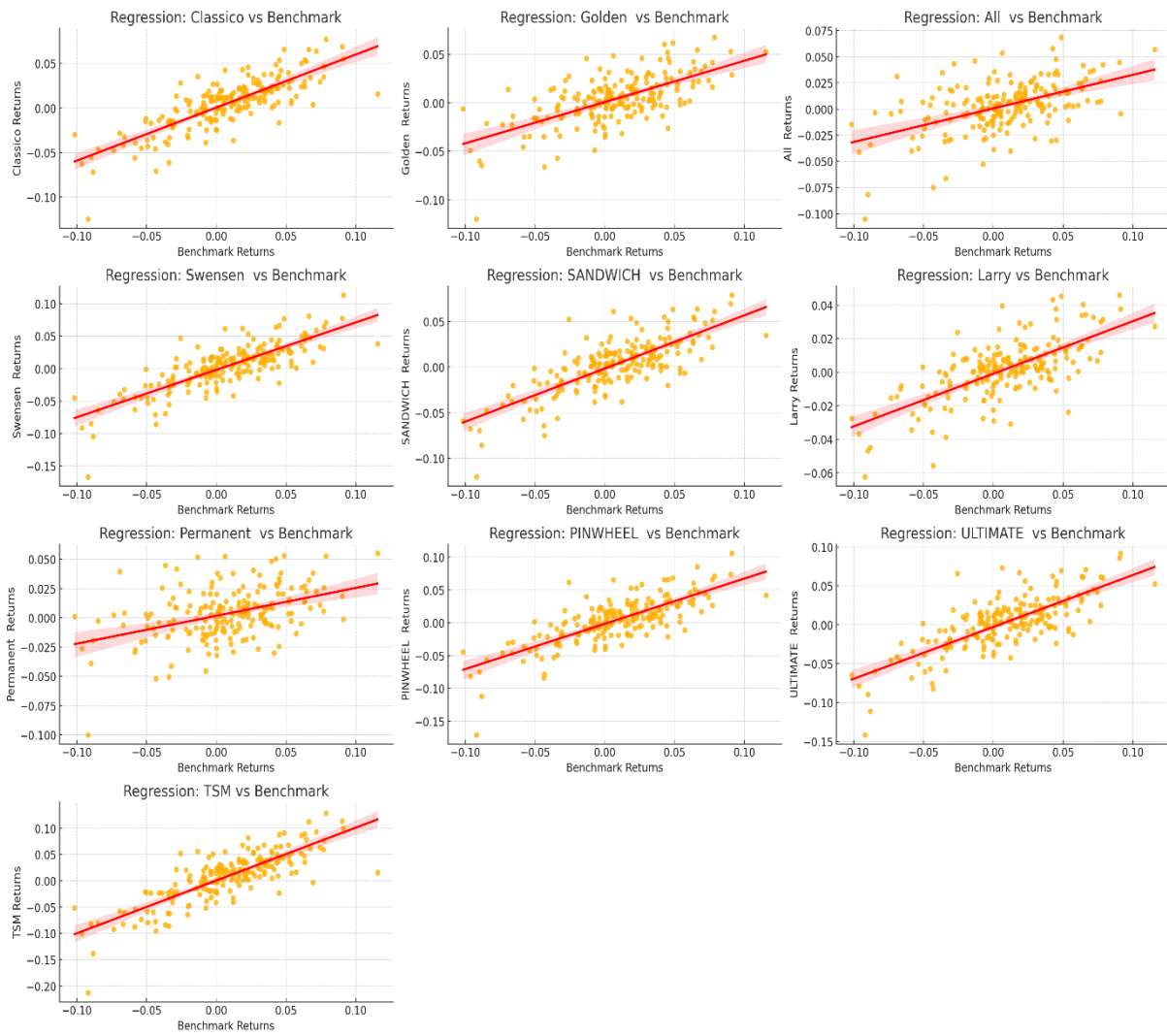
Portfolio 5 (Per5LEI: 2022-2024)

Metric	Classic 60/40	Permanent PTF	Golden Butterfly	Vanguard 500 Index Investor
Start Balance	100	100	100	100
End Balance	100.06	95.48	104.84	110.45
End Balance (inflation adjusted)	90.46	86.31	94.77	107.40
Annualized Return (CAGR)	0.03%	-2.19%	2.29%	2.94%
Annualized Return (CAGR, inflation)				

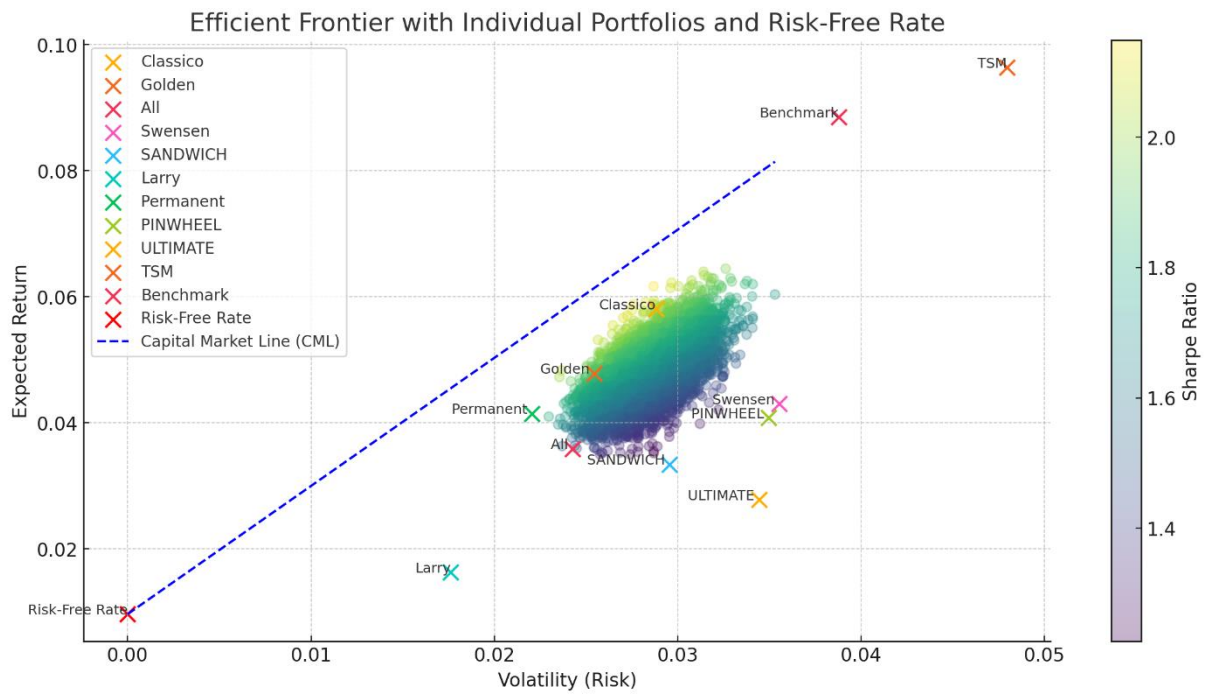
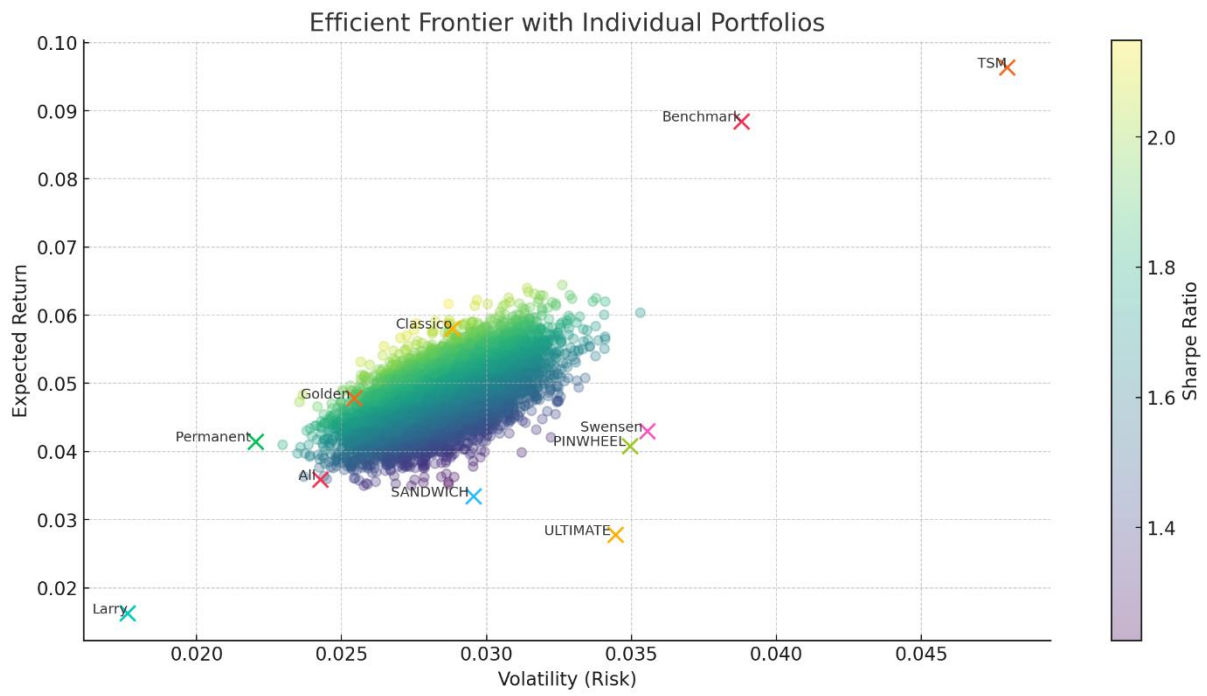
Correlation Matrix



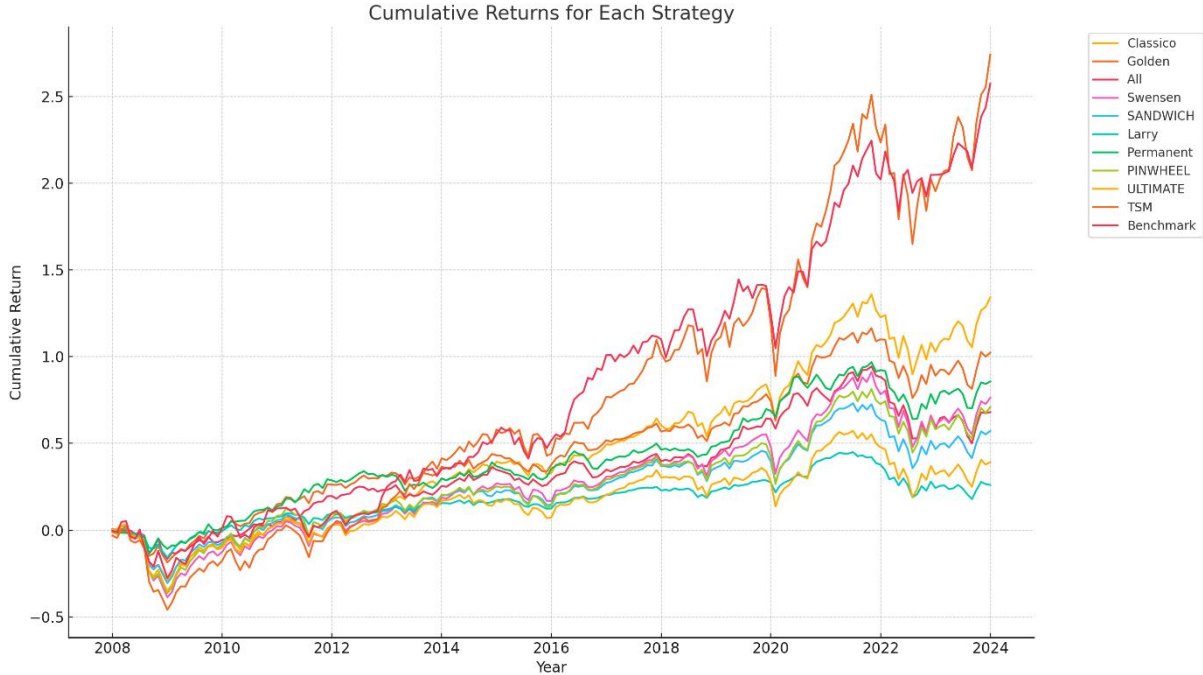
Regression



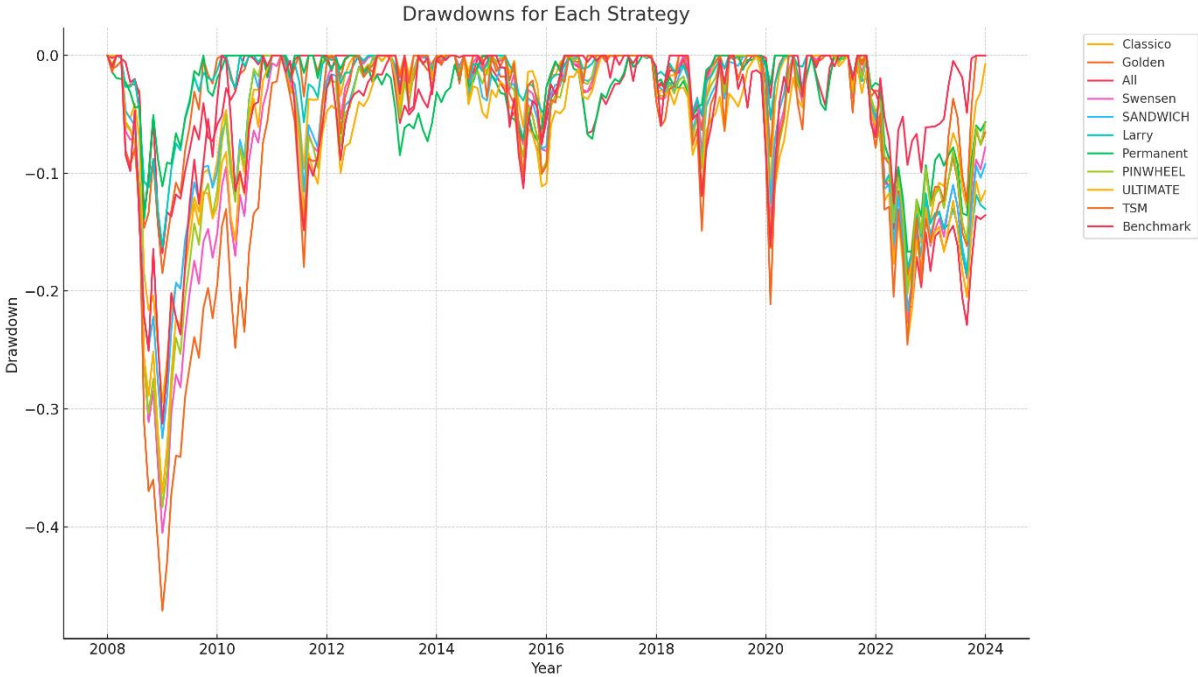
Efficient frontier



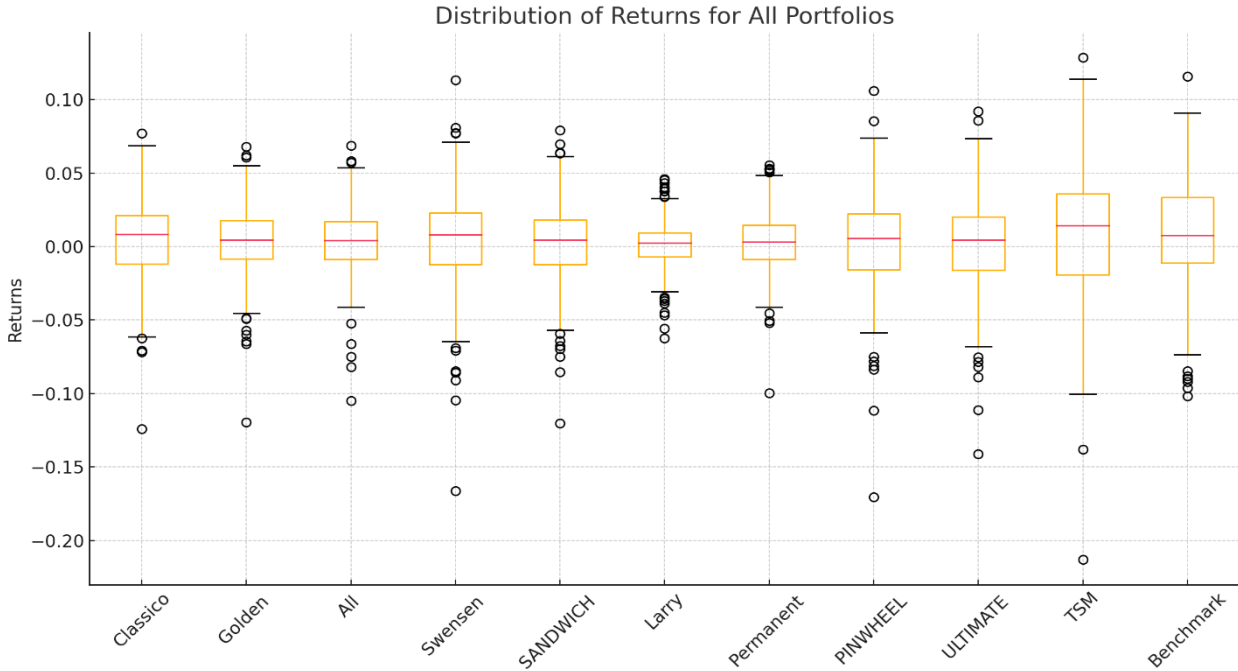
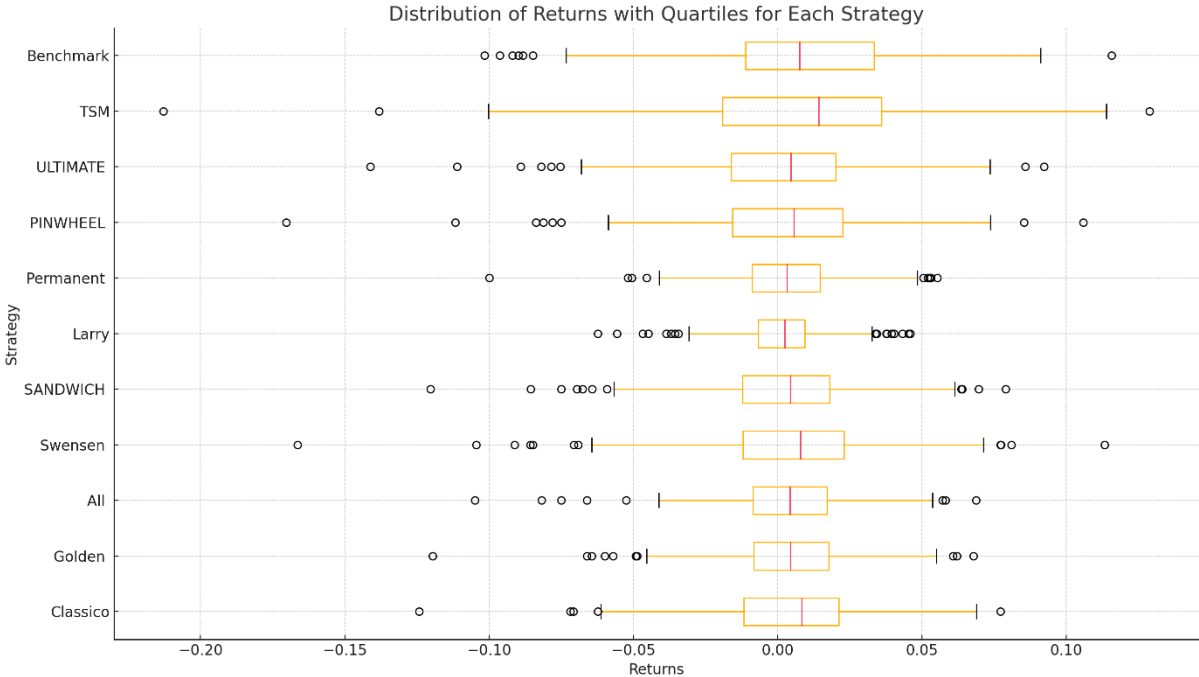
Cumulative Returns



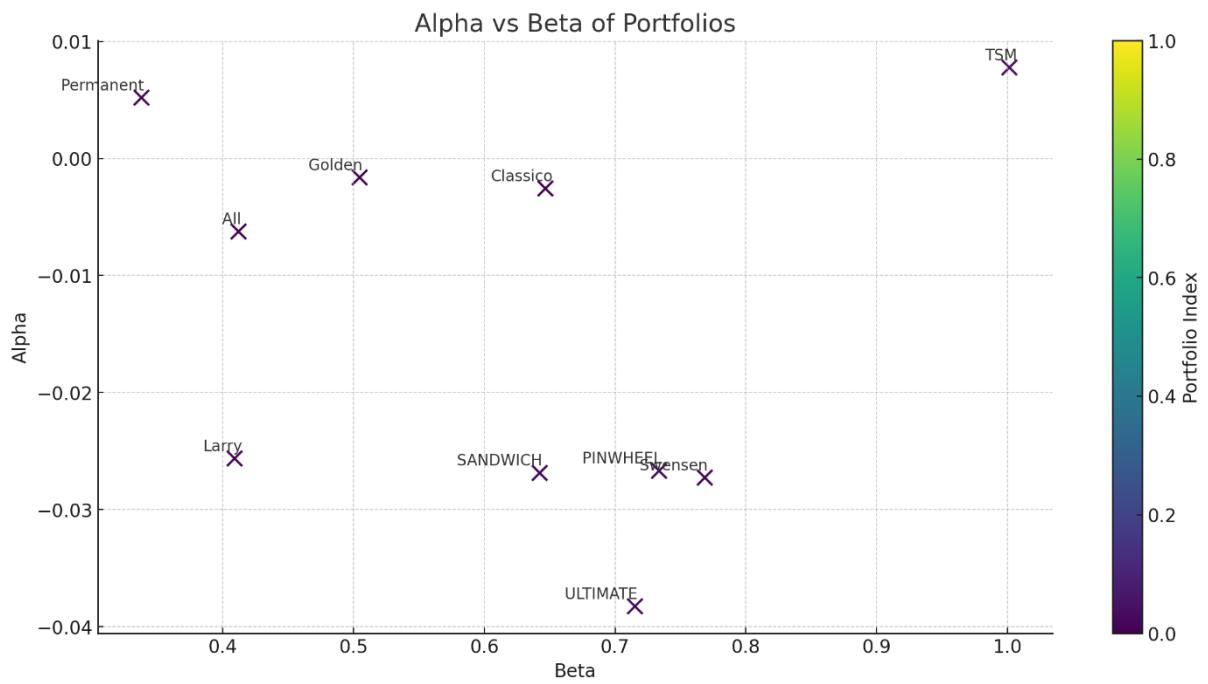
Drawdowns



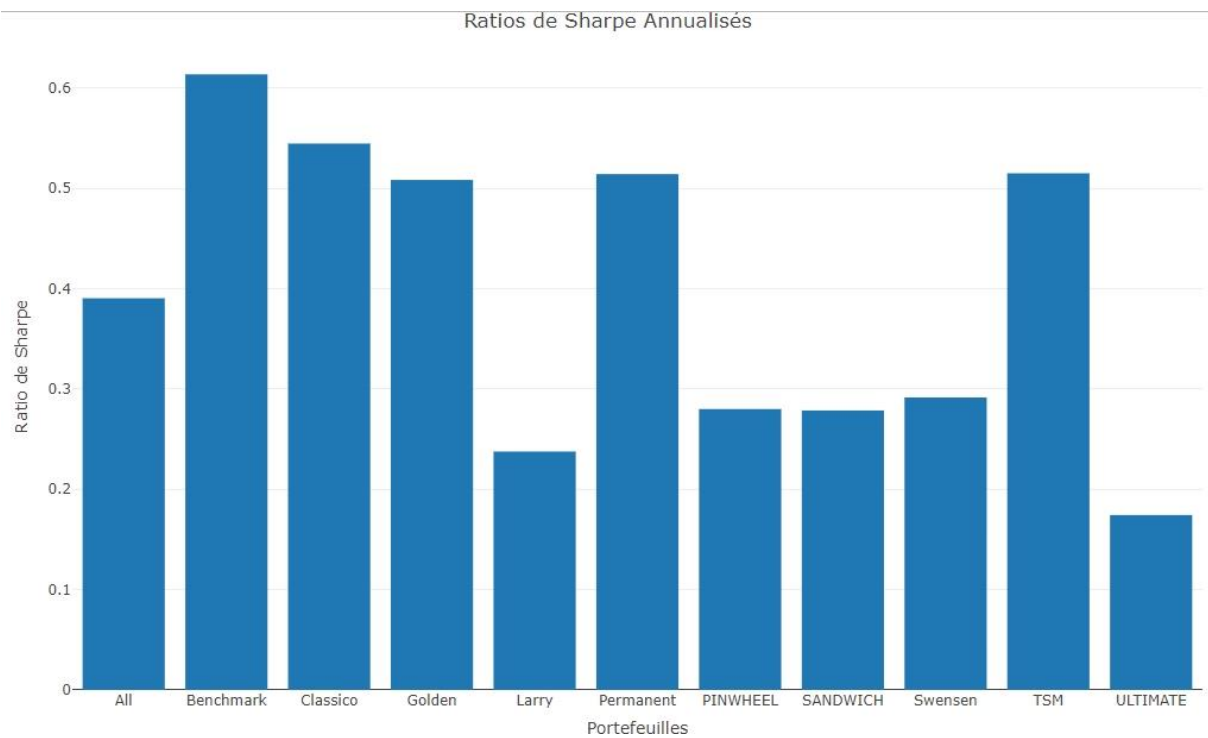
Distribution Of Returns with Quartiles For Each Strategy



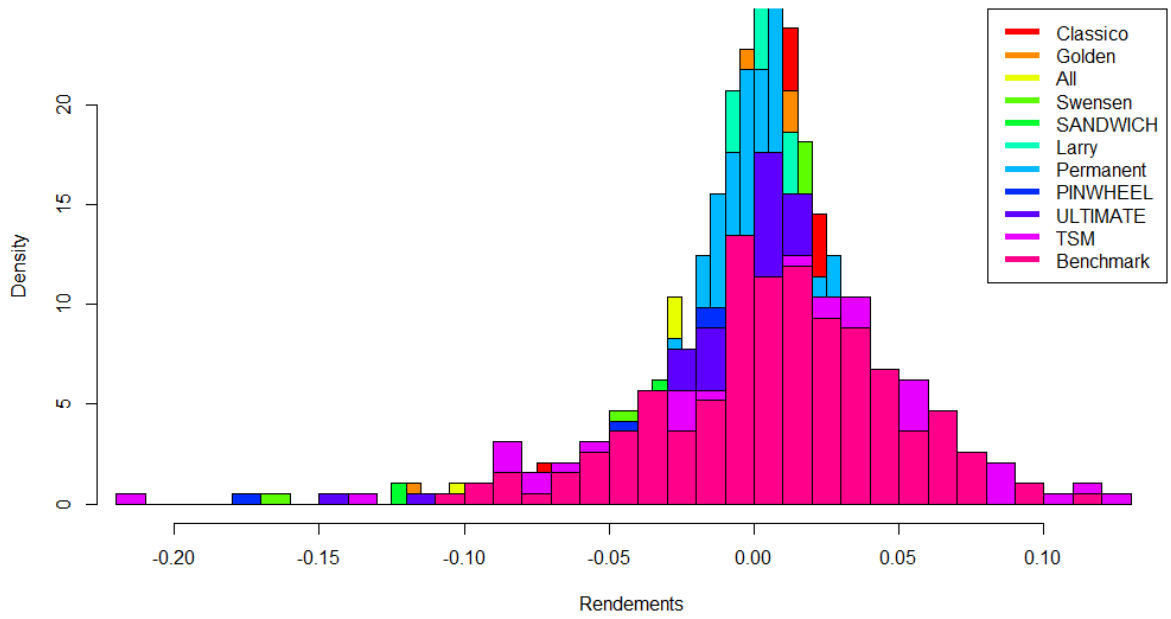
Alpha VS Beta



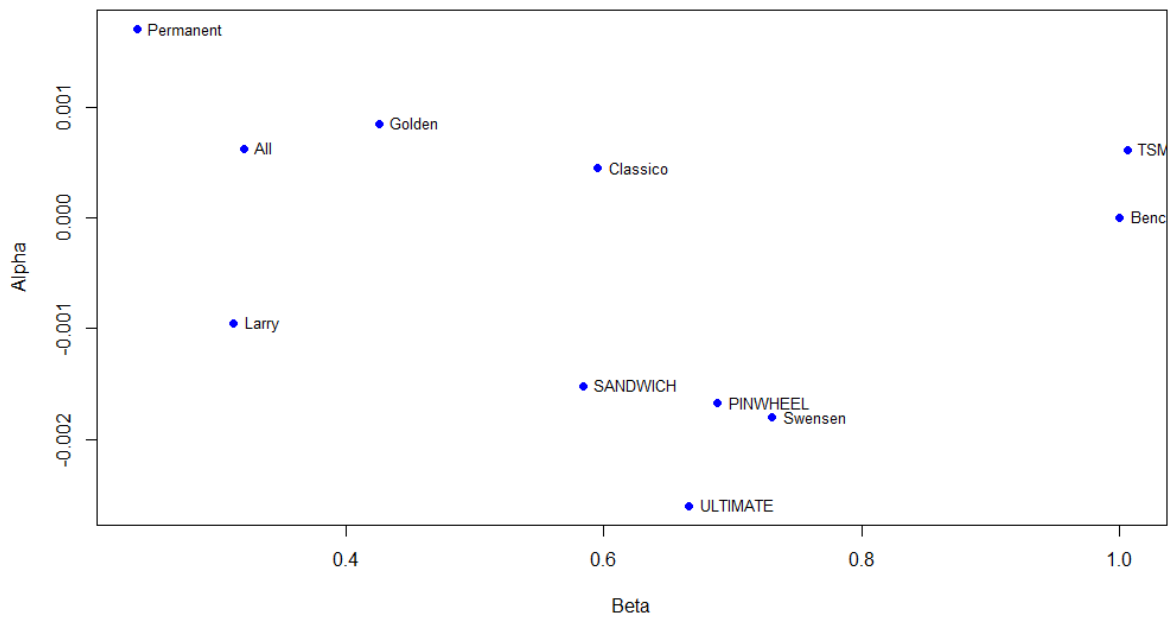
Sharp R

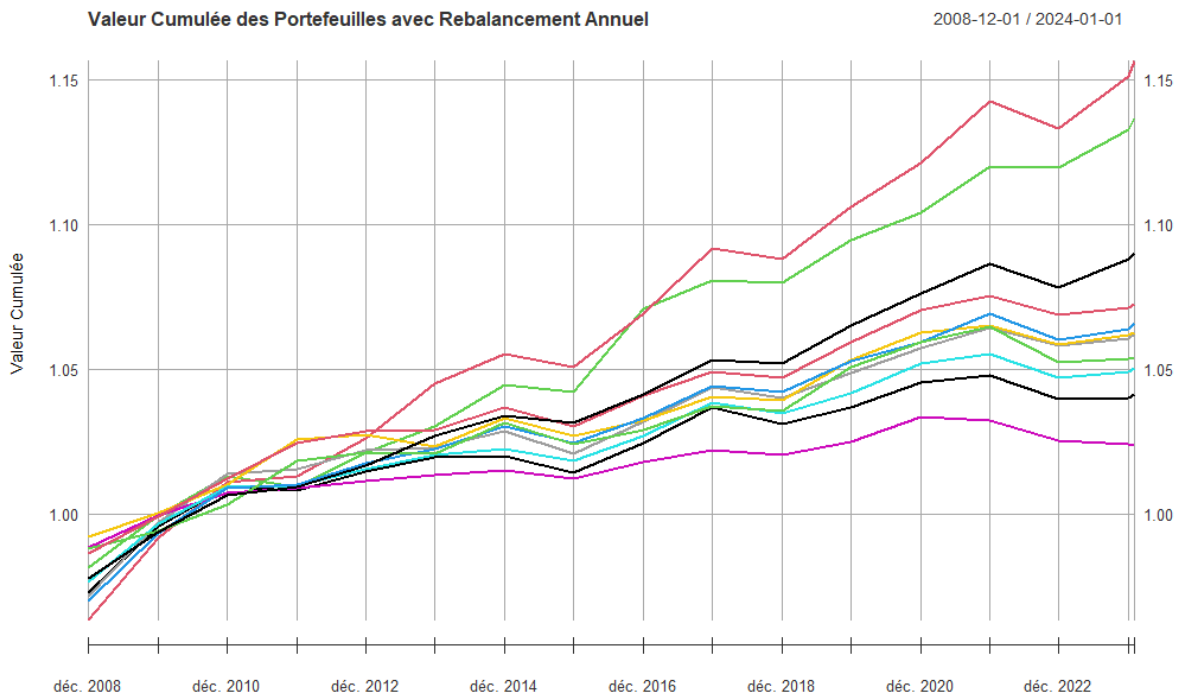
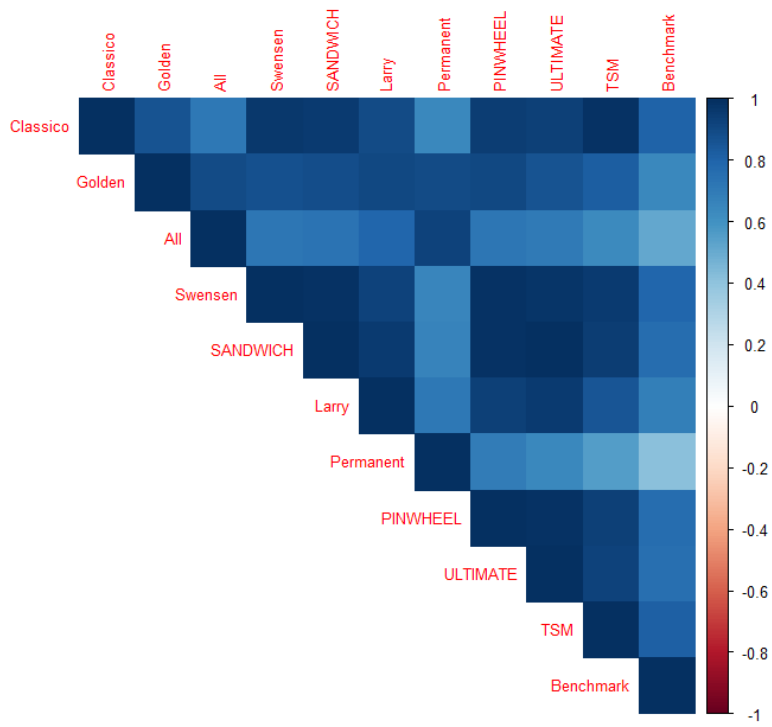


Histogrammes des Rendements

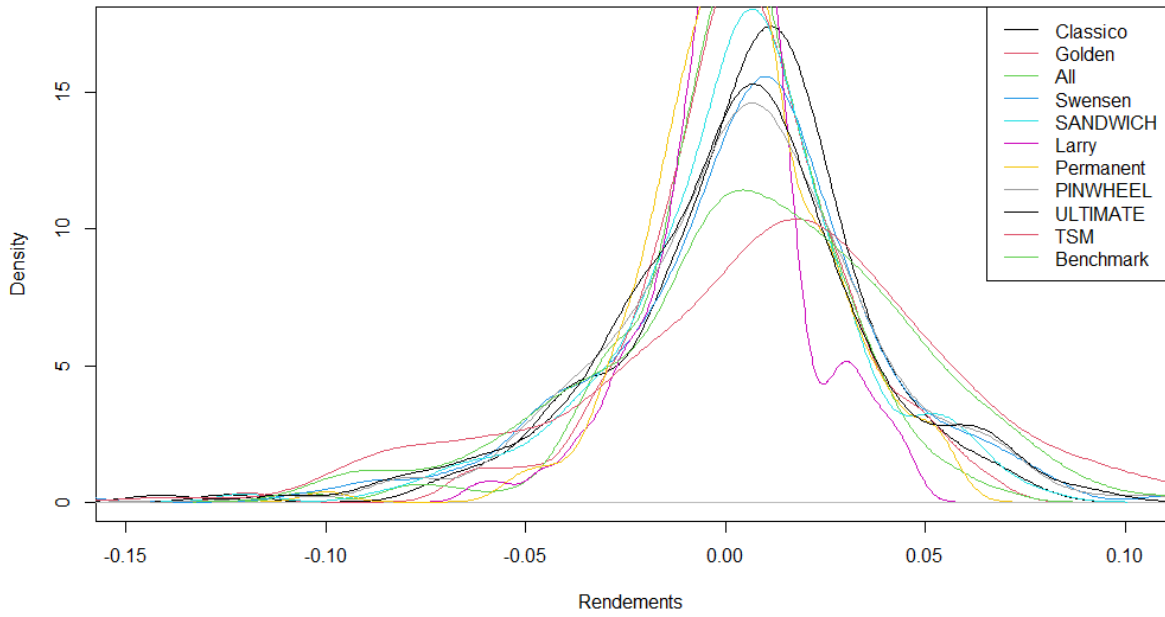


Alpha vs Beta

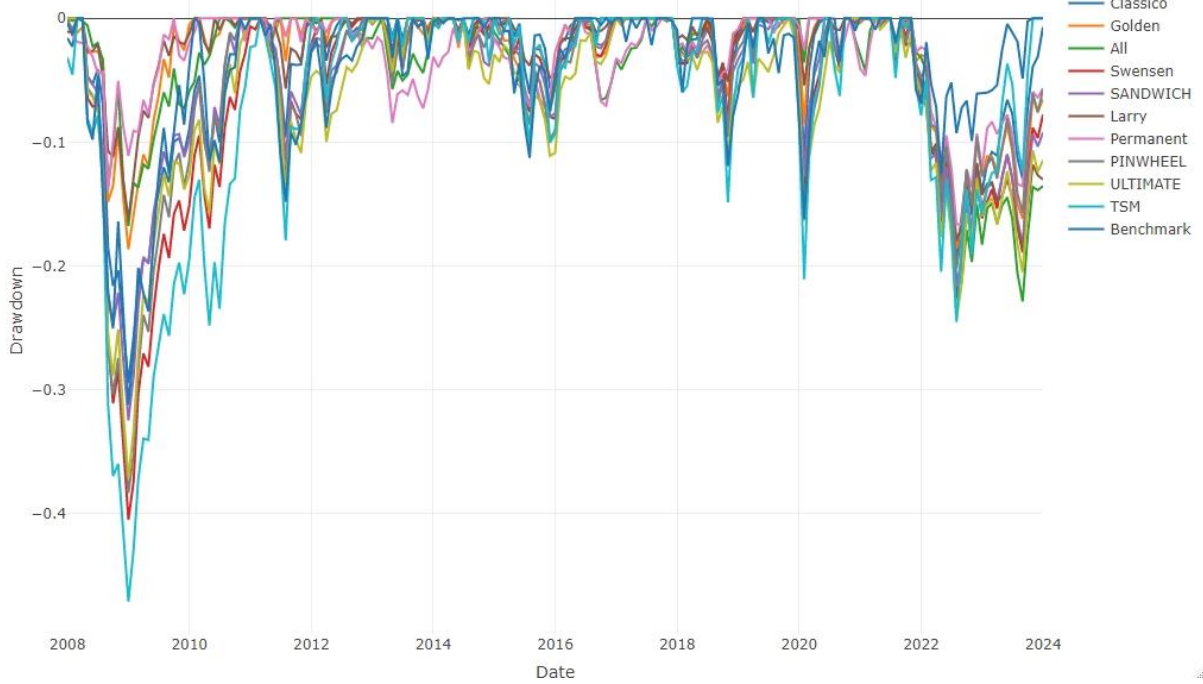




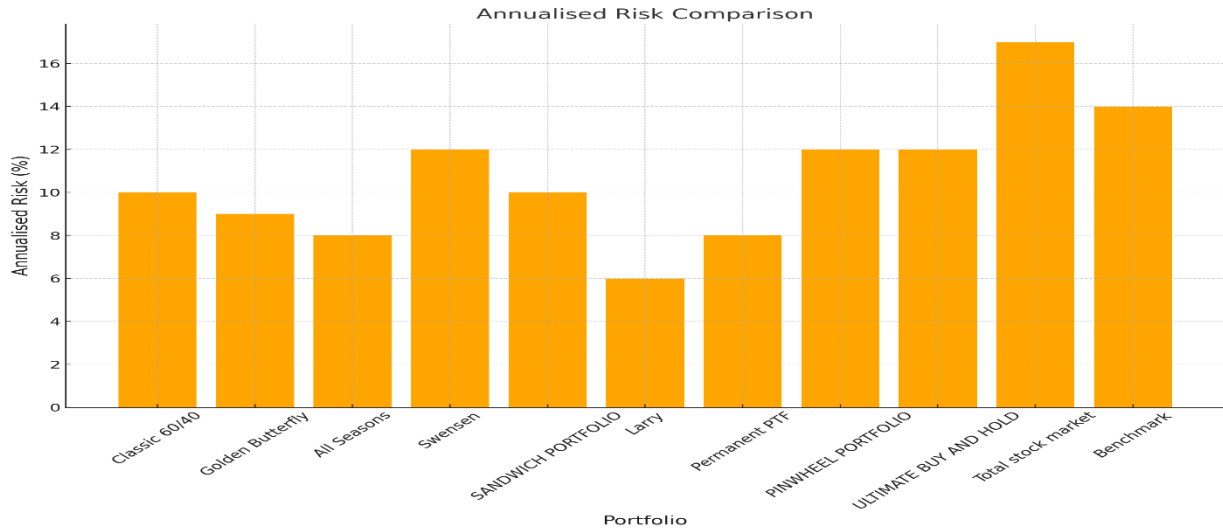
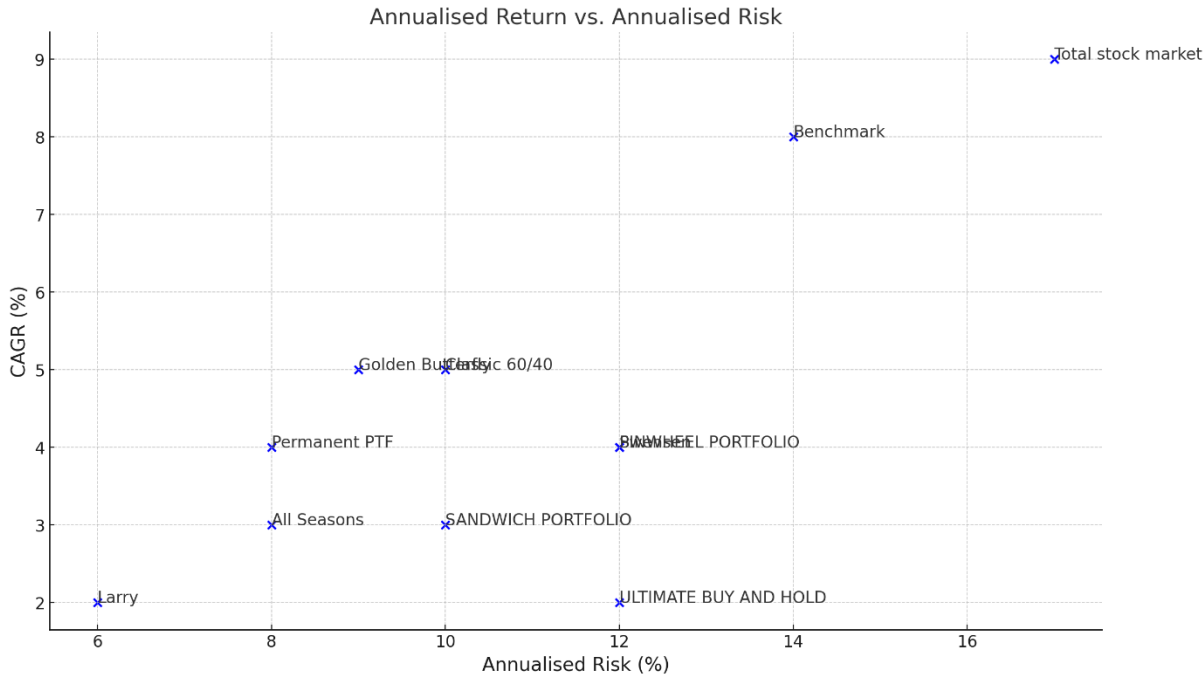
Densité des Rendements



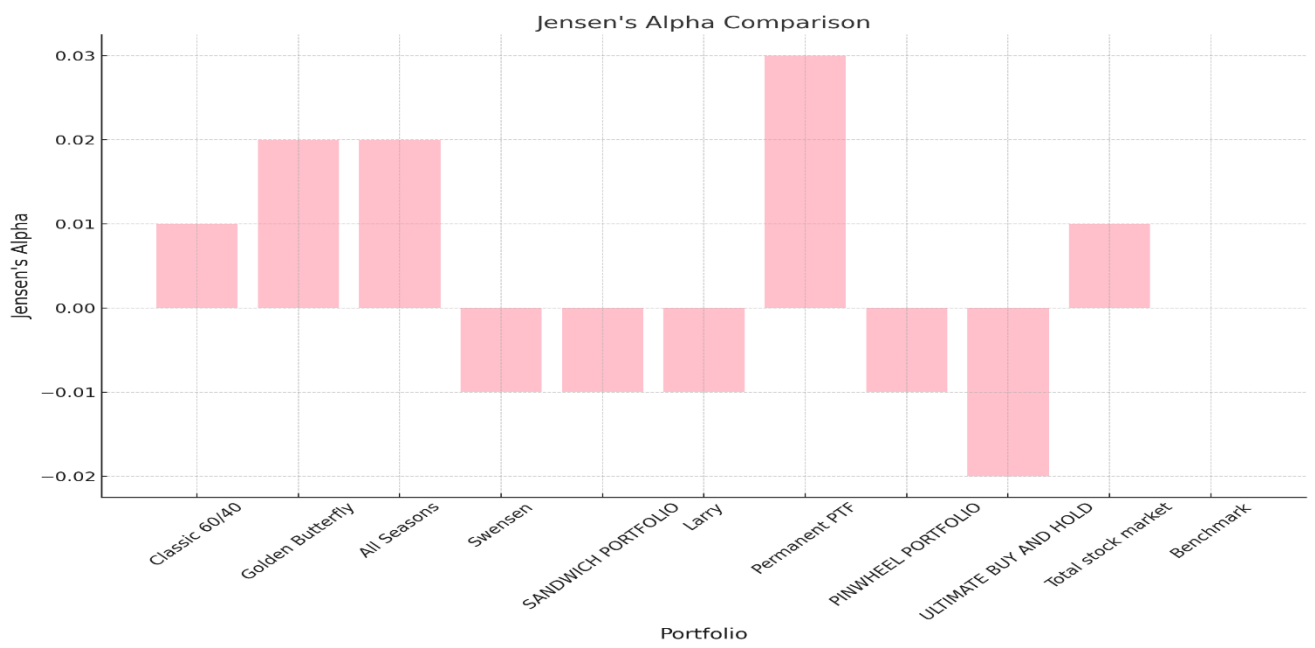
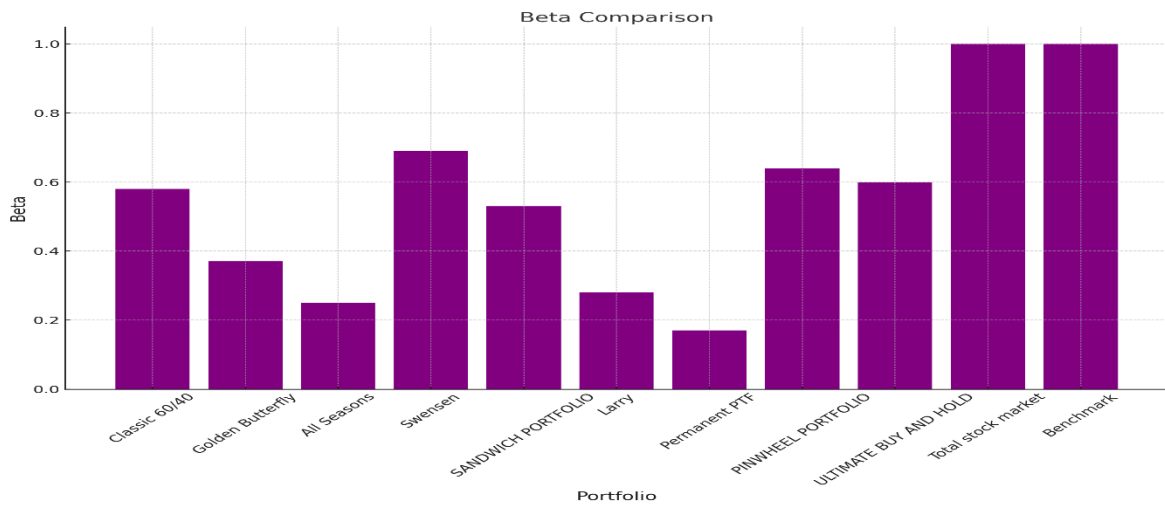
Drawdowns des Portefeuilles



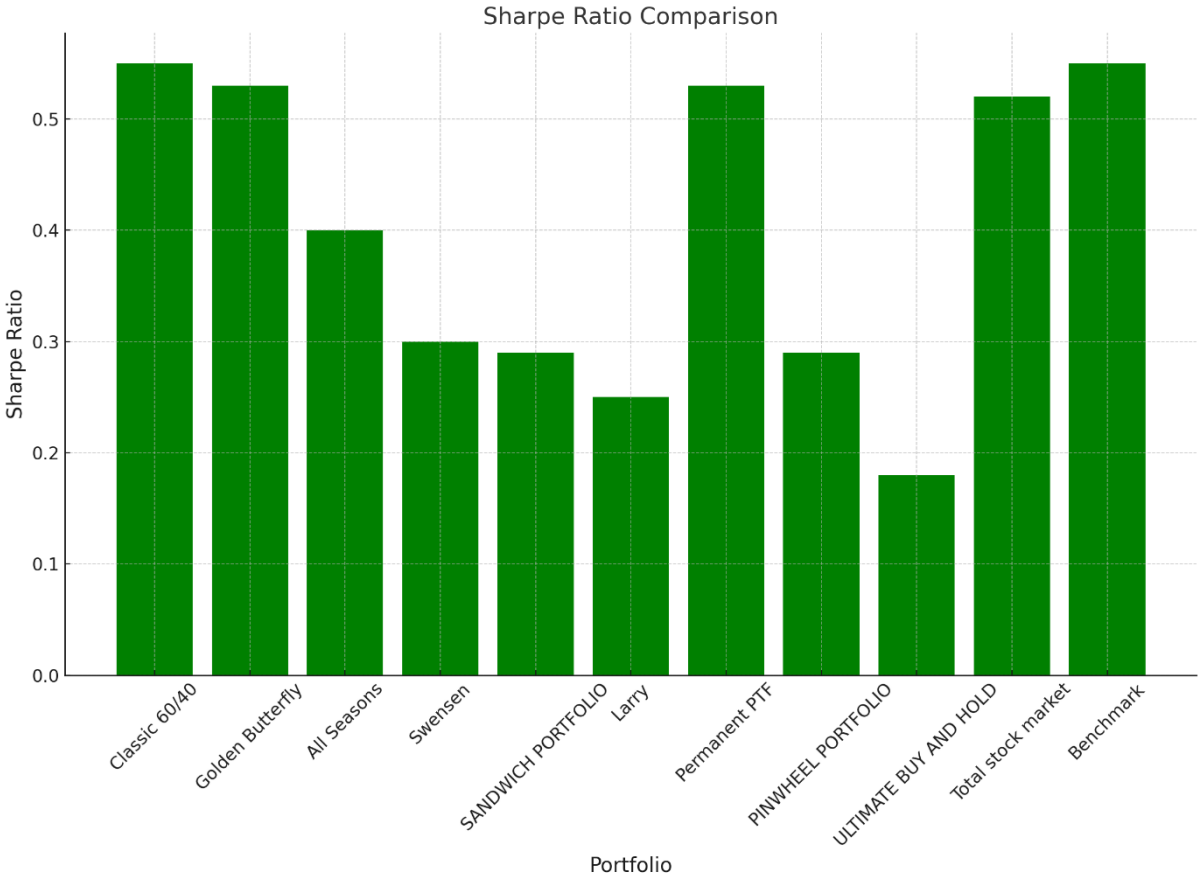
Annualised Return vs. Annualised Risk



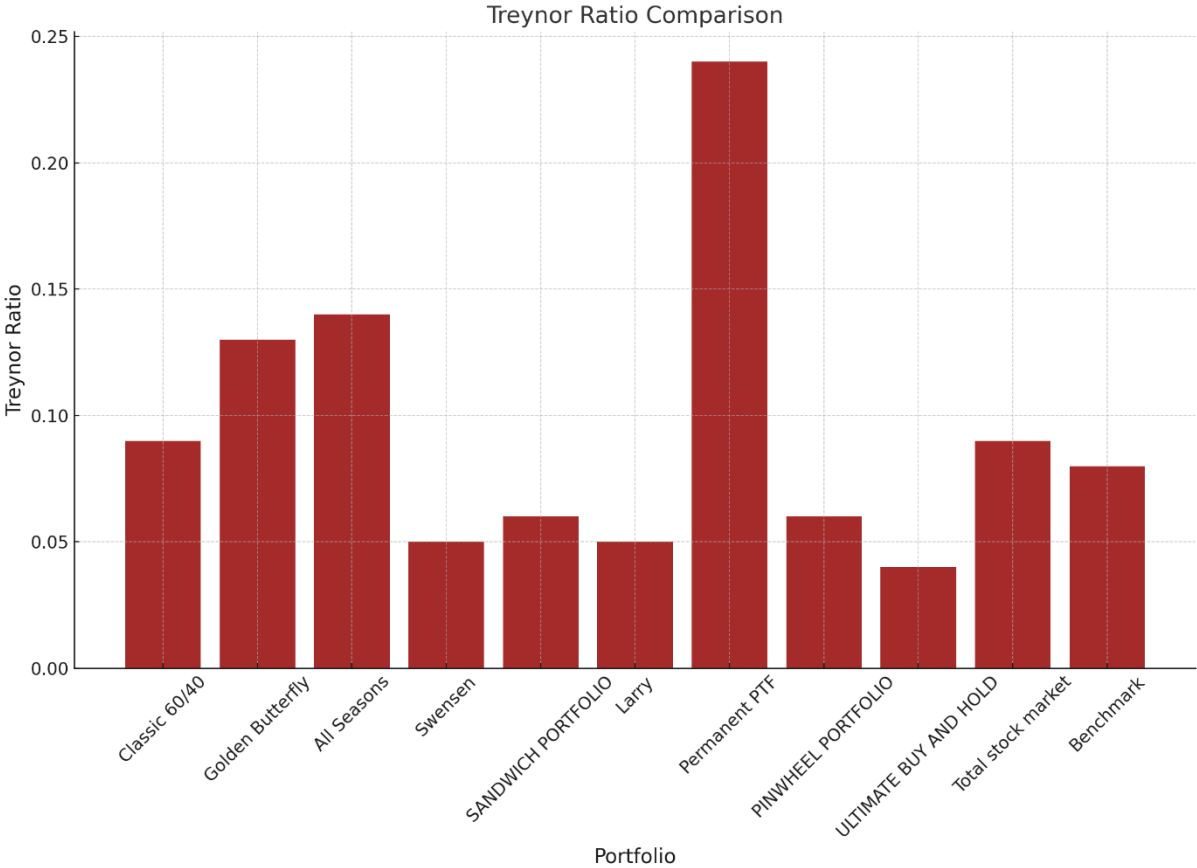
Beta and Jensen's Alpha



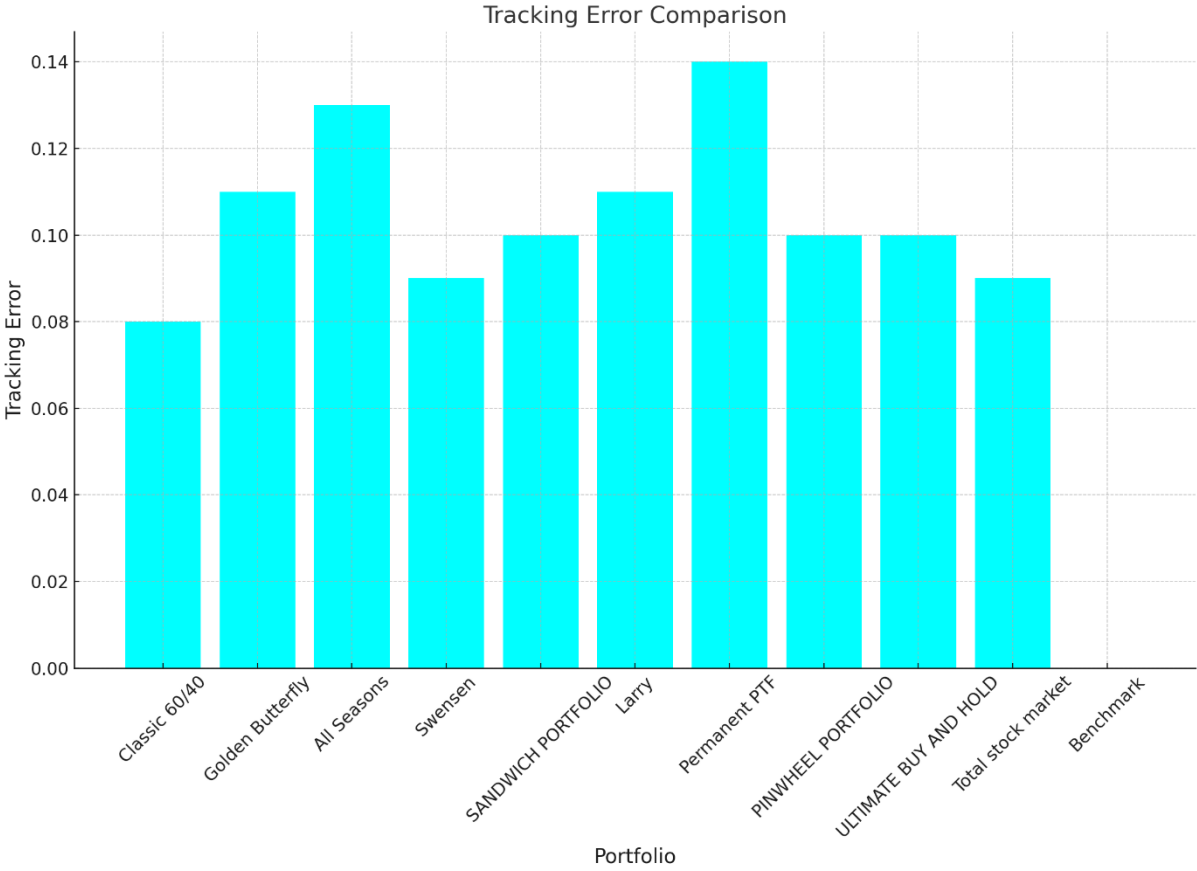
Sharpe Ratio



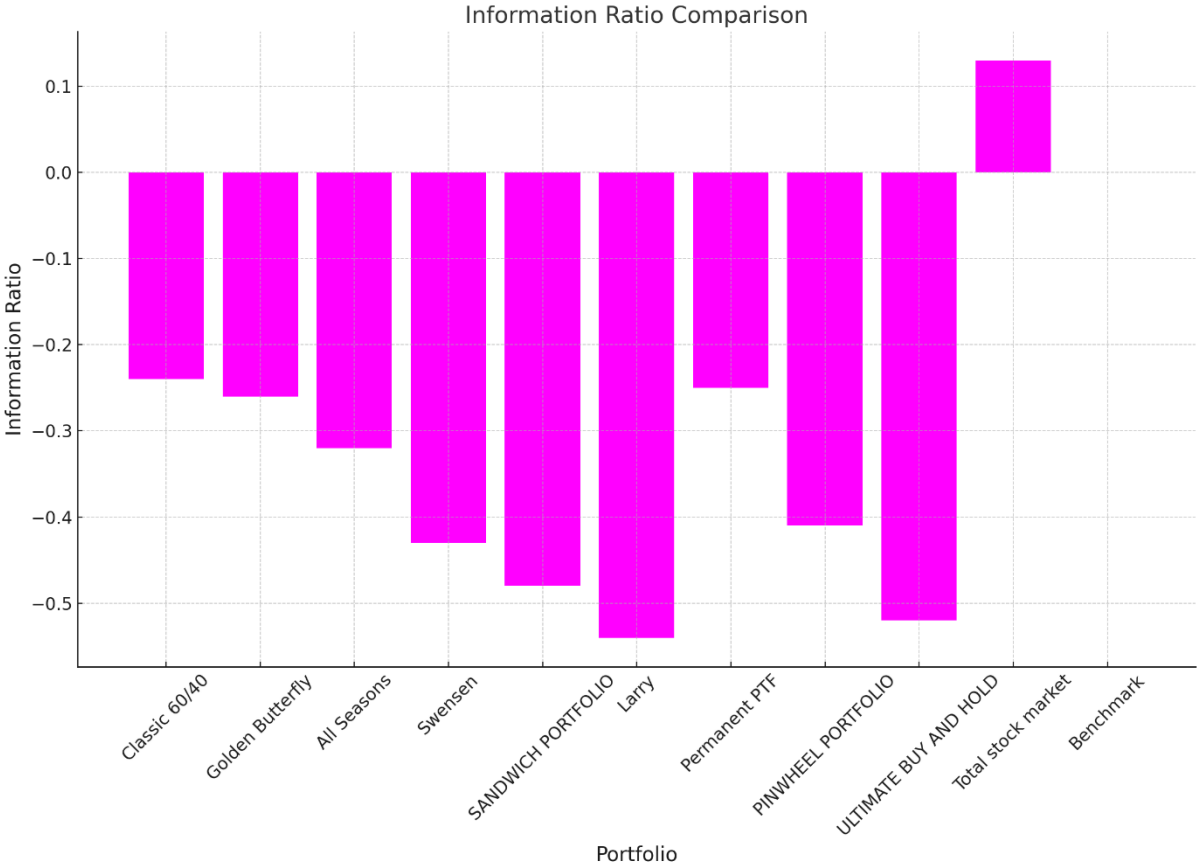
Treynor Ratio



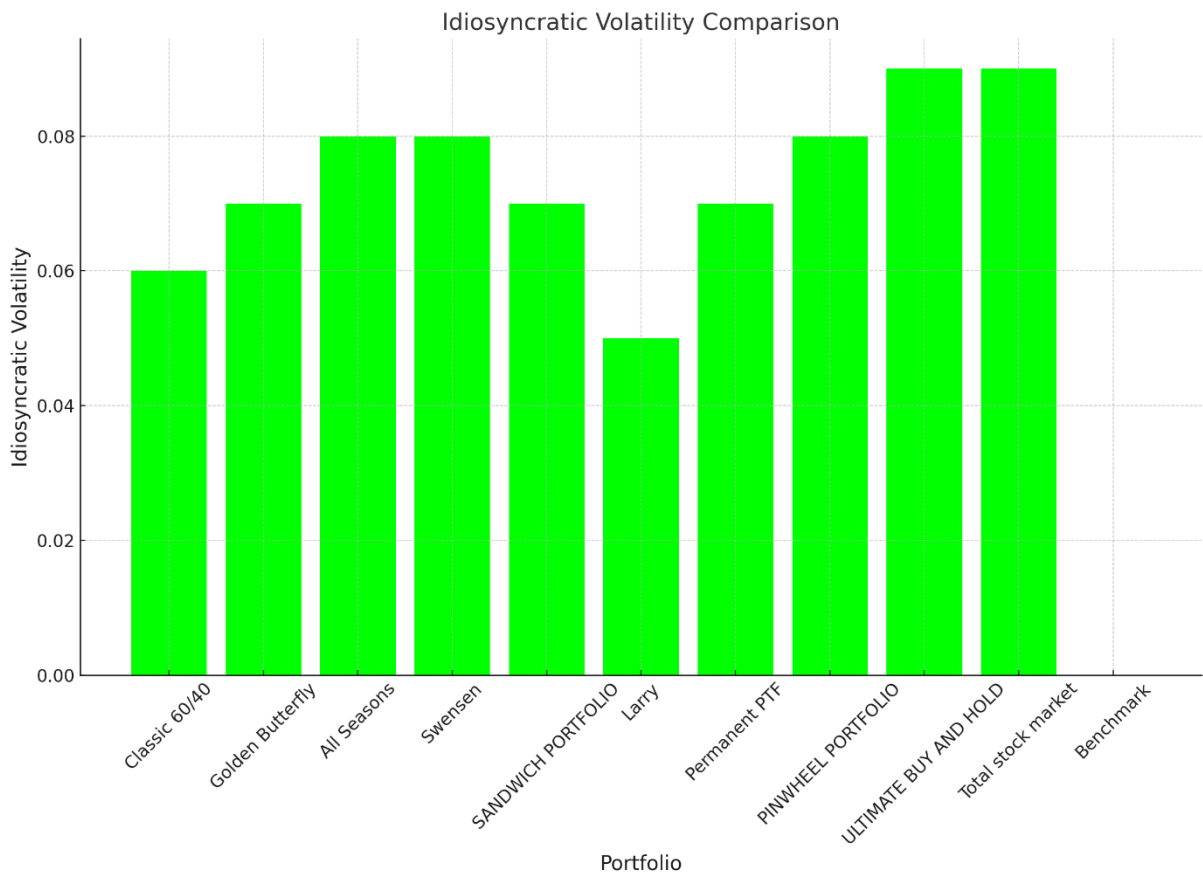
Tracking Error



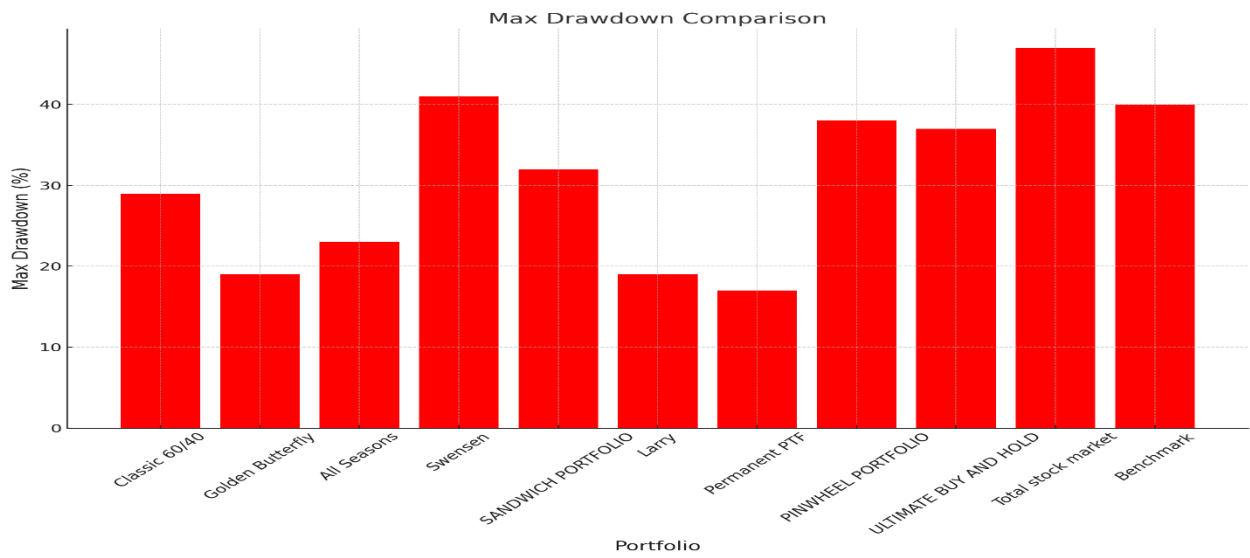
Information Ratio



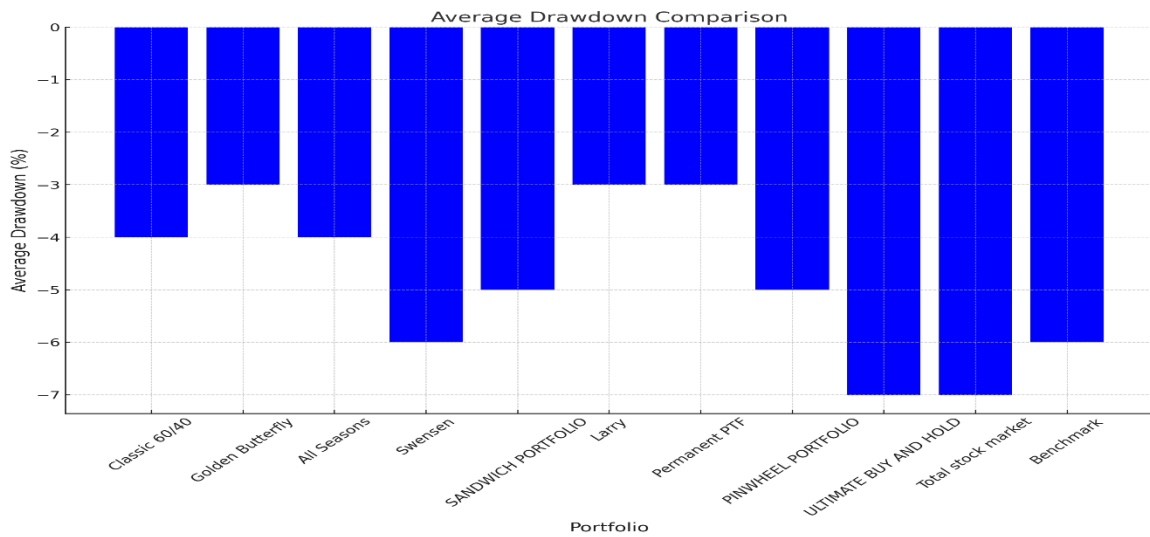
Idiosyncratic Volatility



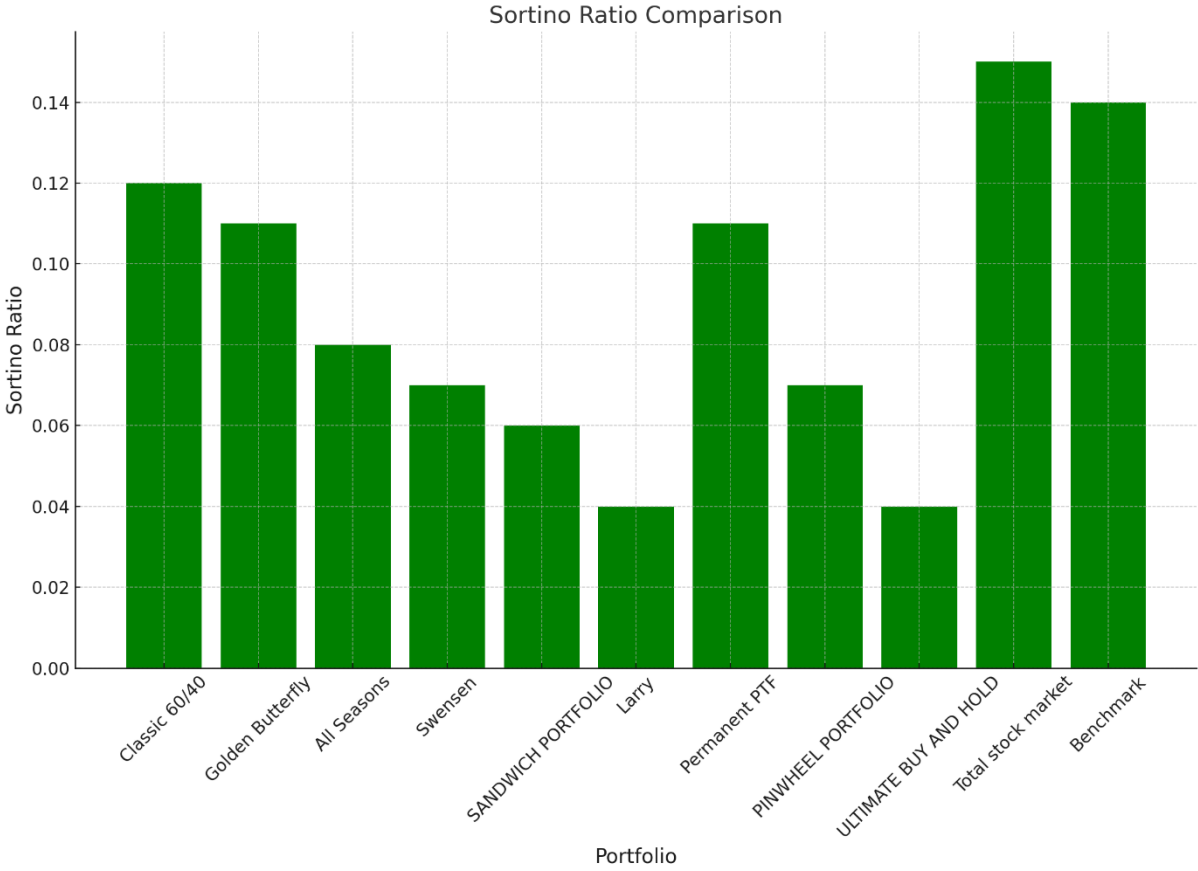
Maximum Drawdown



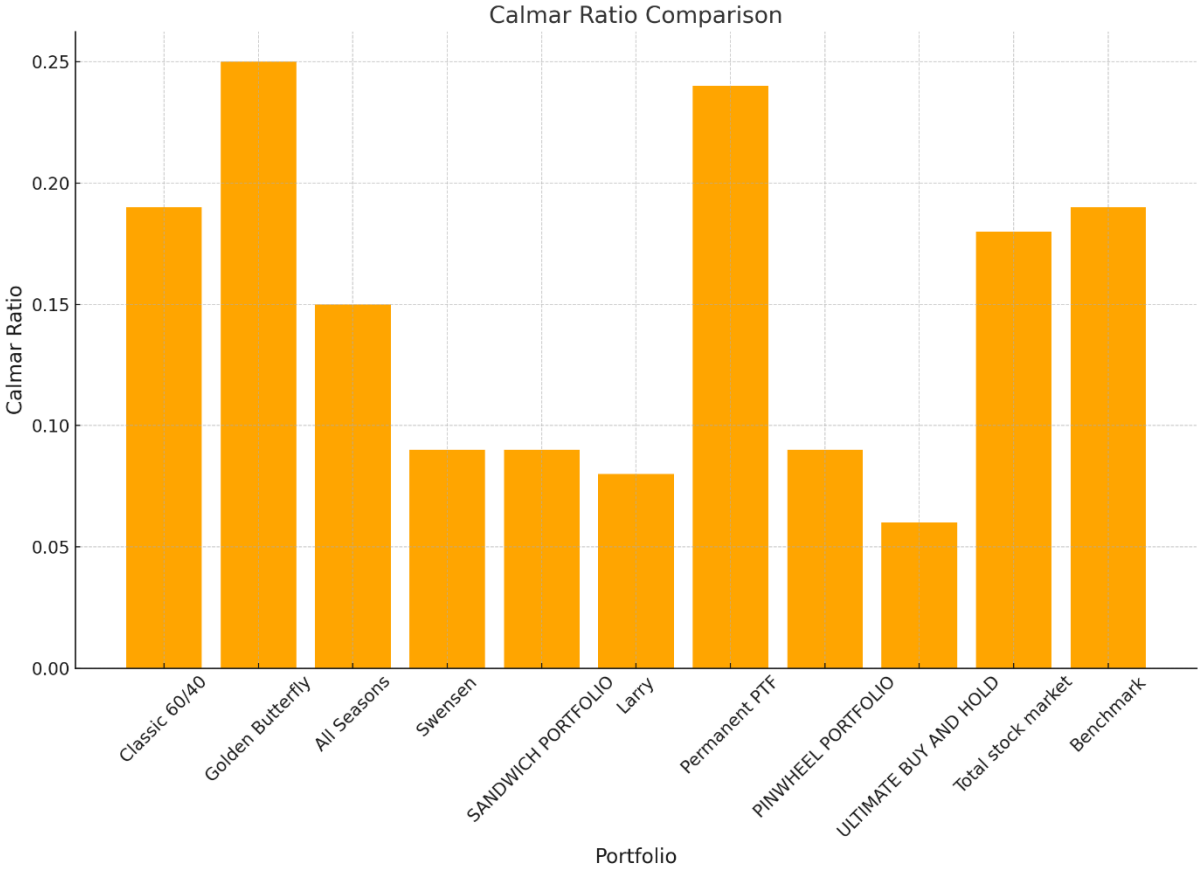
Average Drawdown



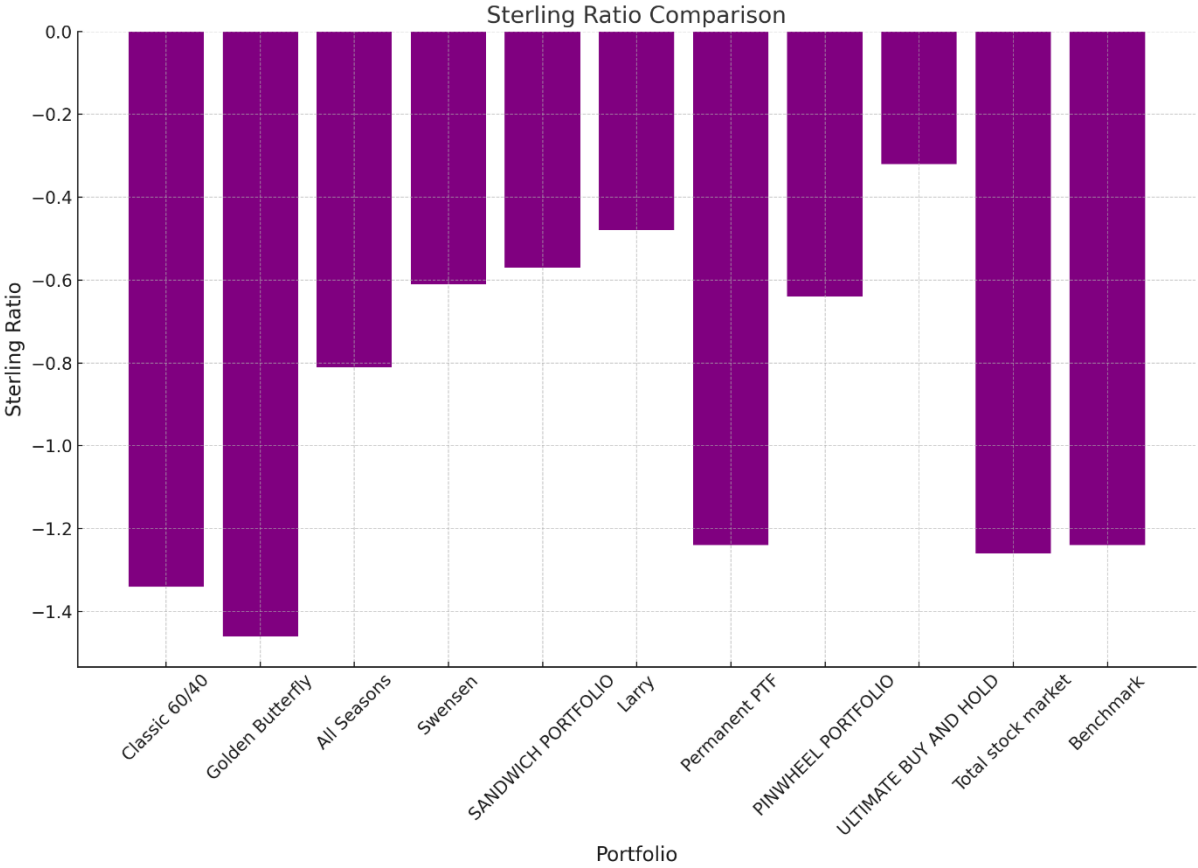
Sortino Ratio



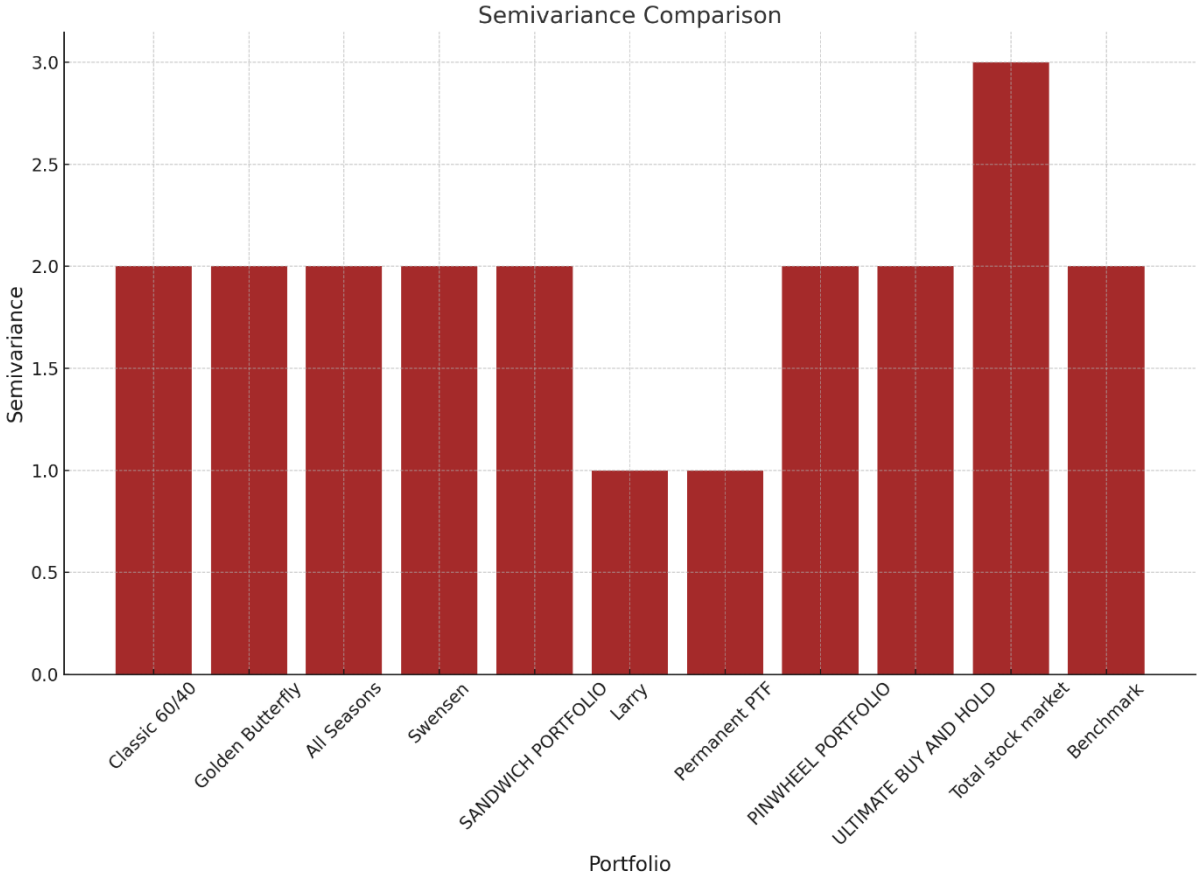
Calmar Ratio



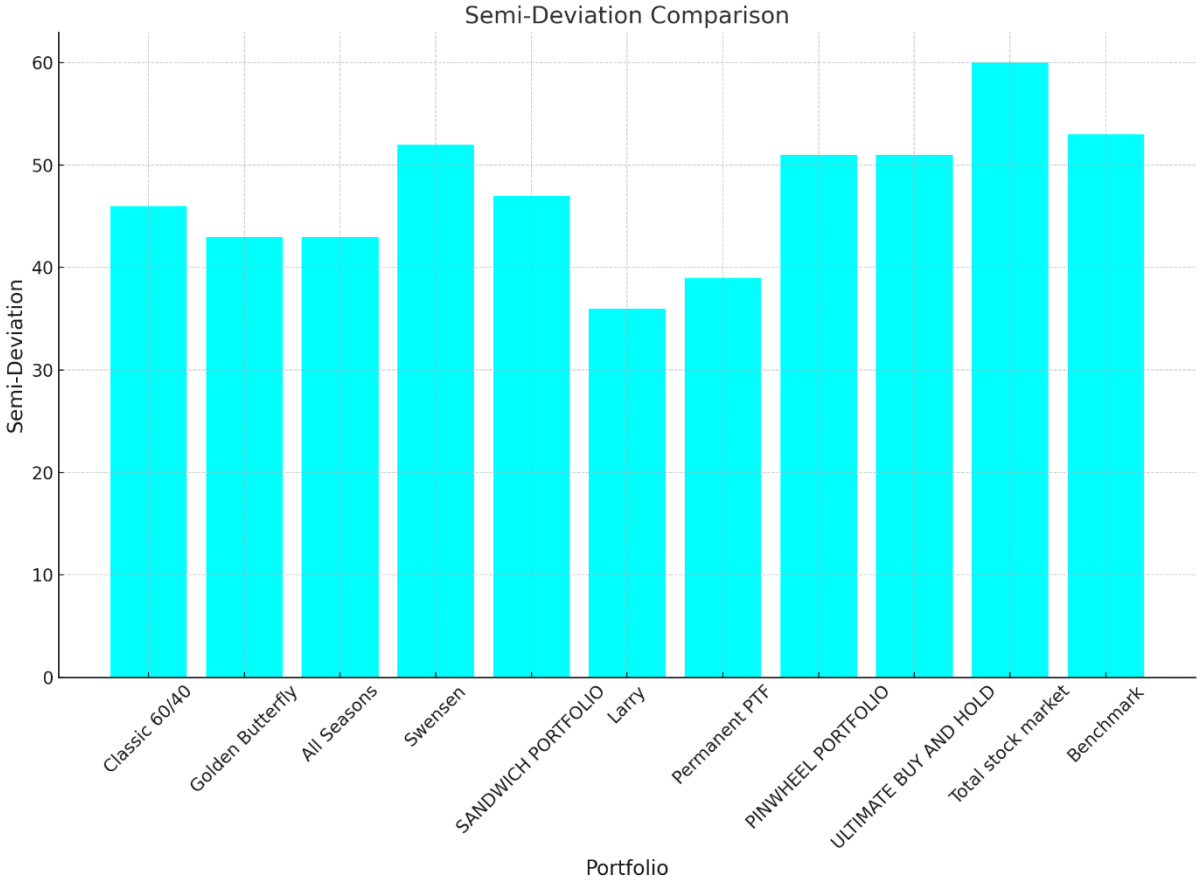
Sterling Ratio



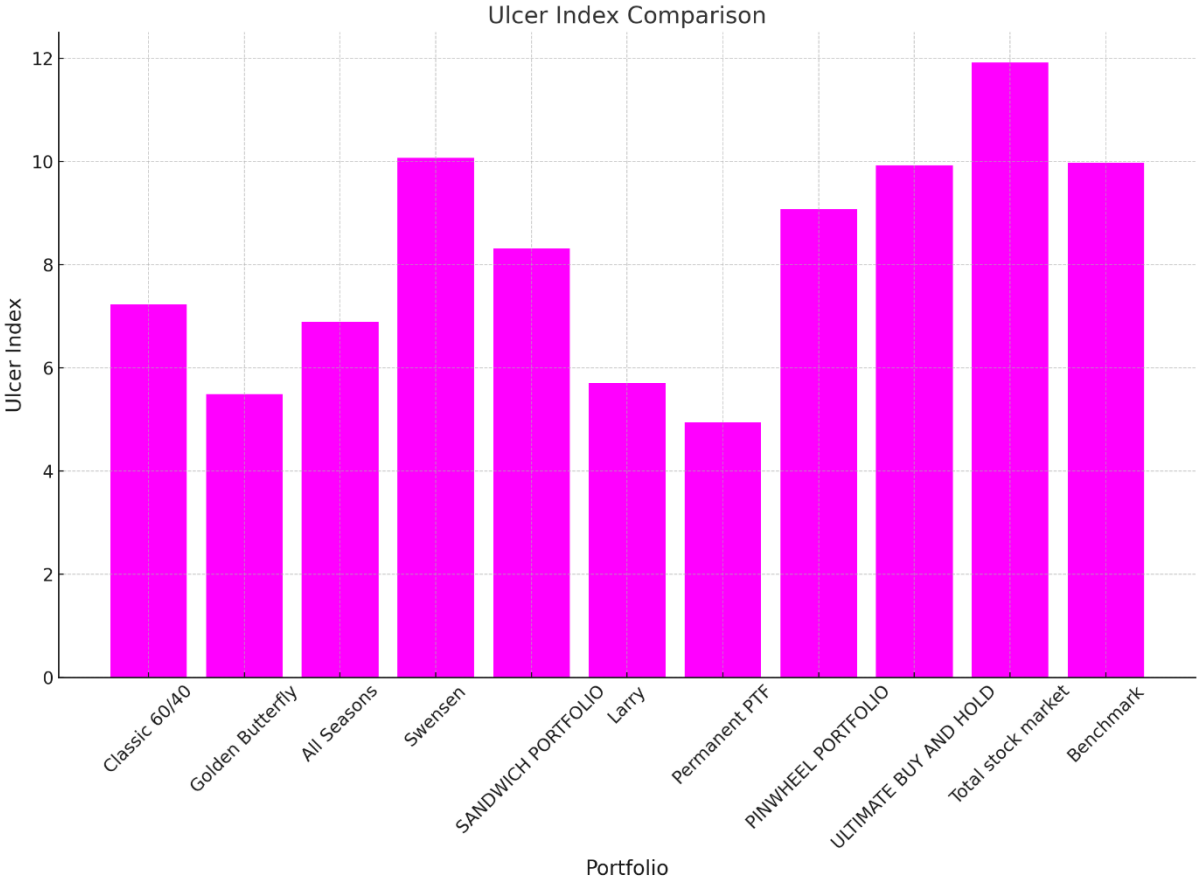
Semivariance



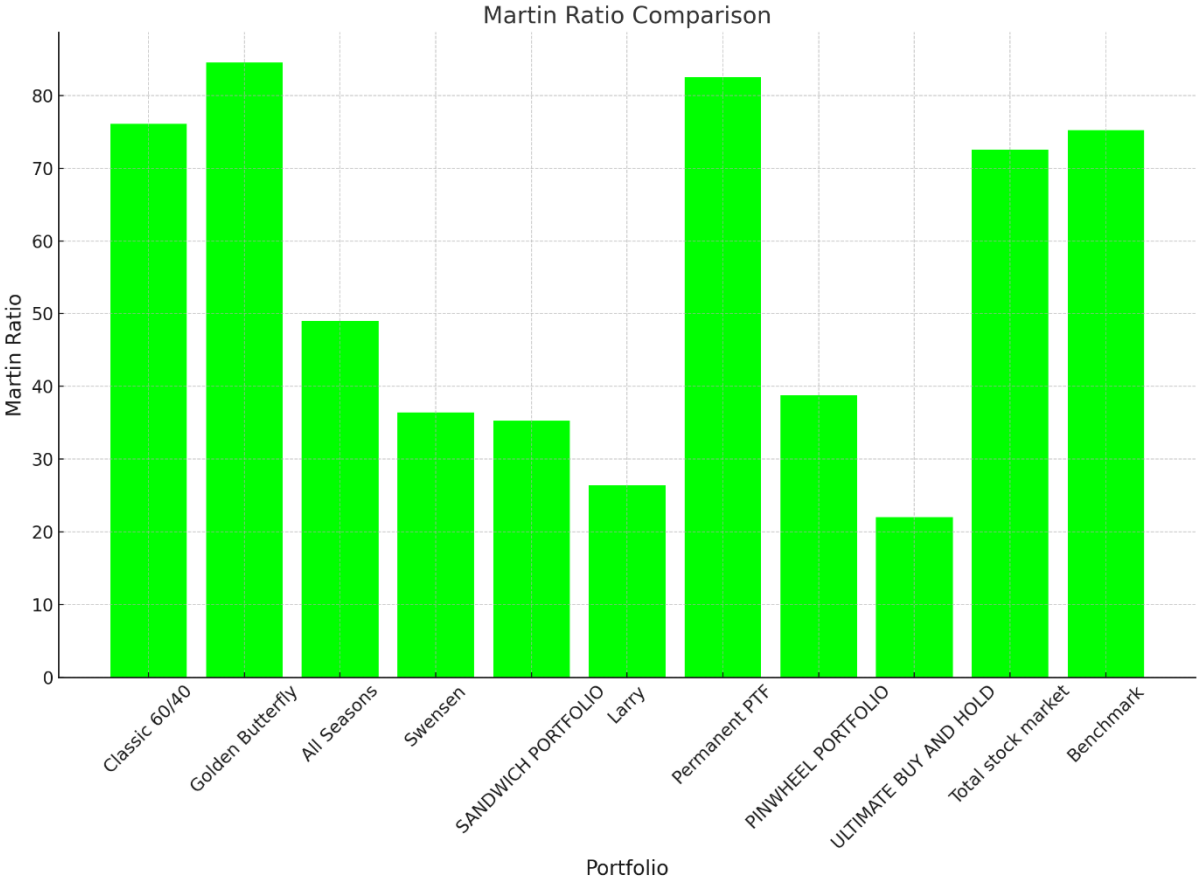
Semi-Deviation



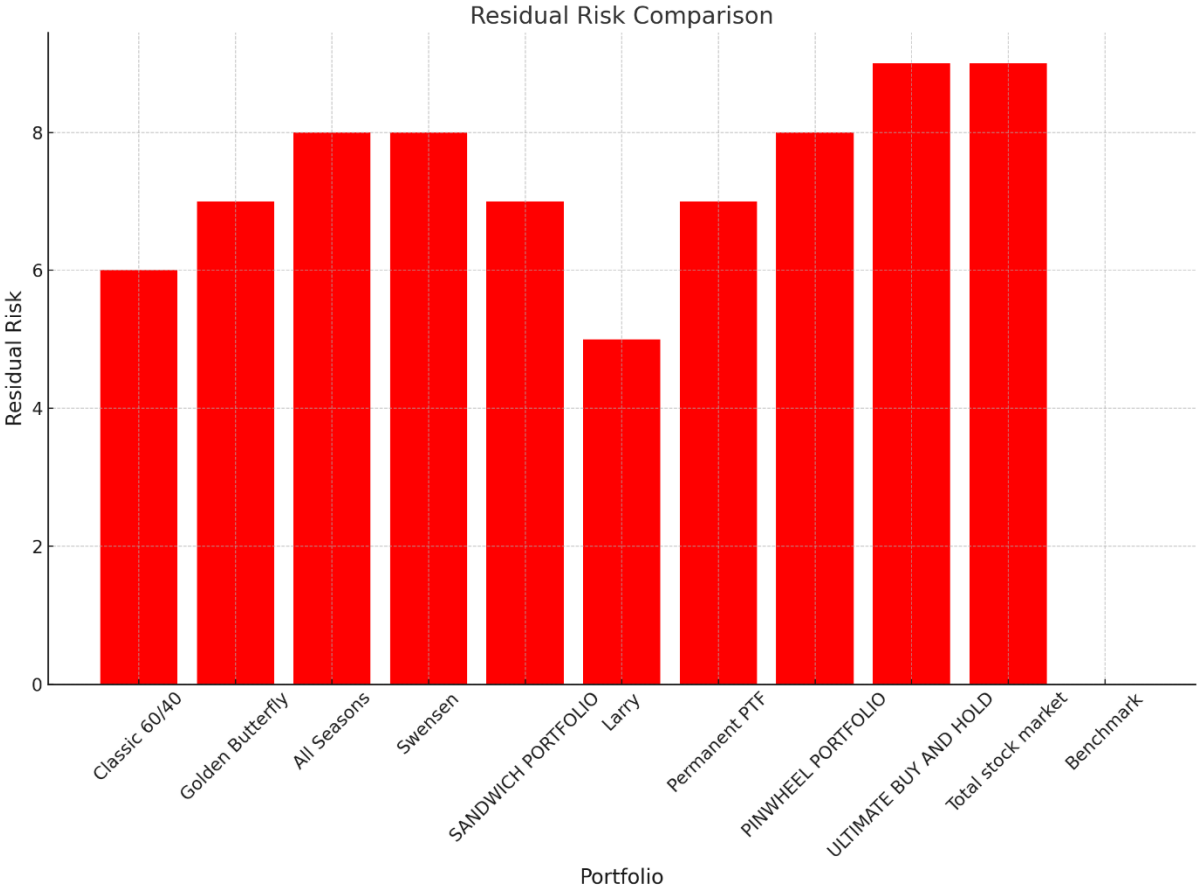
Ulcer Index



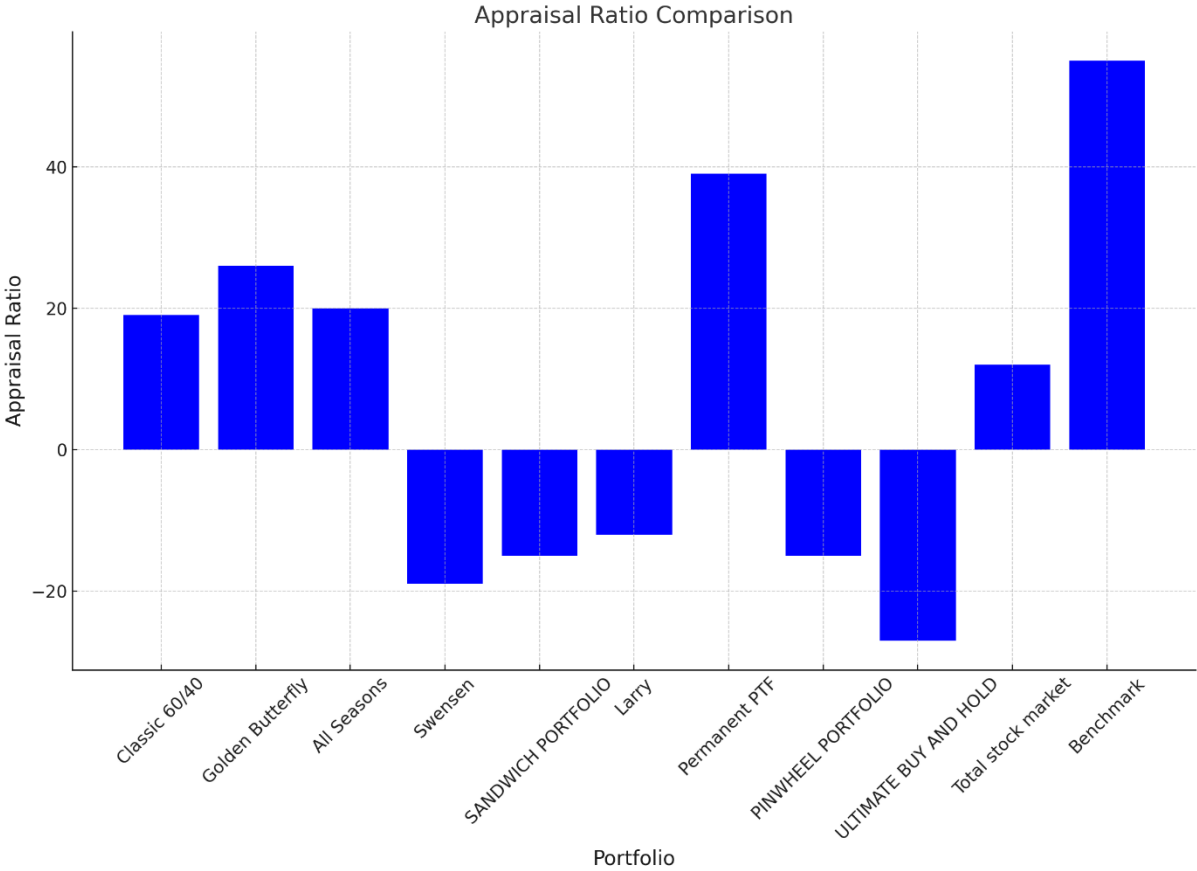
Martin Ratio



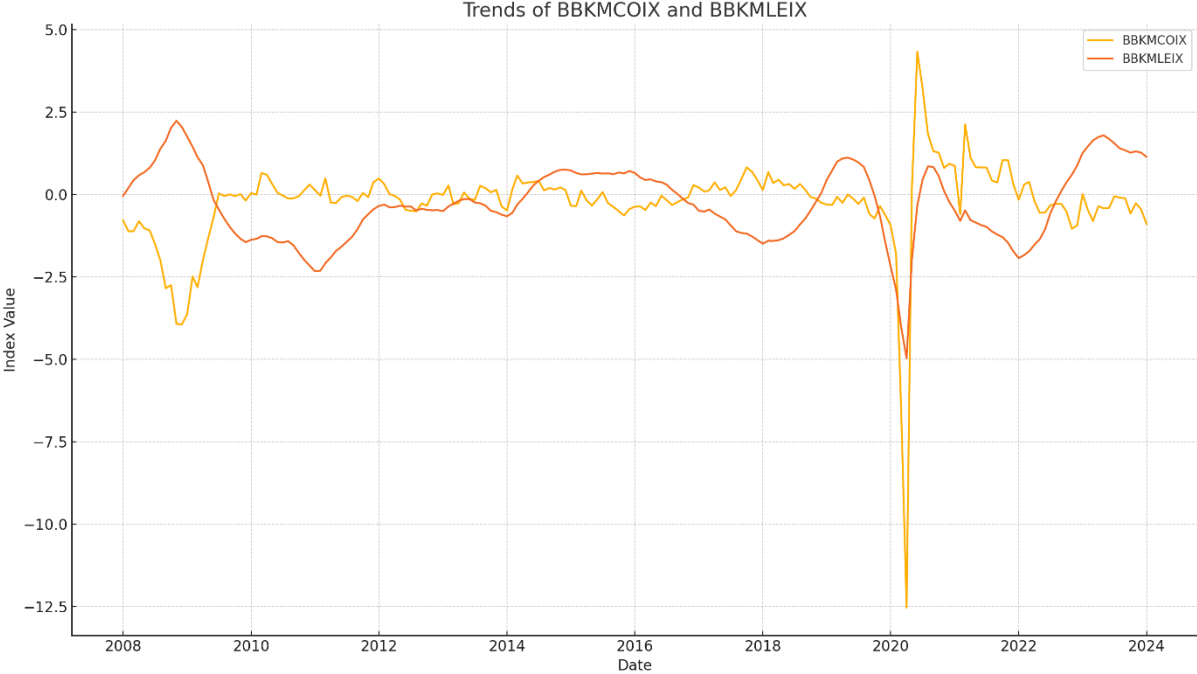
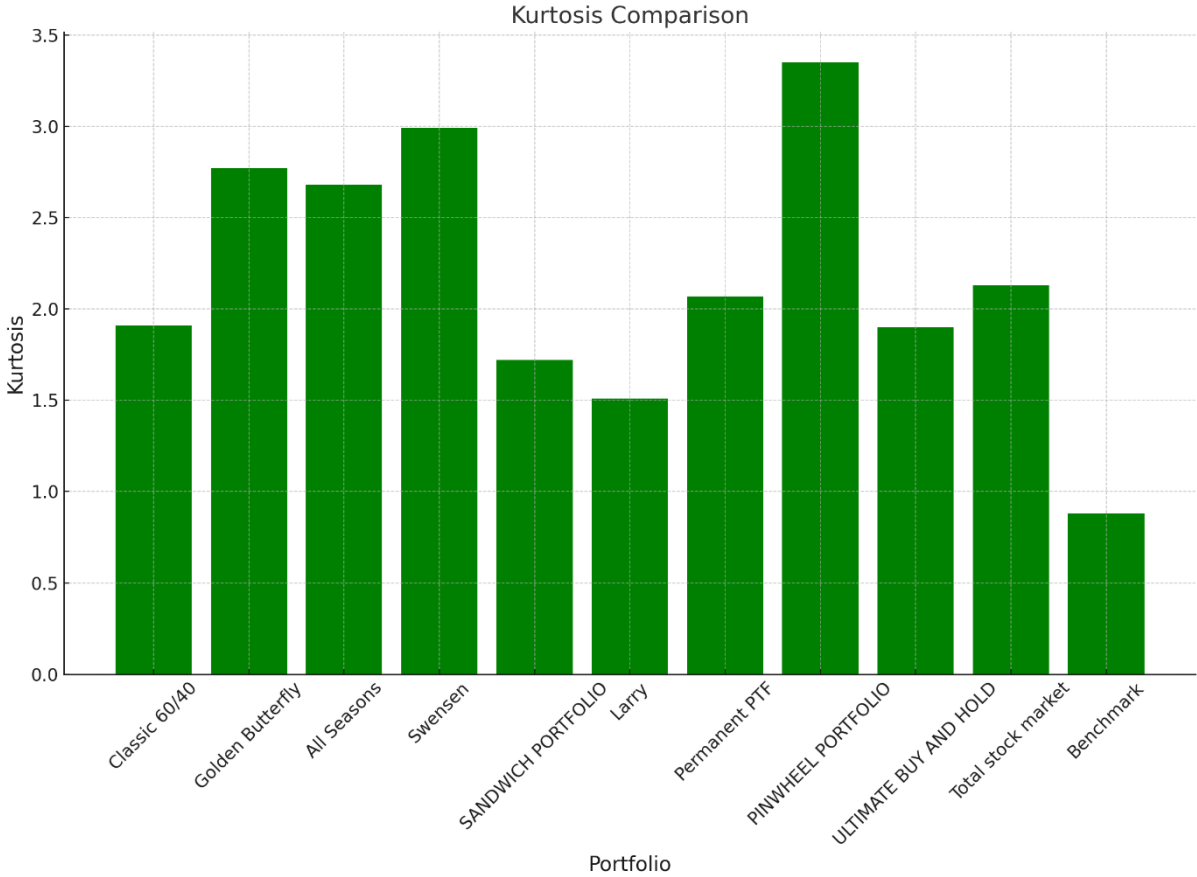
Residual Risk



Appraisal Ratio

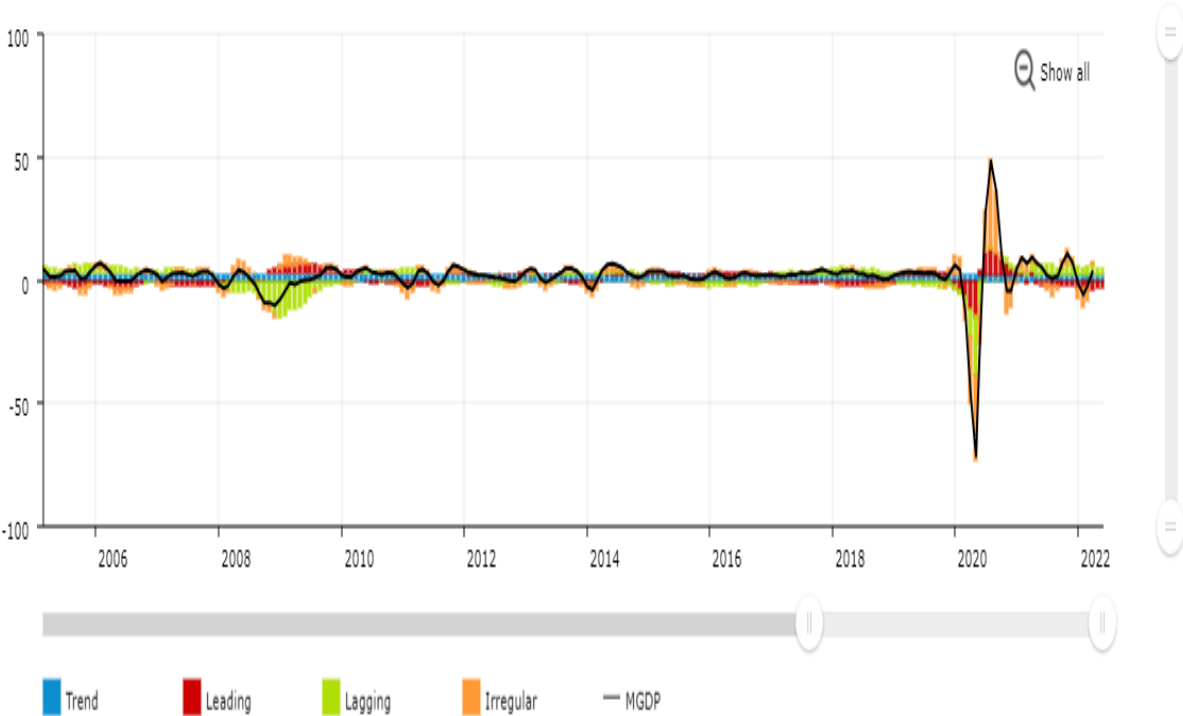


Kurtosis Comparison

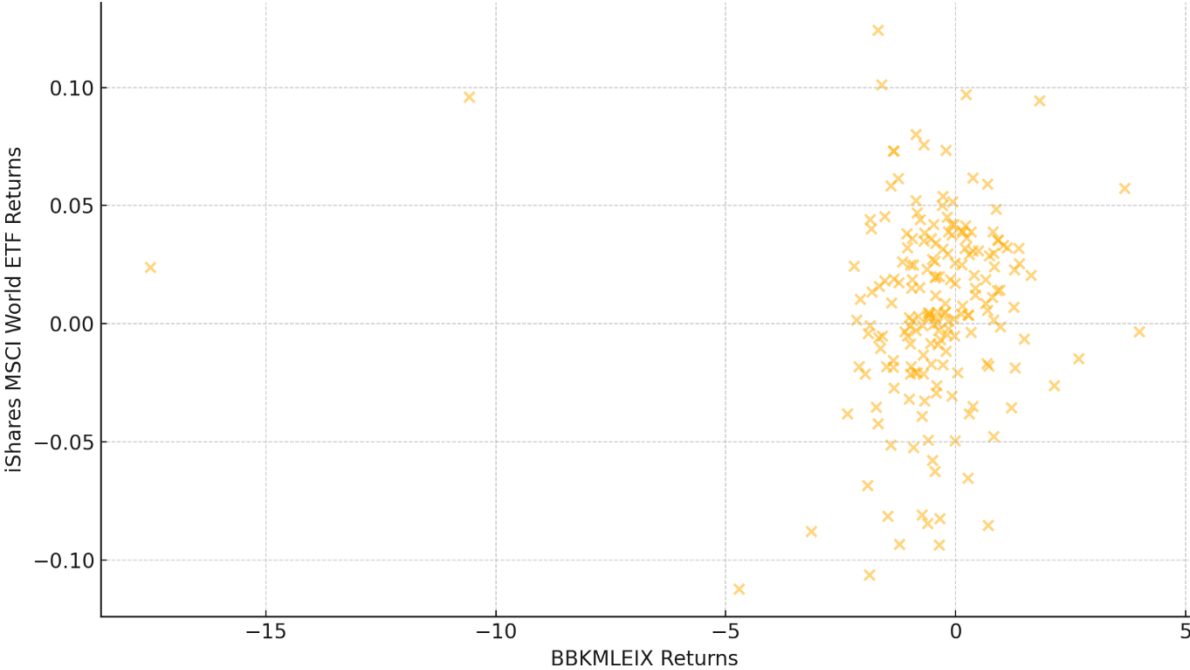


BBK LEI

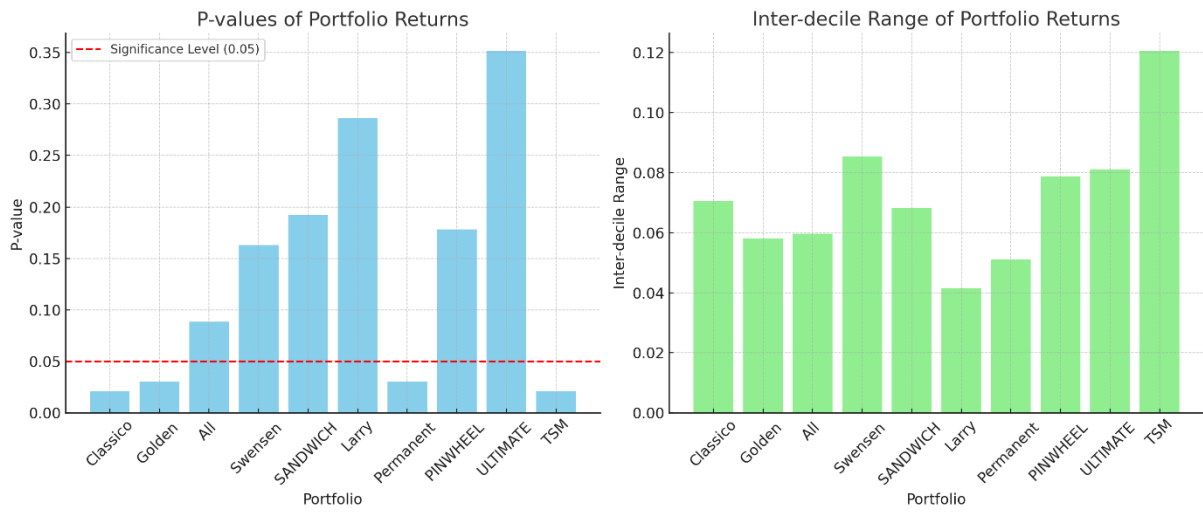
Monthly GDP Growth (annualized)



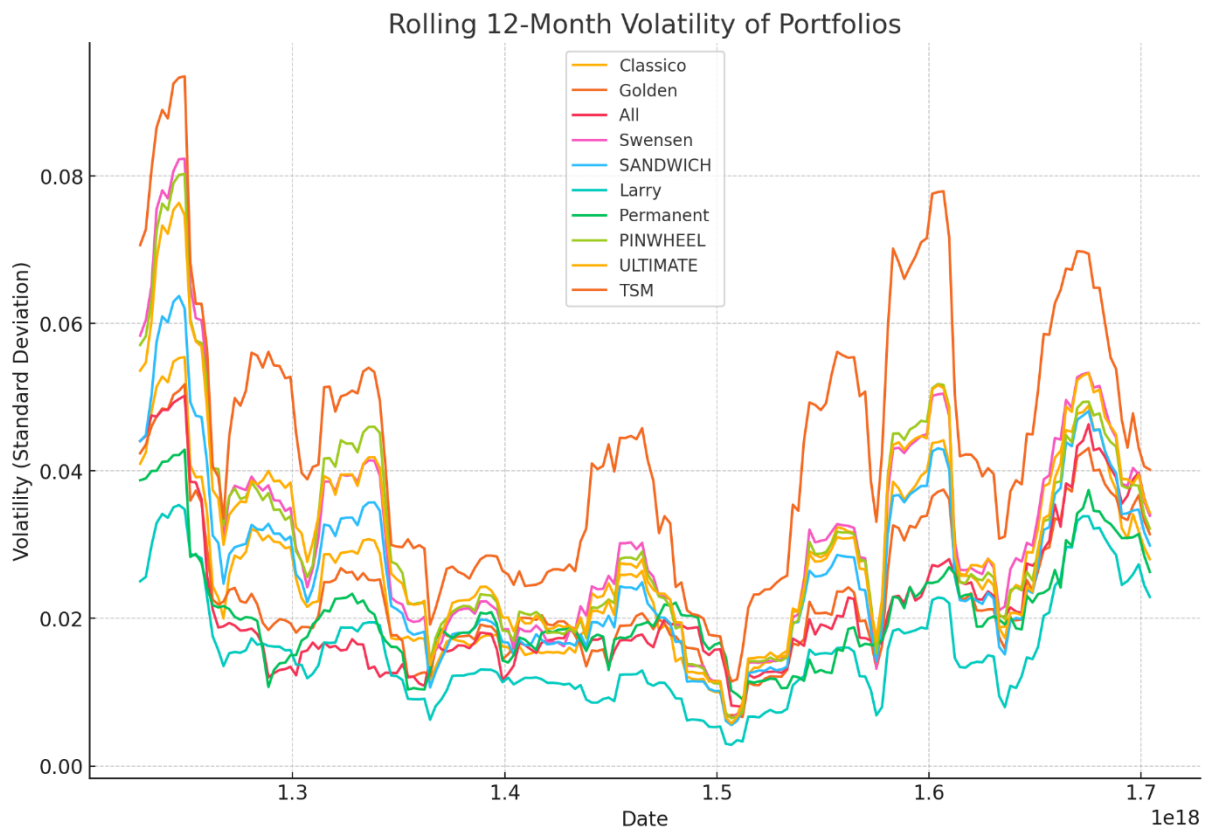
Correlation Between BBKMLEIX and iShares MSCI World ETF



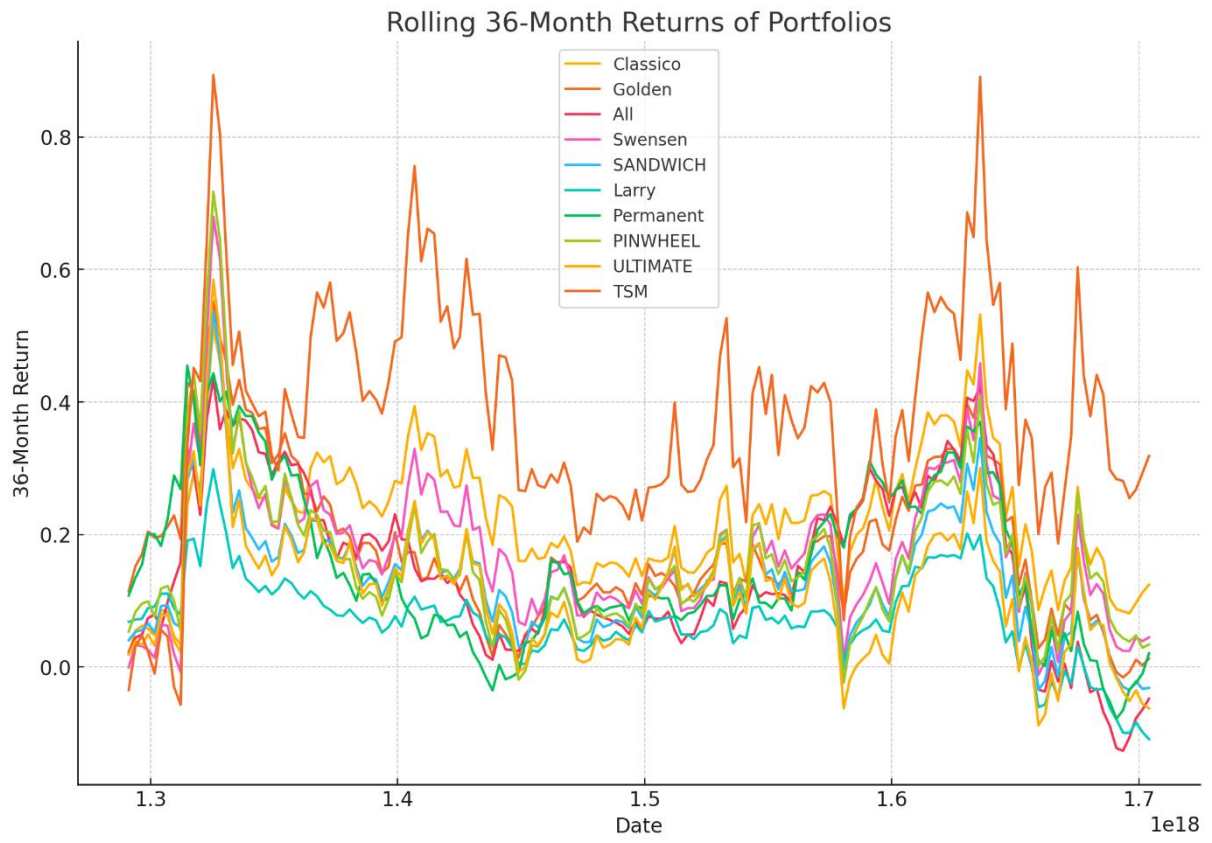
Pvalue/ Decile

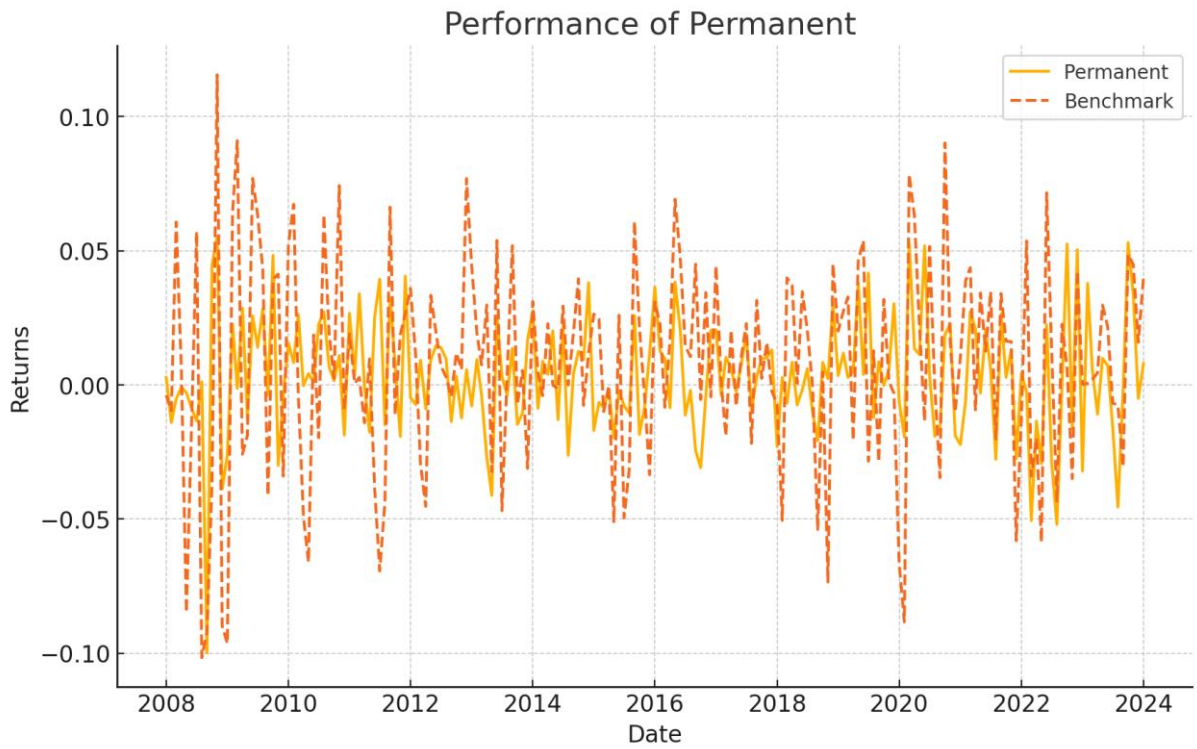
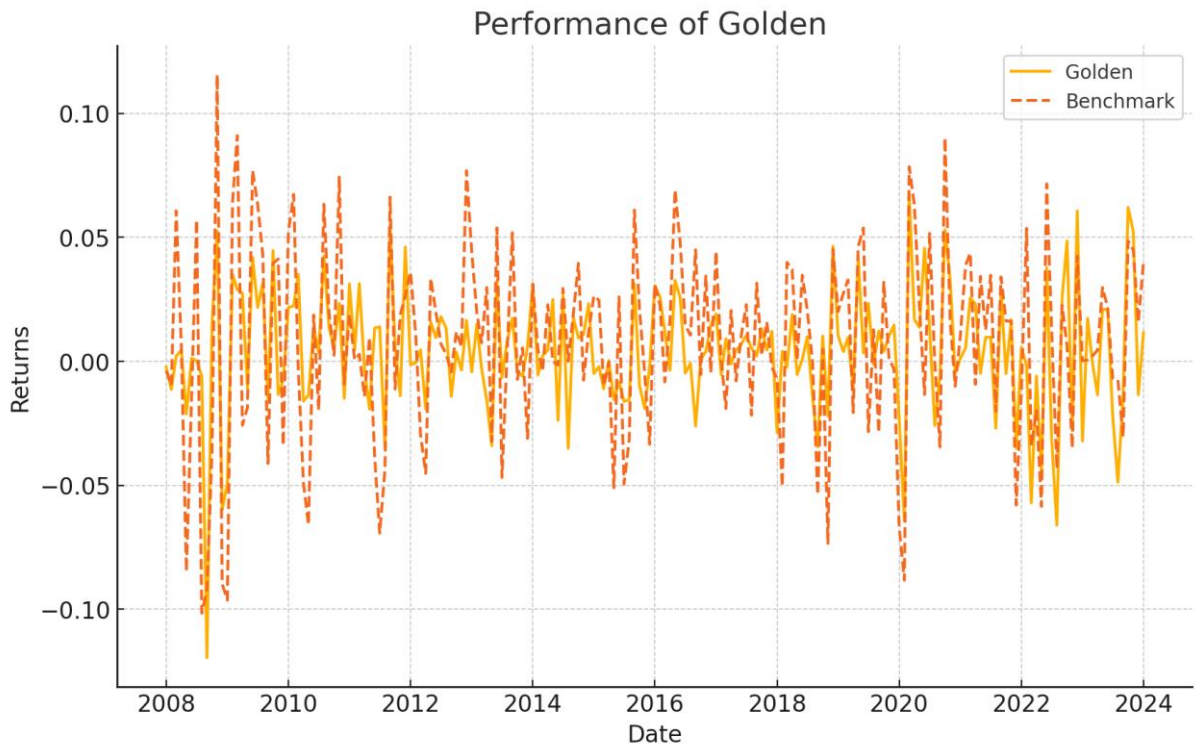


Rolling 12m Risk

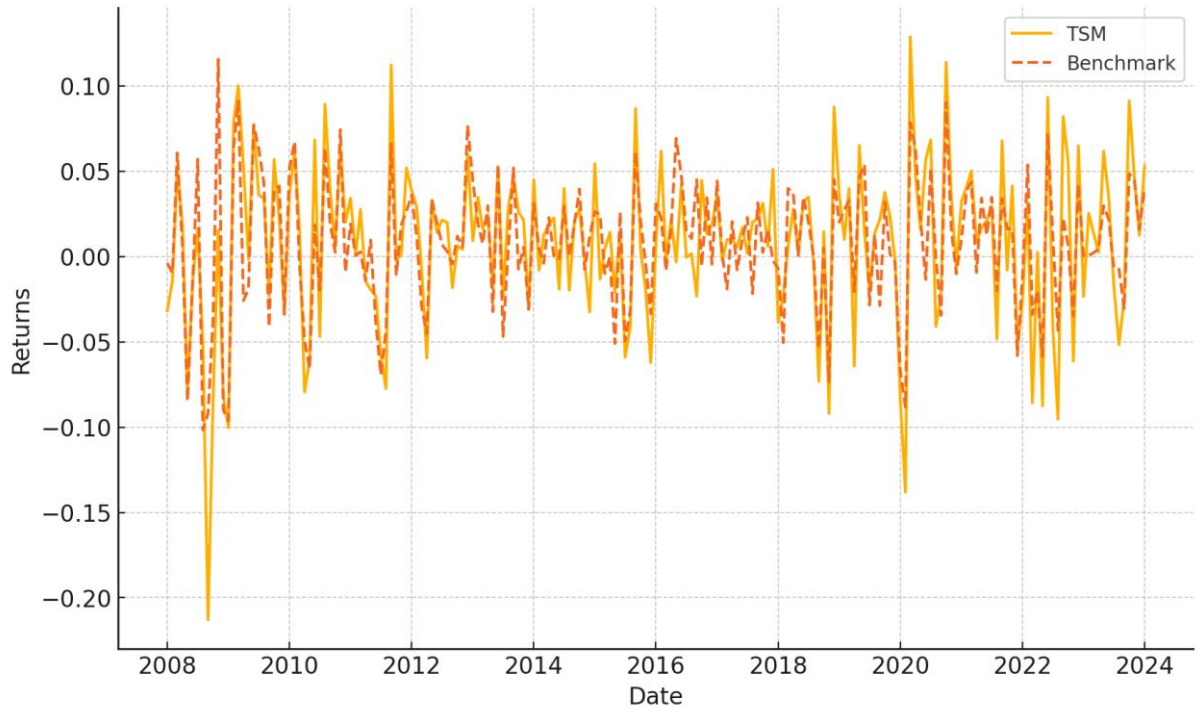


Rolling 36m Return





Performance of TSM



Rebalanced per period

