

Louvain School of Management

Testing Resilient Portfolios for US and Eurozone investors

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Note

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DeepL is employed as a linguistic tool to translate specific terms and identify synonyms. ChatGPT contributed to varying wording, improving structure, and exploring additional concepts related to the research question. Based on these initial suggestions, the selection of scientific sources is conducted independently.

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Beyond their supportive role, these tools also served to challenge the author, which critically assessed possible improvements.

The conceptual development, methodological choices, empirical analysis, and final writing remain entirely the responsibility of the author. This controlled and critical use of AI aimed to enhance the quality of the work, not to delegate.

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1. Introduction

An increasing number of investors manage their portfolios independently, rather than relying on financial intermediaries. Developing online platforms and an easier access to financial information can explain this shift. These tools are both accessible and affordable, which makes independent investing more attractive (Arfina et al., 2023). Exchange-traded funds (ETFs) contribute to this trend. Even if their performance varies by category, equity ETFs and cryptocurrencies are the ones that deliver the highest returns, accompanied by more volatility. Inversely, bond ETFs are less volatile but generate as lower profitability (Chalkevopoulos, 2025). Thus, many investors turn to predefined strategies, often inspired by index investing. This is reflected in the strong growth of index funds in the United States, which increased from around \$55 billion in 1995 to more than \$12.5 trillion in 2021 (Reinganum & Blay, 2022).

Among these strategies, the 60/40 portfolio, combining equities and bonds, is a typical allocation. As today's environment evolves and is characterized by uncertainty, its effectiveness is being questioned (Pham et al., 2025), particularly during periods of market stress. Investors with a long-term horizon who want to avoid frequent rebalancing therefore face a structural limitation.

In this context, resilient portfolios have attracted attention. Actually, these portfolios are not designed to maximize returns in every situation, but rather to remain robust across different economic environments. Their objective is to limit drawdowns, improve recovery dynamics, and maintain a certain level of performance over the long term. This makes them particularly relevant for investors seeking stability without constant portfolio adjustments.

The thesis first reviews the main theoretical concepts related to portfolio construction. It then introduces the different portfolio strategies considered, as well as the hypotheses guiding the analysis. The empirical part includes some statistical tests, such as rolling-window analyses, in order to capture both short-term dynamics and long-term behavior. Finally, the results are interpreted with a focus on diversification, downside risk, and overall portfolio resilience.

2. Literature review

This literature review examines the foundations of resilient portfolios, and guides the search for a portfolio that lasts indefinitely.

2.1. Modern Portfolio Theory

Markowitz's (1952) Modern Portfolio Theory (MPT) affirms that investors can maximize their expected return for a given level of risk by considering the portfolio as a whole instead of aggregated individual assets. For that purpose, diversification combines assets after a careful analysis of variances and covariances, with the aim of reducing the overall risk without sacrificing performance. Sometimes, adding a riskier asset may even lower the all portfolio volatility. This trade-off between risk and return is represented by the efficient frontier.

However, some assumptions are strong, such as the Efficient Market Hypothesis (EMH) which assumes that prices fully reflect all available information (Fama, 1970). It is not always verified, particularly during periods of market stress (Gold, 2017). Moreover, MPT uses volatility as a proxy for risk, considering upward and downward variations equally, while investors are generally more concerned with losses. Thus, portfolios that seem to be efficient in a mean-variance framework may still experience significant drawdowns and long recovery periods. Another limitation is the instability of correlations. Diversification aims to reduce risk, but correlations between asset classes tend to increase during crises, when diversification is most needed (Asness, 2024).

MPT may therefore not fully address the concerns of investors looking for robustness in the long term, particularly in unfavorable market conditions. This leads to growing needs for other methods that focus more directly on drawdown control and portfolio resilience.

2.2. Time-varying correlations and diversification limits

This section examines the instability of correlations and the limits of diversification during market stress. This trend can be observed over longer periods, as the correlation between international equity markets have significantly increased over the years, particularly among developed economies. Consequently, diversification becomes less effective and dynamically adjusting portfolio weights does not help (Christoffersen et al., 2014).

Apart from these evolutionary changes, correlations are subject to market dynamics. One of the solutions is the rolling correlations use, but the choice of rolling window influences results

which makes them unstable (Christoffersen et al., 2014).¹ The choice issue becomes even more striking when extreme conditions are considered: correlations usually tend to grow considerably, making diversification ineffective precisely when it is more necessary (Longin & Solnik, 2001).

2.3. The 60/40 portfolio reference

Choosing the right asset allocation is a real challenge for individual investors, particularly when they aim to maintain it in the long term. Among predefined strategies, the ‘60/40 portfolio’, is composed of 60% equities and 40% fixed-income. It has long been considered a traditional allocation (Pham et al., 2025), as this portfolio balances growth and stability under uncertainty (Bernstein, 2002), making it a portfolio whose historical performance is widely recognized.

However, the macroeconomic environment has evolved into lower expected bond yields and rising inflation, reducing the return potential (Robinson & Langley, 2017). Initially, the stock-bond correlation was low, and bonds are now unable to protect against equity losses. Moreover, this correlation changes by country, ranging from 0.19 in the USA to 0.62 in Europe (Pham et al., 2025). It should be noted that performance is also different across regions, with lower average returns in Europe (3.06%) compared to the US (4.89%) (Pham et al., 2025).

In this context, its diversification benefits appear less reliable, leading some authors to question its future relevance (Robinson & Langley, 2017). Some institutions such as BlackRock (2025) advocate for alternative strategies in a higher inflation environment, but others, like Vanguard, continue to support the 60/40 portfolio based on its long-term performance (Pham et al., 2025).

2.4. Buy-and-hold strategy

Individual investors can decide to keep the same strategy over time. The buy-and-hold strategy constitutes the essence of this thesis. It consists of purchasing a set of assets at an initial date and holding them over time without rebalancing or trading. This strategy can generate high returns over the long term (Forsyth, 2024). This assumption enables an analysis of how portfolio weights evolve over time, reflecting the behavior of investors who maintain their Allocation over the long term.

¹ As previously mentioned, the objective of rolling windows is to capture the dynamic behavior of financial markets, and that, by computing diverse metrics over moving periods rather than over the full sample. The general principle of a rolling window is to calculate a certain statistic over a fixed number of past observations, which is then shifted forward one period at a time.

However, investors are subject to large drawdowns in the eventuality that the portfolio is fully made of equities during market downturns (Feldman et al., 2015). Furthermore, EMH affirms that markets cannot always be outperformed (Fama, 1970), yet some market-timing strategies, notably based on short-term price movements manage to outperform passive strategies in some contexts (Gold, 2017). For instance, during adverse market conditions or bear decades such as 1970-1979 and 2000-2009, reducing the proportion of allocated equities may improve the performance, in comparison to buy-and-hold (Feldman et al., 2015).

Anyway, consistently outperforming a passive approach is complex. Studies mention that trading strategies are generally less effective on individual stocks, especially when transaction costs are taken into account (Hui & Chan, 2014).

2.5. Risk measurement: beyond volatility

Certainly, buy-and-hold is a simple strategy known for long-term performance, but it also exposes investors to downside risk during market downturns. This underlines the importance of appropriately measuring risk.

Standard deviation as a measure of volatility treats upward and downward price movements in the same way, even though investors generally only associate risk with losses (Kumaran, 2013). Consequently, it does not reflect the investor experience during continuous price declines.

Maximum drawdown (MDD) captures the largest loss of a portfolio, from its highest point to its lowest point over a period (Kumaran, 2013). Unlike volatility or value-at-risk, it captures the cumulative effect of consecutive losses (Goldberg & Mahmoud, 2016). This measure is useful because it shows how much an investor could have lost at worst before the asset recovered. Nonetheless, this faces some limitations, focusing only on one extreme event and providing limited information about how often losses occur or how long recovery takes. MDD should therefore be coupled with other risk measures (Kumaran, 2013).

To address these issues, Kumaran (2013) introduces the Ulcer Index (UI), which measures both the depth and the duration of losses. Unlike volatility, this Index ignores upside price movements. The longer and deeper a drawdown persists, the higher the Ulcer Index becomes. Kumaran mentions that this measure better reflects ‘human stress’.

Besides the magnitude of drawdowns, the time spent to recover is a key consideration. In this context, Choi (2021) mentions that assets suffering significant drawdowns are likely to produce less returns, contrary to those that are able to recover quickly. This implies that investors should pay attention to the sequencing of returns rather than just the overall performance.

This perspective introduces the concept of path dependency, which can become significant, as two portfolios with nearly identical does not necessarily have the same experience depending on drawdown depth and duration. Consequently, the risk assessment needs to go beyond standard measures to incorporate both downside dynamics and recovery processes.

2.6. Loss aversion and investor behavior under risk

While alternative risk measures presented above better consider downside risk, they still do not fully understand how investors perceive and react to losses. Behavioral finance, as for it, tries to find out why losses are experienced more intensely than gains and how this impacts investment decisions.

According to Kahneman and Tversky (1979), investors do not evaluate outcomes based solely on final wealth, but they assess gains and losses asymmetrically. Their value function is concave for gains and convex for losses, better known as loss aversion. Indeed, losses are perceived more intensely than equivalent gains, which make individuals more risk-averse when facing gains, preferring certain outcomes, but risk-seeking when confronted with losses in an attempt to avoid them.

To supplement this theory, Kahneman (2011) explains that the decision-making process is often driven by an automatic system named ‘System 1’, consisting of fast judgments based on simplified thinking. Even if these shortcuts are sometimes efficient, biases may occur and lead to immediate emotional responses from investors rather than rationally evaluate long-term outcomes. The opposing system is named ‘System 2’ and refers to a slower and more analytical mode of thinking, mobilized when individuals consciously evaluate information and make deliberate decisions.

This behavior helps to explain the fear related to short-term losses, and the discomfort that comes with it. Thus, focusing on downside risk and recovery dynamics becomes relevant.

2.7. Resilient portfolios

A resilient portfolio is characterized by its ability to withstand market shocks and recover across different economic environments. In other words, it generates returns in normal conditions and recovers after crises. It combines performance, risk management, and long-term stability (Anwar et al., 2023). This section aims to examine the right candidates for resiliency.

2.7.1. All Seasons Portfolio

The ‘All Seasons portfolio’ is a good candidate for resiliency. It is made of 30% large cap stocks, 40% long term bonds, 15% intermediate term bonds, 7.5% commodities and 7.5% gold. Its annual return in the US is 5.3% on average, with a standard deviation of 8.7%. Ray Dalio, its founder, designed a portfolio intended to remain robust across economic environments. The All Seasons Portfolio shows MDD reaching 22%, and the maximum recovery time lasts 10 years, even if it is mostly around one year, indicating a strong ability to recover from market stress across different economic environments. This portfolio is inspired by Dalio’s All Weather Fund, considered as autonomous, and thus recommended to individuals (Portfolio Charts, 2025a).

In 2021, Silverman takes an interest in the investment under uncertain economic conditions. Nevertheless, he only focused on the effect of COVID-19 on the All-Weather Portfolio. Then, to construct several risk parity strategies with and without leverage based, the author based on only two asset classes in the All-Weather portfolio: stocks and treasury bonds. It should integrate other classes to show a larger diversification (Silverman, 2021). The aim of this thesis is to perform a deeper analysis at long-term, considering different regimes and to include all the asset classes.

2.7.2. Permanent Portfolio

The Permanent Portfolio promotes a defensive allocation that aims to perform well across different economic conditions. It is equally divided between Large Cap Stocks, Long term Bonds, Treasury Bills and Gold. Its average return is 5.1% in the US, with a standard deviation of 7.6%. Stocks are for growth, long-term bonds for deflationary periods, gold for inflationary shocks, and cash-like assets for stability during uncertainty (Portfolio Charts, 2025d). With a MDD of -21.5% and a longest period of drawdown of 6 years (The Investor, 2025), this structure constrains drawdowns and keeps a stable long-term performance.

2.7.3. Golden Butterfly Portfolio

A variation of Permanent portfolio is the Golden Butterfly portfolio, that follows an economic risk-parity approach, with a slight orientation toward growth. Unlike the Permanent Portfolio, this portfolio allocates capital equally across five asset classes: large cap stocks, small cap value stocks, long-term bonds, short-term bonds, and gold, each weighted at 20%. It adds exposure to small cap value, which historically has offered higher expected returns. This combination creates better diversification benefits (Portfolio Charts, 2025b). Its average drawdown since 2022 is -2.85%, while its maximum drawdown amounted to -19.41% in October 2022, compared to -25.30% for the S&P 500 (PortfoliosLab, 2026).

2.7.4. Golden Ratio Portfolio

The Golden Ratio Portfolio is built around the mathematical concept of the golden ratio. Frank Vasquez's goal is to balance growth and risk control. Instead of equally weighing each asset, this strategy balances equities and fixed income, often incorporating additional assets such as gold or commodities for diversification. Thus, it is made of 21% Large Cap Growth Stocks, 21% Small Cap Value Stocks, 26% Long term bonds, 16% gold, 10% commodities and 6% treasury bills. The Golden Ratio Portfolio tends to offer competitive long-term returns while maintaining moderate volatility, as its average return is 6.8% in the US, with a standard deviation of 9% (Portfolio Charts, 2025c). However, it has already suffered a MDD of -23.37%, requiring 31 months for recovering (Lazy Portfolio ETF, 2026).

Other portfolios presented on Portfolio Charts fail to meet the definition of resilience used in this thesis, because they exhibit deep drawdowns, long recovery periods, or a strong dependence on specific market regimes.

2.8. International investment and currency risk

Investing internationally is a common way to diversify a portfolio. Its effectiveness depends on the degree of correlation between domestic and foreign markets: lower correlations generally improve diversification benefits, while higher correlations reduce them.. However, correlations across international equity markets have increased over time, notably due to globalization, and they also tend to rise during downside periods, when diversification is the most needed. Nevertheless, international diversification still remains beneficial.

During financial crises, investors may even increase their exposure to foreign equities presenting lower correlations with their domestic market in an attempt to reduce portfolio risk

(Vermeulen, 2011). Nonetheless, it is important to keep in mind that, when converting to the local currency, exchange rate risk represents a source of uncertainty. For instance, exchange rate fluctuations increase the variability of expected returns and make investment outcomes less predictable. In such uncertain environments, companies may postpone irreversible investment decisions, while individual investors tend to become more cautious by delaying investments or accumulating liquidity (Taylor et al., 2021). The objective of this thesis is to compare portfolio resilience across investor currency perspectives.

3. Research gap

Studies about diversification, risk and international perspectives already exist, yet they have been studied separately, making it difficult to explain the complexities of long-term portfolios.

First of all, MPT uses volatility as a measure of risk, which is insufficient to reflect investor's experience during prolonged periods of losses. Other measures like the MDD and the Ulcer Index exist, but these are rarely integrated in a framework of portfolio comparison, particularly when analyzing resilience. In addition, most studies rely on static measures of diversification. However, it has been proven that correlations between asset classes vary and increase during periods of market stress. As a matter of fact, rolling approaches are sometimes used, but their integration into comparative portfolio analyses also remains limited.

Moreover, the sequence of returns and recovery dynamics are often neglected, as opposed to aggregate return and risk measures. Yet, the timing, duration, and recovery from drawdowns help to understand the investor's experience and the resilience of a portfolio.

Regarding portfolio strategies, the ability of predefined allocations such as the 60/40 portfolio to withstand prolonged adverse market conditions is increasingly questioned. There is still much left to be learned about resilient portfolio strategies, particularly about their recovery characteristics or diversification stability, and that, during such environments.

Finally, international diversification is supposed to reduce risk, but the impact of currency exposure on downside risk, drawdowns, and recovery dynamics is rarely explicitly analyzed, particularly for Eurozone investors, for whom currency fluctuations introduce additional layer of uncertainty and thus influence portfolio behavior.

Therefore, this thesis intends to fill the gap through an analysis of the viability of resilient portfolios compared to the traditional 60/40 allocation, from a US and a Eurozone perspective.

4. Research questions and hypotheses

‘To what extent do resilient portfolios provide stronger downside protection and more stable diversification properties than the traditional 60/40 portfolio across different market environments and investor currency perspectives?’. This is the research question this thesis investigates. In order to do so, five hypotheses have been formulated.

4.1. Correlations

H_{A,0}: Correlations between asset classes within resilient portfolios are not significantly different from that of the 60/40 portfolio.

H_{A,1}: Correlations between asset classes within the resilient portfolios are significantly different from that of the 60/40 portfolio.

Correlation is a reputed proxy for diversification, even if it does not remain stable over time, especially during periods of market stress (Asness, 2024; Silverman, 2021). This issue is highlighted in several studies, such as Longin and Solnik’s (2001), which demonstrates that correlations between assets tend to increase in times of market crises, and Christoffersen et al. (2014), who emphasize their variability over time. According to MPT, adding riskier assets tends to decrease the overall portfolio volatility (Markowitz, 1952). Certainly, correlation between equities and bonds is historically low, but this relationship is being questioned (Robinson & Langley, 2017). Resilient portfolios include more types of asset classes than 60/40 portfolio, and each is expected to respond differently to economic shocks. Rather than assuming that lower correlations imply better diversification, this hypothesis aims to assess whether the correlation structures differ significantly between resilient portfolios and the benchmark.

4.2. Drawdowns

H_{B,0}: There is no significant difference in the level and stability of drawdowns between resilient portfolios and the 60/40 portfolio.

H_{B,1}: Resilient portfolios exhibit significantly lower and more stable drawdown levels than the 60/40 portfolio.

Standard deviation as a measure of volatility has been facing some criticism. In contrast, MDD explains the cumulative impact of consecutive losses, focusing on extreme events. Optimizing a portfolio under a mean-variance does not prevent severe drawdowns during crises, jeopardizing their long-term viability (Kumaran, 2013). This is further highlighted by Goldberg and Mahmoud (2016) who argue that drawdown-based measures better capture the actual risk that investors face when they experience persistent losses. However, relying on a single MDD only gives one episode. To overcome this obstacle, this hypothesis analyzes both magnitude and stability of drawdowns. Here, rolling MDD are performed to capture the evolution of losses across different market conditions.

4.3. Resilience across regimes

H_{C,0}: There is no significant difference in portfolio performance and downside behavior between resilient portfolios and the 60/40 portfolio during bear market periods.

H_{C,1}: Resilient portfolios exhibit significantly better performance and improved downside behavior than the 60/40 portfolio during bear market periods.

This hypothesis aims to assess whether resilient portfolios are better able to withstand adverse conditions compared to the traditional 60/40 portfolio. The focus is not only on return performance, but also on downside behavior. It makes it possible to examine the robustness of resilient portfolios during market stress episodes. This perspective is aligned with the concept of resilient portfolios that Anwar et al. (2023) define based on the ability of portfolios to remain stable across different macroeconomic environments, as well as with Silverman (2021), underlining the importance of portfolio behavior during crises.

4.4. Recovery dynamics

H_{D,0}: There is no significant difference in recovery characteristics between resilient portfolios and the 60/40 portfolio.

H_{D,1}: Resilient portfolios exhibit significantly improved recovery characteristics compared to the 60/40 portfolio.

Recovery dynamics reflects how quickly and how often a portfolio returns to its previous peak after a decline. They consider the number of drawdown episodes, the duration of recovery phases, and the total peak-to-trough period. These elements are essential, as literature highlights that market stress periods represent a burden for investors (Kahneman, 2011). Beyond behavior, Choi (2021) shows that assets with large drawdowns tend to provide worse returns subsequently. By doing so, resilience can be evaluated beyond the loss magnitude.

4.5. Currency impact

H_{E,0}: Currency exposure does not significantly affect the performance of resilient portfolios.

H_{E,1}: Currency exposure significantly alters the performance of resilient portfolios.

According to Taylor et al. (2021), exchange-rate variation adds a layer of uncertainty. Currency movements can amplify or dampen returns, increase volatility, and affect the correlation structure between assets. This mechanism is also supported by Vermeulen (2011), who mentions that international diversification benefits depend on correlations between markets, which are themselves influenced by global shocks and currency dynamics. This hypothesis aims to assess whether this willingness to diversify is fulfilled through this currency shift from USD to Euro. Beyond diversification, one of the main objectives consists of maintaining a good balance between risk and return, which is analyzed through this hypothesis.

5. Methodology

5.1. Research design

The objective of this thesis is to assess whether resilient portfolios provide stronger downside protection and more stable diversification properties than the traditional 60/40 portfolio. To achieve this objective, an empirical approach is implemented, based on the analysis of historical time-series data.

The study analyzes and compares four resilient portfolios with the 60/40 benchmark: the All Seasons, Permanent, Golden Butterfly, and Golden Ratio portfolios. This enables to directly assess whether alternative portfolio constructions provide more resilience compared to a traditional allocation. The analysis is conducted from both US and Eurozone perspectives, in order to account for the impact of currency exposure on portfolios behavior.

The empirical work is structured around several dimensions. Firstly, performance is assessed through cumulative and annualized returns. Secondly, risk is analyzed using both traditional and downside measures, such as volatility, MDD, and the Ulcer Index. Afterwards, diversification is examined through correlations, including rolling correlations, with the aim of capturing their time-varying nature. Finally, recovery dynamics and risk-adjusted performance are evaluated to supplement investor's experience.

The analysis combines full-sample statistics with rolling windows, because capturing both long-term trends and short-term dynamics is necessary. It makes it possible to account for the time-varying behavior of financial markets, particularly during periods of stress. In addition, paired t-tests and bootstrap procedures are implemented to assess whether the observed differences between portfolios are statistically significant.

This framework provides a sufficiently comprehensive approach to assess portfolio resilience. Indeed, it integrates performance, risk, diversification, and recovery dimensions, which is in line with the hypotheses formulated in the previous section.

5.2. Data selection and sample construction

All the asset data is obtained from Bloomberg on a daily basis. This Terminal constitutes the primary data source as it is recognized for its reliability and the availability of long historical time series. The choice of daily data is motivated by the need to accurately capture the dynamics

of portfolio risk, particularly for measures that are sensitive to short-term fluctuations, such as volatility, drawdowns, and time-to-recovery. By doing so, risk measures are computed more precisely, as it incorporates all the observations of asset prices rather than aggregated observations.

The objective is to reconstruct the chosen resilient portfolios as well as the benchmark, which is possible through indices representing the different asset classes included in each portfolio. These are large cap stocks, large cap growth stocks, small cap value stocks, long-term bonds, intermediate-term bonds, short-term bonds, treasury bills, commodities and gold.

The repartition across the different asset classes is provided on PortfolioCharts.com (Portfolio Charts, n.d.), which also offers corresponding exchange-traded funds (ETFs). However, all available ETFs did not provide sufficiently long historical time series and have their limitations. Thus, total return indices were preferred to ensure consistency and maximize the length of the sample period, which is essential to examine resilience over the long-term. The tickers used are listed below:

- SPLG: S&P 500, representing **Large Cap Stocks**
- M1US000G: MSCI USA Growth Index, representing **Large Cap Growth Stocks**
- RTY: Russell 2000 Value Total Return Index, representing **Small Cap Value Stocks**
- TLT: iShares 20+ Year Treasury Bond ETF, representing **Long-Term Bonds**
- LUACTRUU: Bloomberg US Corporate Total Return Value Unhedged USD (10Y+), representing **Intermediate-Term Bonds**
- I28478US: Bloomberg US 1-3 Year Treasury Total Return Index, representing **Short-Term Bonds**
- LD20TRUU: Bloomberg US Treasury Bills Index, representing **Treasury Bills**
- BCOMTR: Bloomberg Commodity Total Return Index, representing **Commodities**
- XAU: Gold Spot Price, representing **Gold**

As specified, total return was privileged whenever possible, and was always expressed in USD. This format ensures that dividends and coupon payments are included in the performance of the assets, which is more realistic. Nevertheless, some ETFs are used instead, due to the lack of sufficiently long data: this is the case with SPLG and TLT. It potentially leads to a slight

underestimation of performance, particularly for income-generating assets: equities and bonds. This limitation should be kept in mind when interpreting long-term performance comparisons. Also, ETFs being designed to closely replicate the performance of their underlying indices, they still remain a relevant proxy. A specific case is gold, represented by gold spot price (XAU), which is a spot price and does not generate income. The absence of total return does not represent a bias. Finally, LUACTRUU, used as a proxy for intermediate-term bonds, is a total return index composed of bonds with different maturities. This proxy choice is mainly driven by long-run data availability constraints. As a result, the bond allocation may incorporate some additional credit risk compared to a traditional Treasury-based intermediate-term bond allocation.

The final sample covers the period from July 31st, 2002 to December 31st, 2025 and includes 5,845 daily return observations. The aim is to select the longest possible time horizon in order to capture as many market environments and stress episodes as possible. However, the data availability represents a constraint, since all asset classes included in the portfolio constructions have to be represented over the entire sample. The absence of longer historical data for one specific asset class before this starting date results in a reduction in the overall time horizon.

5.3. Data preprocessing and database construction

The imported data is first sorted by ascending date, which guarantees that all calculations, like returns and rolling measures, are computed on properly ordered observations. Then, the dataset is cleaned by solving the problem of missing values that results from non-trading days or data availability issues. To ensure continuity in the analysis, missing observations are filled using the last observation carried forward (LOCF) method. It replaces missing values with the most recent available observation which preserves the time-series structure while avoiding jumps in the data.

Once the dataset is cleaned, daily returns ($r_{i,t}$) are computed for each asset. The return of asset i at time t is defined as:

$$r_{i,t} = \frac{P_{i,t}}{P_{i,t-1}} - 1$$

This serves as the basis for portfolio construction and the analysis that follows. The first observation is therefore lost in the process, as returns require both current and previous price levels. Finally, all return series are aligned by date in order to ensure consistency across assets, making sure that all assets contribute to the portfolio return on the same trading days.

5.4. Portfolio construction and investment assumptions

Portfolio weights reflect the predefined strategic asset allocation of each portfolio and remain constant over time in terms of initial allocation, without any rebalancing. In fact, the portfolio construction follows a buy-and-hold approach. This assumption makes it possible to observe how portfolio weights evolve endogenously over time, depending on the relative performance of each asset. The initial portfolio value (V_0) is normalized to one monetary unit and allocated across assets according to predefined weights w_i , such that:

$$V_0 = \sum_{i=1}^N w_i = 1$$

where w_i represents the initial weight allocated to asset i and N the total number of assets in the portfolio. The value of each asset evolves independently according to its own return path, and the total portfolio value (V_t) at time t is given by:

$$V_t = \sum_{i=1}^N w_i \prod_{s=1}^t (1 + r_{i,s})$$

where V_t is the total portfolio value at time t , w_i the initial weight of asset i , and $r_{i,s}$ the return of asset i at time s . In fact, t represents the evaluation date of the portfolio, while s is the intermediate time periods used to compound the returns of asset i from period 1 to t . Daily portfolio returns ($r_{p,t}$) are then computed based on the evolution of the total portfolio value. The portfolio return p at time t is defined as:

$$r_{p,t} = \frac{V_t}{V_{t-1}} - 1$$

where $r_{p,t}$ is the portfolio return at time t , while V_t and V_{t-1} are the portfolio values at times t and $t - 1$, respectively. It should be noted that an implication of the buy-and-hold assumption is that portfolio weights are not constant over time, but they drift as a result of differential asset performance. Assets with higher returns progressively represent a larger share of the portfolio, in contrast to underperforming assets. This mechanism reflects the behavior of investors who do not rebalance their portfolios, typically the least experienced ones. Admittedly, this assumption simplifies the analysis, but it also represents a limitation. Nevertheless, it permits to evaluate the resilience of each portfolio without any intervention.

5.5. Performance and risk measures

Portfolio performance can be evaluated through several complementary indicators, capturing both return and risk dimensions. It permits a broader assessment of portfolio behavior.

5.5.1. Return measures

Performance is first assessed through cumulative and annualized returns. The cumulative return (R) represents the total growth of one monetary unit invested at the beginning of the period. It

$$R = \prod_{t=1}^T (1 + r_{p,t}) - 1$$

The annualized return, also referred to as the Compound Annual Growth Rate ($CAGR$), is computed as:

$$CAGR = (1 + R)^{\frac{1}{T}} - 1$$

where T represents the number of years in the sample. This metric allows for comparability across investment horizons by expressing returns on a yearly basis.

5.5.2. Volatility and downside risk measures

Volatility (σ) is used as a standard measure of total risk. It measures the dispersion of returns around their mean, although it does not distinguish between upside and downside variations. It is computed as the standard deviation of daily returns ($\text{std}(r_{p,t})$), annualized using the square-root-of-time rule:

$$\sigma = \text{std}(r_{p,t}) * \sqrt{252}$$

Given the limitations of volatility, additional indicators focusing on downside risk are considered. The MDD measures the largest observed loss from a peak to a trough over the sample period, and is expressed as a negative percentage:

$$MDD = \min_t \left(\frac{V_t - \max_{s \leq t} V_s}{\max_{s \leq t} V_s} \right)$$

where V_t corresponds to the portfolio value at time t , while $\max_{s \leq t} V_s$ is the highest portfolio value previously reached up to time t .

Furthermore, the Ulcer Index (UI) is used to measure both the depth and persistence of drawdowns, through the following formula:

$$UI = \sqrt{\frac{1}{T} \sum_{t=1}^T D_t^2}$$

where $D_t = 100 * \left(\frac{V_t}{\max_{s \leq t} V_s} - 1 \right)$ represents the percentage drawdown at time t . Unlike volatility, this measure focuses exclusively on downside movements.

5.5.3. Risk-adjusted performance measures

To evaluate performance relative to risk, risk-adjusted measures are computed.

First, the Sharpe ratio measures excess return per unit of total risk:

$$Sharpe = \frac{E(r_{p,t} - r_{f,t})}{\sigma} * \sqrt{252}$$

where $r_{f,t}$ represents the daily risk-free rate. This ratio allows for comparison across portfolios by accounting for both return and volatility.

The Sortino ratio, for its part, complement this approach by focusing only on downside risk:

$$Sortino = \frac{E(r_{p,t} - MAR)}{\sigma_d} * \sqrt{252}$$

where MAR is the minimum acceptable return, set to zero in this study to isolate downside volatility by considering only returns below zero as harmful for investors, and σ_d is the standard deviation of negative returns only. It provides a better representation of investor risk perception.

The Calmar ratio is also computed to evaluate return relative to extreme downside risk. Unlike the Sharpe ratio, which uses volatility, the Calmar ratio divides annualized return by the maximum drawdown experienced over the period. The formula is:

$$Calmar = \frac{CAGR}{|MDD|}$$

where $CAGR$ is the annualized return and $|MDD|$ is the absolute value of MDD. This measure is relevant, because resilience is closely related to the ability to limit severe drawdowns.

5.6. Diversification analysis

Diversification represents the way asset returns move together. To reduce risk, notably, diversification is crucial. However, as highlighted in the literature, correlations are not stable over time and tend to increase during periods of market stress, which may reduce the desired and needed diversification.

On the one hand, the correlation between two asset returns r_i and r_j is presented as:

$$\rho_{i,j} = \frac{\text{Cov}(r_i, r_j)}{\sigma_i \sigma_j}$$

where $\text{Cov}(r_i, r_j)$ represents the covariance between the returns of assets i and j , while σ_i and σ_j denote the standard deviations of the returns of assets i and j . On the other hand, the average pairwise correlation allows for a direct comparison of diversification between portfolios. Computed within each portfolio, it is obtained by calculating the average of the elements of the upper triangle of the correlation matrix, excluding the diagonal, in order to avoid double counting. For a portfolio of N assets, it gives:

$$\bar{\rho} = \frac{2}{N(N-1)} \sum_{i < j} \rho_{i,j}$$

where N is the number of assets in the portfolio, and the factor 2 accounts for the fact that only the upper triangular elements of the correlation matrix are considered, excluding duplicate correlations and diagonal elements.

However, static correlations are not sufficient, because they do not consider the dynamic that characterizes financial markets. That is why rolling correlations are computed. A 252-day window is chosen as it corresponds to one trading year, in order to reflect medium-term dynamics.

Then, in order to reduce the impact of overlapping observations and serial dependence, one observation is retained every 63 trading days. This step ensures that the statistical tests are conducted on less dependent data points, improving the robustness of the results. These latter paired t-tests aim to test the significance and thus compare the average rolling correlations of resilient portfolios with those of the 60/40 benchmark.

5.7. Rolling window methodology

As previously mentioned, the objective of rolling windows is to capture the dynamic behavior of financial markets, and that, by computing diverse metrics over moving periods rather than over the full sample. The general principle of a rolling window is to calculate a certain statistic over a fixed number of past observations, which is then shifted forward one period at a time.

In this study, rolling windows are used for both correlation and drawdown analyses. Firstly, for diversification measures, a 252-day window is used, corresponding to one trading year. Secondly, for downside risk analysis, the horizons are shorter: 63-day and 126-day windows. It permits to capture short and medium-term drawdown dynamics. For a given metric $f(\cdot)$, the rolling measure at time t over a window of size L (length) is:

$$f_t = f(r_{t-L+1}, \dots, r_t)$$

In this way, it introduces serial dependence in the resulting time series. Thus, the dataset is thinned by retaining observations at regular intervals, reducing the overlap between consecutive windows. In this study, one observation is kept every 63 trading days, which corresponds to approximately one quarter.

5.8. Statistical methodology

It is essential to check if the observed differences between portfolios, especially between each resilient version and the benchmark, are statistically significant. The statistical methods used evaluate the robustness of the results.

5.8.1. Paired t-tests

For each comparison, the difference between the two series is computed, and the t-test evaluates whether the mean of these differences is statistically different from zero. The test statistic is defined as:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

where $\bar{d}$ represents the average difference between the two series, s_d is the standard deviation of these differences, and n the number of observations.

5.8.2. Bootstrap methodology

Bootstraps are implemented to assess differences in risk-adjusted performance measures, which is relevant as return distributions may deviate from normality. The bootstrap procedure consists of repeatedly resampling the observed data with replacement to generate a large number of simulated samples. For each resample, the statistic of interest is recomputed, allowing to construct an empirical distribution of the estimator. More precisely, let $\hat{\theta}$ be the statistic of interest. The bootstrap distribution is obtained by generating B resamples and computing $\hat{\theta}^{(b)}$ for each iteration $b = 1, \dots, B$.

The difference between two portfolios is evaluated using the distribution of the bootstrapped differences. Confidence intervals are constructed using the empirical quantiles of the bootstrap distribution, and p-values are derived based on the proportion of simulated differences exceeding zero in absolute value.

The statistical tests should be interpreted as indicative rather than definitive, given the number of comparisons, the dependence of rolling-window observations, and the path-dependent nature of drawdown measures

5.9. Currency conversion and international perspective

The extension to a Eurozone investor perspective helps to examine the impact of currency exposure on portfolio performance and risk characteristics. This enables to determine whether portfolio resilience stays unchanged when returns are expressed in a different currency.

USD asset prices are converted into euros thanks to the daily exchange-rate data from the Federal Reserve of Economic Data (FRED), namely the ‘US Dollars to One Euro Spot Exchange Rate’ (EUR/USD). Since this series is expressed as dollars per euro, the conversion into euros is performed by dividing USD-denominated prices by the EUR/USD exchange rate, which is equivalent to multiplying them by its reciprocal (USD/EUR). The conversion is directly based on prices rather than return, ensuring a consistent comparison of portfolio performance for both US and Eurozone investors. After that, returns are recomputed.

In addition, the risk-free rate is adapted to the investor’s currency. The US analysis relies on a US risk-free rate, while the Eurozone perspective uses a European risk-free rate, which is necessary to adequately compare the risk-adjusted performance measures. The risk-free rate for the US investor comes from the FRED and corresponds to the ‘Market Yield on U.S. Treasury

Securities at 30-Year Constant Maturity’. For the Eurozone investor, the selected proxy is the ‘Germany 10-Year Government Bond Yield’, also obtained from FRED. A shorter-term risk-free proxy would ideally have been preferred for both regions. However, comparable short-term Eurozone sovereign series were not consistently available over the full sample period. Therefore, longer-term sovereign yields are retained in order to preserve greater consistency between the US and Eurozone perspectives.

It is established that currency fluctuations introduce an additional source of variability (Taylor et al., 2021), affecting positively or not returns and risk measures, but also influencing correlations between assets. Therefore, comparing US and Eurozone perspectives provides insight into how currency risk reshapes portfolio behavior, particularly in terms of volatility, drawdowns, and recovery dynamics.

6. Results and interpretation

6.1. Performance comparison

The cumulative returns of the portfolios give a first insight to value their performance. Over the full period, each one generates positive returns (*Appendix 1.*). The long-term growth dynamics, as one dollar or euro is invested in a portfolio at the beginning, are illustrated in *Appendix 2.*

From a US perspective, the Golden Ratio portfolio is the best performer, with a cumulative return of 724.51%. The Golden Butterfly, 60/40, and Permanent are in intermediate positions, respectively 613.53% and 645.12%, suggesting that a broader asset diversification does not necessarily translate into higher performance. The All Seasons portfolio records the lowest cumulative return at 471.96%, reflecting its more defensive allocation.

Obviously, annualized returns (CAGR) are more revealing. The Golden Ratio portfolio achieves the highest annualized return (9.43%) thanks to its multiple-asset diversification made of 42% equity. However, differences with other portfolios remain small, lying between 7.73% and 8.95%. The underperforming portfolios are typically characterized by a defensive allocation, and less exposure to equities.

When shifting to a Eurozone investor perspective, the ranking of portfolios does not change, because exchange-rate fluctuations act just as an adjustment factor. Nevertheless, the magnitude of portfolio returns appears high, but when annualized, it is to a lesser extent. Indeed, the Golden Ratio remains the best performer (594.05%), directly followed by the 60/40 (527.22%).

Eurozone investors may benefit from systematically lower long-term returns compared to the US perspective, but, once annualized, the differences with the US perspective become narrower, around 0.80 pp. (percentage points), which is considered as non-significant.²

In summary, the small reduction of returns is due to exchange-rate effects. When the euro appreciates against the dollar, part of the returns generated in USD is eroded once converted into euros, and inversely. Defensive portfolios tend to provide lower cumulative returns, in contrast to more growth-oriented ones. This trade-off is valid across both currency perspectives, but a difference in investor's experience across perspectives is not established.

6.2. Risk analysis

Assessing portfolio risk is essential for investors looking for stability, especially to last even during adverse conditions. The detailed results are reported in *Appendix 1*.³

6.2.1. Volatility

Volatility captures the dispersion of returns over time. The results highlight some differences across portfolios, alongside their asset allocations.

From a US perspective, the All Seasons exhibits the lowest annualized volatility (8.31%), consistent with its defensive positioning and high bond exposure. The Permanent follows closely (9.12%), while the Golden Butterfly shows a moderate level of risk (10.33%). The Golden Ratio has a greater volatility (11.22%), just like the 60/40 allocation (12.42%), suggesting a certain sensitivity to equity market fluctuations.

From a Eurozone perspective, there is a slight growth in the volatility of all portfolios (*Appendix 1*). This is due to the fact that these investors face not only risk related to asset price movements, but also those of the USD/EUR exchange rate. However, the relative ranking stays broadly similar, meaning that currency exposure affects risk but not portfolio structure.

In more stable portfolios, currency variations account for a larger share of total risk than in more volatile allocations, where they tend to be partially absorbed within existing market

² Paired t-tests on daily returns between US and Eurozone investor perspectives indicate no statistically significant differences across portfolios. Mean daily return differences (EU - US) remain close to zero, ranging from -0.000019 for the All Seasons portfolio ($t = -0.26$, $p = 0.796$) to -0.000023 for the Permanent portfolio ($t = -0.30$, $p = 0.762$), corresponding to annualized differences between -0.0049 and -0.0057.

³ Differences in volatility and Ulcer Index across currency perspectives are not formally tested for statistical significance, as these metrics are computed as aggregated measures over the full sample period. Nevertheless, it can be stated that additional variability is introduced by exchange-rate fluctuations.

fluctuations. For instance, the All Seasons portfolio is particularly affected, as volatility increases by 2.65 pp. once returns are expressed in euros. This is consistent with the defensive nature of these portfolios, which rely on lower volatility and therefore experience a relatively larger proportional deterioration under currency adjustments. Conversely, the Golden Ratio or Golden Butterfly portfolios experience a smaller increase, as their already higher asset volatility reduces the relative impact of exchange-rate fluctuations.

Thus, investing in resilient US portfolios when belonging to the Eurozone remains a diversification strategy, although it brings additional risk that has to be kept in mind by investors that seek defensive allocations. Globally, it should be admitted that such kinds of allocations imply lower risk than more growth-oriented ones, and this, across both perspectives.

6.2.2. Ulcer Index

The Ulcer Index serves as a complement to the perspective of risk and must be compared relatively between portfolios. This measure captures the depth and persistence of drawdowns. Unlike volatility, which considers that all fluctuations are equal, Ulcer Index focuses on downside risk, therefore more relevant in terms of investor's discomfort feeling.

From a US perspective, resilient portfolios display relatively low Ulcer Index values, ranging from 5.52 for the Golden Butterfly portfolio to 6.91 for the Golden Ratio portfolio. These results suggest a stronger ability for resilient portfolios to limit prolonged and severe drawdowns. In contrast, the 60/40 portfolio records the highest Ulcer Index (8.19), indicating greater exposure to sustained losses. Despite its cumulative return, it may represent a certain burden for investors during periods of market stress.

From a Eurozone perspective, Ulcer Index values tend to increase slightly (*Appendix 1.*), reflecting the impact of currency fluctuations on downside persistence. Even when underlying US assets recover relatively smoothly in dollar terms, adverse EUR/USD movements may delay the recovery of the portfolio in euro terms and prolong periods below previous peaks. Consequently, drawdowns may appear more persistent and severe for Eurozone investors, particularly for the Permanent Portfolio and the 60/40 allocation. Nevertheless, resilient portfolios continue to outperform the 60/40 allocation, maintaining lower levels of drawdown intensity and duration.

6.3. Diversification

Diversification is a central element of portfolio construction, as it determines how assets combine to influence overall risk. During the sample period, the average correlation between asset classes within each portfolio is computed to compare resilient portfolios to the 60/40 benchmark. These results are available in *Appendix 3*.

Considering the local currency (USD), the 60/40 portfolio exhibits a negative average correlation (-0.1047), which is coherent with the historical diversification benefits between equities and bonds. In contrast, resilient portfolios display slightly positive but relatively low correlations. For instance, the Permanent portfolio shows the lowest level (-0.0070), suggesting near independence between its components, while the Golden Ratio (0.0842) and Golden Butterfly (0.0886) portfolios remain moderately correlated. The All Seasons portfolio records a higher value (0.1296), indicating stronger co-movements between its assets.

However, this static view does not fully capture the evolution of correlations. The distribution of rolling average pairwise correlations, presented in *Appendix 3*., shows how diversification behaves over time. While the 60/40 portfolio exhibits the lowest average correlation, it also has the highest dispersion. So, the diversification provided by the stock-bond relationship is not stable over time. Inversely, resilient portfolios display narrower distributions, highlighting a certain correlation stability between asset classes. Paired t-tests are conducted on rolling correlations, using a 63-day frequency to reduce serial dependence. The results indicate that correlation structures differ significantly between resilient portfolios and the 60/40 benchmark.⁴ In the same way, across all resilient portfolios, the mean correlation differences remain statistically significant at the 1% level, with p-values well below conventional thresholds.⁵

Economically, higher correlations do not necessarily imply weaker diversification. Indeed, the 60/40 portfolio historically benefited from a negative relationship between stocks and bonds, while resilient portfolios diversify by combining numerous asset classes. Overall, the results support HA,1: Correlation structures differ significantly between resilient portfolios and the traditional 60/40 allocation.

⁴ Paired t-tests comparing resilient portfolios with the 60/40 benchmark indicate statistically significant differences in mean correlations across all specifications: All Seasons (+0.2680; $t = 14.36$, $p < 0.01$), Permanent (+0.1550; $t = 7.52$, $p < 0.01$), Golden Butterfly (+0.2380; $t = 13.72$, $p < 0.01$), and Golden Ratio (+0.2230; $t = 9.99$, $p < 0.01$).

⁵ Pairwise comparisons across resilient portfolios also indicate statistically significant differences in average correlations in most cases: All Seasons vs Permanent (+0.1138; $t = 28.52$, $p < 0.01$), All Seasons vs Golden Butterfly (+0.0306; $t = 7.16$, $p < 0.01$), All Seasons vs Golden Ratio (+0.0456; $t = 9.45$, $p < 0.01$), Permanent vs Golden Butterfly (-0.0832; $t = -16.25$, $p < 0.01$), Permanent vs Golden Ratio (-0.0681; $t = -15.11$, $p < 0.01$), and Golden Butterfly vs Golden Ratio (+0.0151; $t = 2.39$, $p < 0.05$).

The diversification relationships between US and Eurozone investor perspectives change once exchange-rate effects are incorporated (*Appendix 3.*). Correlations increase across all portfolios, while the dispersion between them becomes narrower. This is particularly visible for the 60/40 portfolio, showing the strongest rise in average rolling correlation (+0.4186). Conversely, the All-Seasons portfolio is the least affected (+0.1322). Its diversified allocation, combining equities, bonds, gold and commodities provides robustness to currency conversion, which is supported by the statistical tests performed.⁶

Overall, these results support the idea that diversification should not be assessed solely through the level of correlations, but also through their stability over time. While the 60/40 portfolio benefits from negative correlations on average, resilient portfolios offer more stable diversification patterns across different market conditions.

6.4. Downside risk

MDD focuses on extreme events and give therefore an essential insight into long-term portfolio sustainability. It is particularly interesting for long-term investors, as it reflects the worst-case scenario experienced during the investment horizon (*Appendix 4*).

6.4.1. MDD over the entire period

From a US perspective, the 60/40 portfolio exhibits the largest MDD (-39.30%), in line with the literature. All resilient portfolios, for their part, display significantly lower drawdowns: between -27.43% for the Golden Ratio and -19.84% for the Permanent portfolio. In terms of frequency, the 60/40 portfolio also exhibits more drawdowns during the sample period (369), compared to resilient portfolios, ranging from 277 to 313. Results are accessible in *Appendix 5*. and indicate that resilient portfolios are more effective in limiting extreme losses.

When shifting to a Eurozone perspective, the depth of MDD decreases first (up to 8.70 pp. for the All Seasons), except for the Permanent allocation (-1.42 pp.). The 60/40 portfolio remains the most exposed, but the ranking among resilient portfolios changes slightly. Secondly, the number of drawdowns also diminishes across all portfolios. The 60/40 portfolio still records the highest number of drawdown episodes (221), while resilient portfolios continue to experience fewer drawdowns (from 169 to 210), confirming a more stable downside risk profile.

⁶ Paired t-tests on 252-day rolling average correlations indicate statistically significant increases in correlations for all portfolios once returns are expressed from the perspective of a Eurozone investor. Mean correlation differences range from +0.4186 for the 60/40 ($p < 0.01$), to +0.2129 for the Permanent portfolio ($p < 0.01$), +0.1688 for the Golden Ratio ($p < 0.01$), +0.1599 for the Golden Butterfly ($p < 0.01$), and +0.1322 for the All Seasons ($p < 0.01$), which remains the least affected allocation.

However, the full-period analysis is not sufficient because a single MDD reflects only one historical episode and therefore fails to account for how drawdowns evolve over time. Then, drawdowns are typically path-dependent, and investing before or after a period of market stress can lead to various drawdowns. Using rolling windows is thus necessary, as well as testing the statistical significance of observed differences between the resilient and the 60/40 portfolios.

6.4.2. Rolling MDD

Two rolling windows are considered: 63 days and 126 days. The table of results is available in *Appendix 4*.

6.4.2.1. Three-month window

The three-month window enables an analysis focused on market stress. This is particularly important, because it is during short-term drawdowns that investors are most likely to panic.

Considering the US portfolios, the benchmark suffers from the largest average drawdowns (-5.01%), confirming its higher vulnerability to short-term market stress. Resilient portfolios, for their part, endure less pronounced losses, with values ranging from -3.62% for the All Seasons portfolio to -4.76% for the Golden Ratio portfolio. Paired t-tests indicate that some differences are statistically different, but others not.⁷ If resilient portfolios are compared between them, a clear hierarchy can be observed: the difference between the All Seasons and Permanent portfolios is not statistically significant, but they significantly outperform the Golden Butterfly and Golden Ratio portfolios. The Golden Butterfly itself also exhibits significantly lesser drawdowns than the Golden Ratio.⁸

Beyond the average, the minimum rolling drawdown highlights extreme downside events. The 60/40 again records the worst outcome (-30.77%), while resilient versions remain less affected, with values from -23.06% to -13.97%. Drawdowns dispersion reinforces these results. The 60/40 exhibits the highest variability (4.56%), indicating less stable downside behavior, whereas resilient portfolios display lower dispersion, suggesting more predictable drawdown patterns.

⁷ Welch t-tests comparing mean rolling drawdowns with the 60/40 benchmark indicate statistically significant differences for the All Seasons (+1.36 pp.; $t = 4.41$, $p < 0.001$), Permanent (+1.12 pp.; $t = 2.94$, $p < 0.01$), and Golden Butterfly portfolios (+0.59 pp.; $t = 2.34$, $p < 0.05$). The Golden Ratio also exhibits a lower mean rolling drawdown (+0.23 pp.), although the difference is not statistically significant at the 10% level ($t = 1.06$, $p = 0.293$).

⁸ Pairwise comparisons of mean rolling drawdowns indicate no statistically significant difference between the All Seasons and Permanent portfolios (+0.24 pp.; $t = 1.52$, $p = 0.132$). The All Seasons exhibits significantly lower drawdowns than the Golden Butterfly (+0.76 pp.; $t = 5.43$, $p < 0.01$) and Golden Ratio portfolios (+1.13 pp.; $t = 6.96$, $p < 0.01$). The Permanent portfolio also displays significantly lower drawdowns than the Golden Butterfly (+0.52 pp.; $t = 3.09$, $p < 0.01$) and Golden Ratio portfolios (+0.89 pp.; $t = 3.90$, $p < 0.01$), while the Golden Butterfly exhibits lower drawdowns than the Golden Ratio portfolio (+0.37 pp.; $t = 4.33$, $p < 0.01$).

To summarize, this three-month window consistently shows that resilient portfolios outperform the 60/40 benchmark across all dimensions of downside risk.

6.4.2.2. [Six-month window](#)

A six-month window focuses on more prolonged market perturbations, in the medium-term. The differences with the previous window are clearer in *Appendix 4*. In this case, the patterns observed over shorter horizons remain valid over more persistent market conditions. The 60/40 remains the most exposed to prolonged losses (-7.26%), while resilient portfolios reduce the drawdowns' severity, with average values ranging from -5.27% to -6.82%. The significance is such that the All Seasons again gives highest mean difference compared to the benchmark: the average rolling drawdowns is 1.95 pp. less severe than the 60/40. Then, the Permanent (+1.59 pp) and Golden Butterfly (+1.06 pp) results are also statistically significant, unlike the Golden Ratio.⁹ Among resilient portfolios, certain differences can be established, such as between the All Seasons and Golden Butterfly or the Permanent and the Golden Ratio, but that is not always the case.¹⁰ Some resilient portfolios provide more stable downside protection not only in short-term stress periods, but also during more persistent market downturns.

6.4.3. [Eurozone perspective and currency effects](#)

The currency effects induces a small increase of rolling drawdowns across all portfolios (*Appendix 4*). It is the expected additional source of variability, but this increase is uniform, which explains that resilient portfolios generally continue to exhibit lower and more stable drawdowns than the 60/40 benchmark, even when returns are expressed in euros. In addition, currency change does not automatically deteriorate resilience, but that depends on the portfolio structure: those that already relying on defensive assets, or that hold numerous asset types, are more capable to absorb the fluctuations due to currency.

As additional insight, it worths to analyze the best and worst performances on both a daily and yearly basis. The comparison in *Appendix 8*. firstly shows that the most important daily losses remain relatively similar across both perspectives. However, the strongest positive daily returns

⁹ Welch t-tests comparing MDD with the 60/40 benchmark indicate statistically significant differences for the All Seasons (+1.95 pp.; $t = 3.39$, $p < 0.01$), Permanent (+1.59 pp.; $t = 2.24$, $p < 0.05$), and Golden Butterfly portfolios (+1.06 pp.; $t = 2.33$, $p < 0.05$). The Golden Ratio portfolio also exhibits a lower rolling MDD (+0.50 pp.), although the difference is not statistically significant at the 10% level ($t = 1.27$, $p = 0.211$).

¹⁰ Pairwise comparisons of rolling MDD indicate no statistically significant difference between the All Seasons and Permanent portfolios (+0.36 pp.; $t = 1.34$, $p = 0.188$), or between the Permanent and Golden Butterfly portfolios (+0.53 pp.; $t = 1.57$, $p = 0.122$). Significant differences remain for All Seasons vs Golden Butterfly (+0.89 pp.; $t = 3.67$, $p < 0.01$), All Seasons vs Golden Ratio (+1.45 pp.; $t = 4.79$, $p < 0.01$), Permanent vs Golden Ratio (+1.09 pp.; $t = 2.42$, $p < 0.05$), and Golden Butterfly vs Golden Ratio (+0.56 pp.; $t = 3.57$, $p < 0.01$).

are generally lower for Eurozone investors. For instance, the 60/40 portfolio records a peak daily return of +7.77% in USD, compared to +6.52% in EUR, while the All Seasons portfolio declines from +5.64% to +4.41%. Exchange-rate movements can slow recovery phases, but slightly moderate extreme upward and downward movements. The annual results reinforce this observation, as worst yearly returns become less negative in euro terms, except for the Permanent portfolio. Moreover, this conversion reshapes the all performance path, as a year considered as exceptional for US investors may appear less pronounced for euro-area investors.

6.4.4. Overall interpretation

In general, the results support HB,1, although some differences are not always statistically significant: Resilient portfolios generally exhibit shallower and more stable drawdowns than the 60/40 benchmark. This advantage is observed across different time horizons and remains robust under currencies. So, the 60/40 portfolio delivers certainly interesting returns, but it exposes investors to significantly higher downside risk, both in magnitude and variability.

6.5. Recovery dynamics

Resilience is not only about how much a portfolio loses, but also about how long it remains below its previous peak. A slow recovery can represent a burden for investors, even when losses are finally recovered. The time to recovery dimension helps distinguish portfolios that limit damage from those that are also able to restore capital within a reasonable period. This is particularly relevant, as one of the main objectives of resilient portfolios is to remain robust through adverse market conditions. Detailed results can be found in *Appendix 5*.

6.5.1. US investor perspective

From a US perspective, the time-to-recovery differs between portfolios. For instance, the 60/40 exhibits relatively short average recovery durations (6.98 days), but this must be interpreted with caution, given the frequency of drawdowns previously mentioned. This benchmark's characteristic may be more difficult for investors to tolerate psychologically, even if losses remain moderate on average. The 60/40 experiences many relatively short drawdown episodes on average, while remaining highly exposed to rare but extremely severe crises, such as the 2008 financial crisis. Then, resilient allocations tend to experience slightly longer average recoveries, ranging from 9.01 to 11.12 days, reflecting a trade-off between frequency and persistence of losses.

Looking at extreme cases (*Appendix 9.*), it can be stated that the Permanent Portfolio records the shallowest drawdown and the shortest total drawdown duration among US portfolios (528 days), with a peak-to-recovery phase of 294 days. Its balanced exposure to long-term bonds, treasury bills, gold, and equities seems to provide both protection and capacity to restore capital quickly during intense market stress. Taking the example of the Golden Ratio portfolio, its downside resilience is weaker: a deeper drawdown (-27.43%), longer recovery phase (393 days), and longer total duration (626 days) make it a portfolio that is too similar to a traditional allocation, which supports growth potential, but reduces downside resilience.

It should be noted that statistical tests moderate the following interpretations¹¹. Resilient portfolios are generally associated with fewer and less severe drawdowns than the benchmark. However, differences in average recovery time, peak-to-trough duration, and total drawdown duration are not statistically significant at the 10% level, despite economically meaningful differences. This suggests that recovery dynamics depend rather on the timing and structure of individual crises, which creates substantial dispersion across drawdown episodes. Consequently, resilience differences appear economically meaningful, but not statistically. So, the results provide partial support for HD,1, which mentions a decrease of drawdown severity and frequency for resilient portfolios, because differences in recovery duration are not always statistically significant.

6.5.2. Eurozone investor perspective

The shift from a US dollar investing to a Euro one modifies the portfolio resilience, especially their temporal characteristics (*Appendix 9.*). For instance, the number of drawdown episodes declines across all portfolios, which is particularly striking in the 60/40 portfolio (-148 episodes), which is initially not considered as resilient. In fact, exchange rates considerations reshape the return path, and it can neutralize local declines in some periods, leading to fewer but more prolonged drawdowns.

Indeed, the average drawdown duration increases across all strategies and nearly doubles for the All Seasons, Permanent and 60/40 portfolios. It must be stated that this rise is not driven exclusively by longer recoveries after the trough. This is partly due to the increase in average

¹¹ Welch t-tests comparing recovery dynamics between resilient portfolios and the 60/40 benchmark indicate no statistically significant differences at the 10% level. Mean recovery duration differences range from +2.03 days for the Golden Ratio portfolio ($p = 0.424$) to +4.13 days for the Permanent portfolio ($p = 0.251$). Similar conclusions apply to total drawdown duration and peak-to-trough duration, with all p-values remaining above 0.10.

peak-to-trough duration across all portfolios. It underlines that the entire drawdown process matters, not only the recovery phase. From a behavioral finance perspective, sudden market crashes cause immediate fear among individuals, but inversely, gradual and persistent declines may be more difficult to tolerate, as they can create a sensation of stagnation and undermine investor confidence. However, total durations differences are not statistically significant at the 10% level.¹² As well, recoveries durations are not statistically different from the benchmark.¹³

Overall, a portfolio may appear robust in local terms, yet display different recovery dynamics once foreign exchange is introduced. Although these differences are not always statistically significant, the results economically suggest that currency exposure may influence not only the magnitude of losses, but also their timing and persistence, thereby shaping the investor's perception of portfolio resilience and persistence.

6.6. Risk-adjusted performance

While raw returns provide an initial assessment of performance, they do not account for the level of risk taken to achieve them. Risk-adjusted measures therefore offer a more comprehensive perspective by relating returns to the underlying risk exposure (*Appendix 6.*).

6.6.1. Sharpe ratio

Actually, the Sharpe ratio measures the excess return generated per unit of risk and is therefore useful to determine whether higher returns compensate for the additional volatility. A Sharpe ratio below 0.5 is considered weak, values between 0.5 and 1 are acceptable, and a ratio between 1 and 2 indicates a strong performance. Sharpe ratios above 2 are viewed as excellent, although rarely observed and difficult to keep over long periods.

From a US perspective, resilient portfolios outperform the benchmark in terms of Sharpe ratio. At the first place, the Permanent portfolio records the highest value (0.576), despite not delivering the highest cumulative return (613.53%). Its relatively low volatility (9.12%) allows it to generate greater returns per unit of risk. This result is consistent, as the Permanent portfolio

¹² For total drawdown duration, mean differences range from -14.77 days for the All Seasons portfolio ($t = -1.54$, $p = 0.125$) to -10.54 days for the 60/40 benchmark ($t = -1.64$, $p = 0.101$), with no statistically significant differences at the 10% level across resilient portfolios.

¹³ For recovery duration, mean differences range from -6.37 days for the 60/40 benchmark ($t = -1.58$, $p = 0.114$) to -3.86 days for the Golden Ratio portfolio ($t = -1.14$, $p = 0.256$), with no statistically significant differences at the 10% level. For peak-to-trough duration, differences are more pronounced, reaching -9.71 days for the All Seasons portfolio ($t = -1.82$, $p = 0.070$) and -8.60 days for the Permanent portfolio ($t = -1.82$, $p = 0.071$), suggesting marginal significance at the 10% level.

combines growth assets with defensive components: long-term bonds, treasury bills and gold. The 60/40 benchmark (0.467) ranks last, due to higher volatility relative to returns. Economically, resilient portfolios appear to offer a modest improvement in risk-adjusted performance, although bootstrap tests do not provide evidence of statistically significant differences relative to the benchmark.¹⁴ When shifting to a Eurozone perspective, the overall ranking remains unchanged, but Sharpe ratios seem to be slightly improved for some portfolios.

As a robustness check, Sharpe ratios are also recalculated using a zero risk-free rate. This is implemented because consistent short-term risk-free series are not always available over the full sample period. Although Sharpe ratios mechanically increase under the zero risk-free specification, the main conclusions remain unchanged. Resilient portfolios continue to display higher Sharpe ratios than the traditional 60/40, but none of the differences is statistically significant in either the US or Eurozone investor framework.

6.6.2. Sortino ratio

The Sortino ratio provides a complementary perspective by focusing exclusively on downside risk, by considering only returns falling below a minimum acceptable return (MAR). In this thesis, MAR is set to 0%. The Sortino ratio therefore measures performance relative to a no-loss threshold, rather than relative to any rate.

From a US perspective, all portfolios belonging to the sample exhibit Sortino ratios above 1, generating returns that more than compensate for their downside risk. Values between 1 and 1.5 are generally considered good in empirical finance (Colin, 2026). Economically, resilient portfolios tend to outperform the 60/40 benchmark: they are apparently able to better manage adverse market conditions. This is consistent with previous findings on drawdowns, as portfolios that limit the depth and persistence of losses naturally achieve stronger downside-adjusted performance. The Permanent (1.392) and All Seasons (1.351) portfolios, in particular, display strong Sortino ratios, reflecting their balanced exposure between growth and downside protection. The worst candidate is the 60/40, at 1.063. It is acceptable, but investors are exposed to more frequent or deeper drawdowns relative to the return generated. However, Bootstrap comparisons provide an important nuance. Although all resilient portfolios display higher

¹⁴ Bootstrap tests comparing Sharpe ratios with the 60/40 benchmark indicate no statistically significant differences at the 10% level. Observed differences are +0.041 for the All Seasons ($p = 0.799$), +0.111 for the Permanent ($p = 0.602$), +0.067 for the Golden Butterfly ($p = 0.631$), and +0.078 for the Golden Ratio ($p = 0.529$), while all confidence intervals include zero. A block bootstrap robustness check (block size = 21 trading days) leads to similar conclusions, with p-values of 0.846, 0.634, 0.612, and 0.528 respectively.

Sortino ratios than the benchmark, these differences are not statistically significant.¹⁵

From a Eurozone perspective, Sortino ratios also decline across portfolios, due to the combined impact of currency-induced volatility and slightly lower returns. Nevertheless, resilient portfolios maintain an advantage over the 60/40 allocation, highlighting the robustness of their downside protection mechanisms.

6.6.3. Calmar ratio

The Calmar ratio relates returns to MDD, thereby directly linking performance to extreme downside risk. Unlike Sharpe or Sortino ratios, the Calmar ratio concentrates on extreme downside risk, answering to the question: ‘how much return is generated per unit of worst historical loss?’.

From a US perspective, resilient portfolios generally display economically higher Calmar ratios than the 60/40 benchmark, reflecting their ability to limit severe losses while maintaining competitive returns, as proposed through previous findings, where resilient portfolios exhibit significantly lower downside risk. The Permanent portfolio has the highest Calmar ratio (0.441), followed by the Golden Butterfly (0.390), and the Golden Ratio (0.344). The 60/40, for its part, records the lowest Calmar ratio (0.228). Economically, resilient allocations provide greater return per unit of extreme downside risk. However, Bootstrap tests limit the statistical significance of results.¹⁶ As a robustness check, a block bootstrap resampling procedure preserving 21-day return sequences is also applied. Under this alternative resampling scheme, all observed differences remain economically positive but statistically weaker, consistent with the interpretation that part of the outperformance may depend on persistent market regimes and volatility clustering.

¹⁵ Bootstrap tests comparing Sortino ratios with the 60/40 benchmark indicate higher downside risk-adjusted performance for resilient portfolios, although no difference is statistically significant at the 10% level. Observed differences are +0.285 for the All Seasons ($p = 0.274$), +0.330 for the Permanent ($p = 0.300$), +0.188 for the Golden Butterfly ($p = 0.362$), and +0.164 for the Golden Ratio ($p = 0.381$). A block bootstrap robustness check (block size = 21 trading days) leads to similar conclusions, with p-values of 0.259, 0.295, 0.347, and 0.382.

¹⁶ Bootstrap tests comparing Calmar ratios with the 60/40 benchmark indicate higher return-to-drawdown efficiency for resilient portfolios, although no difference is statistically significant at the 10% level. Observed differences are +0.135 for the All Seasons ($p = 0.420$), +0.159 for the Permanent ($p = 0.413$), +0.086 for the Golden Butterfly ($p = 0.505$), and +0.079 for the Golden Ratio ($p = 0.501$). The block bootstrap robustness check (block size = 21 trading days) leads to similar conclusions, with p-values of 0.420, 0.324, 0.370, and 0.408 respectively. Confidence intervals widen further under block resampling, which is consistent with the path-dependent nature of the Calmar ratio and supports a cautious interpretation of the observed differences.

From a Eurozone perspective, Calmar ratios generally improve after the conversion, indicating a better balance between return and MDD. The main exception is the Permanent portfolio, whose Calmar ratio slightly declines under the Euro perspective, suggesting that part of its defensive characteristics are linked to the domestic monetary environment.

Finally, differences between the US and Eurozone results are partly influenced by their divergence in risk-free rates (*Appendix 7.*). Nevertheless, HE,1 cannot be accepted, as the differences between resilient portfolios and the benchmark remain statistically insignificant.

6.7. The importance of currency perspective

Exchange-rate exposure is not limited to a simple conversion from one currency into another. Rather, it constitutes a financial risk in its own right that can reshape portfolio outcomes. Hofmann, Shim and Shin (2025) show that exchange-rate fluctuations affect investors' decisions by modifying their capacity to take risk. Indeed, currency movements directly influence gains and losses in the local currency, which can lead, on the one hand, to amplified returns when currency appreciates, or, on the other hand, to weaken them in case of depreciation. In addition to that, currency fluctuations simply increase total portfolio volatility. When exchange rates move generally, they can affect several assets at once, leading to the fact that different investments move closely together, even if they are initially well diversified. As a result, the various properties of resilient portfolios may be questioned. For Eurozone investors, it is entirely relevant to evaluate US resilient portfolios, and this requires reassessing whether their resilience characteristics persist once exchange-rate risk is considered.

Another important dimension is the difference in risk-free rate across regions. As illustrated in *Appendix 7.*, US risk-free rates is higher than in the Euro Area, which even turn negative over certain periods. This gap directly affects risk-adjusted performance measures and could partially explain differences both perspectives.

6.8. Portfolio behavior during major bear market cycles

This analysis identifies bear market episodes, considering that they are periods during which the S&P 500 declines by at least 20% from its previous peak. This threshold is commonly used to define strong market stress (Li et al. 2020). The end of a crisis is defined when the market fully recovers its previous peak. Focusing on these periods, the named resilient portfolios can be compared to the benchmark to evaluate their resilience. The individual episodes are described in *Appendix 10*.

6.8.1. Subprime Crisis (2007-2012)

The first bear-market episode of the sample begins in 2007, following the collapse of mortgage-related credit markets. It rapidly reaches the global banking system, which is reflected in equity market. There, investors reallocated risky assets toward safe ones, like government bonds and gold.

Resilient portfolios benefit from not relying solely on equities, which clearly pays off. For US investors, the 60/40 experiences the deepest drawdown (-39.30%), far exceeding the second worst portfolio, the Golden Ratio (-25.97%). This is economically coherent, given the high exposure to equity-oriented assets. Diversification based mainly on the stock-bond relationship therefore appears less robust than broader than multi-asset diversification.

By contrast, the Permanent portfolio may be the strongest performer, limiting drawdown to -18.57%. This is mainly explained by its allocation to long-term bonds, treasury bills and gold, which is absolutely appropriate during a crisis dominated by deflation. Long-term treasury bonds also benefit from falling interest rates, as lower rates imply bond prices that go up. Combined with treasury bills that provide liquidity, and gold that hedges against systemic uncertainty, such a portfolio is especially adapted to this environment.

In general, it is observed that the resilient portfolios are able to preserve capital more effectively than the benchmark. The concept of resilience is not only about lowering volatility, but to hold assets that respond positively in case of stress. To support this, one US dollar invested at the beginning of the bear market grows to 1.64 dollars in the Permanent Portfolio, compared with only 1.16 dollars in the benchmark.

This also applies for Eurozone investors, but with additional currency effect. When assets are converted into euro, outcomes are enhanced. This means that currency exposure reinforced the typical protection of diversified portfolios. In this euro extension, resilience is amplified by

exchange rates, which serves as additional protection rather than being an extra source of instability. This is also visible in final wealth values, as one euro invested in the Permanent portfolio increases to 1.80 euros by the end of the recovery, versus 1.27 euros for the 60/40.

Whether an individual invests in dollars or euros, the Permanent portfolio seems to be the smartest choice for a crisis that corresponds to the characteristics of the Subprime crisis, that is to say in a deflationary crisis regime.

6.8.2. COVID-19 Pandemic Crash (2020)

The COVID-19 market crash is driven by extreme uncertainty. In such a context, investors rush toward liquidity and move away from equities. Even if the decline is sharp and severe, the recovery is also unusually rapid due to a monetary intervention. Unlike the Subprime crisis, this financial shock is not structural but rather caused by an external event.

For US investors, the 60/40 portfolio generated a positive return at the end of the crisis (+2.27%) but it is characterized by a higher volatility (33.47%) and a larger MDD (-28.23%). By comparison, the Permanent and All Seasons portfolios delivered higher cumulative returns over the period, with lower volatility and shallower drawdowns. This suggests that bonds and gold are useful in such stress periods. It should also be noted that, because these portfolios lost less during the downturn, they entered the recovery phase from a stronger position and benefit from the rebound. Beyond cumulative return, another perspective reinforces this point: one dollar invested at the beginning of the cycle becomes 1.15 dollars in the Permanent Portfolio, against only 1.02 dollars in the benchmark. The key takeaway is that when policy support is quick, resilient portfolios are able to preserve capital while also ensuring a stronger recovery.

Results are more mixed for Eurozone investors. Resilient portfolios still reduce drawdowns, sometimes by half relative to the 60/40, but returns are less impressive than for US investors. This suggests that exchange rates partly offset the domestic recovery, measured in US dollars, reducing part of the performance gap between resilient portfolios and the benchmark. The difference remains small: one euro invested in the 60/40 fell below its initial value (0.94 euro) and the Permanent Portfolio goes to around 1.05 euros. Even though the currency effect slows returns, a defensive allocation still helps contain the shock. From a Eurozone perspective, the conclusion remains unchanged: even if currency exposure limits performance, resilient portfolios still tend to provide downside protection in case of uncertainty environment.

6.8.3. Inflation crisis (2022-2023)

The 2022 bear market is fundamentally different, as its origine is an inflation and interest-rate shock. Due to rising inflation, central banks had to tighten monetary policy, which increased bond yields, and therefore made both equities and bonds fall. In such a case, diversification becomes less reliable. This period challenged initial assumptions of the traditional 60/40 allocation. Indeed, bonds are supposed to correct equities decline. However, since 2022, this relationship is falling apart.

For US investors, resilient portfolios are heavily challenged, especially those with large long-duration bonds. In fact, this asset class is very sensitive to interest rates. The Permanent portfolio remains the best and gets close to the 60/40, but seems less volatile with a slightly lower MDD in absolute terms. What is particularly interesting is that the Permanent portfolio continues to hedge, but much less effectively than during deflationary crises such as 2008. The All Seasons and Golden Ratio, as for them, suffered more, due to their large part of bonds, making them directly vulnerable to rising rates. So, multiple-asset diversification is not sufficient when some components are simultaneously exposed to the same macroeconomic shock. Under these conditions, the 60/40 portfolio is not clearly dominated, highlighting that portfolio resilience depends on market conditions. Resilient portfolios are not universally superior, but rather depend on the macroeconomic regime driving market stress.

The results are more favorable for Eurozone investors, especially regarding drawdowns and even in terms of returns, as some portfolios ended the cycle slightly positively. This suggests that exchange rates partly offset domestic losses when returns are converted into euros. However, resilient allocation face some limitations: when inflation impacts both stocks and bonds at the same time, bond protection become less reliable and changing currency becomes thus a valuable source of resilience.

Overall, HC,1 appears supported, as resilient portfolios generally display better downside resistance than the 60/40 portfolio during major bear market episodes.

7. Global discussion

This Master thesis aimed to assess whether resilient portfolios provide better diversification and protection against downside risk, compared to the traditional 60/40 allocation, across different market environments and from an international perspective. The answer can be nuanced, because resilience is a dynamic characteristic relying on portfolio construction, macroeconomic conditions, and currency exposure.

From a domestic perspective, resilient portfolios appear more effective at limiting drawdown severity as well as their frequency. In particular, their return profiles are competitive and they are known for their ability to make portfolio performance more stable in the long-term. Beyond the traditional stock-bond relationship, diversification across multiple asset classes enhances robustness during periods of market stress. However, more defensive portfolios can limit the potential of growth, a trade-off that must be considered depending on the investor's objective.

Then, the major bear market episodes show that resilient portfolios do not systematically outperform in terms of returns during crises. Nevertheless, their behavior is not uniform across stress episodes. Some allocations perform better in inflationary shocks, while others are more effective in deflationary ones, suggesting that resilience depends on economic conditions. Here, the definition of resilience really comes into its own: it should not be considered as a global protection, but rather as the ability to adapt across different types of shocks.

Furthermore, the Eurozone perspective reveals that portfolio resilience depends also on currency. Even if the ranking remains similar, but diversification benefits observed in a US dollar framework deteriorate when performance is converted into Euros. Moreover, even when drawdown magnitudes remain comparable, their duration tend to increase. Regarding risk-adjusted performance measures, resilient portfolios are efficient even when the currency effect is considered, but this exposure tend to affect both returns and volatility. This phenomenon induce a preserved Sharpe ratio but alters the perception of risk, which investors must bear without a systematic increase in expected returns.

The results suggest that resilient portfolios generally offer stronger downside protection and stability across market regimes than the 60/40 benchmark. However, these benefits depend on the structure of the portfolio, the nature of shocks, and the investor's currency. In this way, resilient portfolios are a good alternative to improve robustness.

8. Limitations of the thesis

This thesis presents several limitations, mainly linked to the data selection, the appropriateness of metrics or the validity of assumptions. Firstly, the empirical analysis exclusively uses US data, except specific elements such as the Eurozone risk-free rate. This represents a geographical bias, because it is not a truly internationally diversified portfolio. Also, regarding the data selection, the use of total return indices does not account for transaction costs or management fees, which may modify the real performance. Then, the analysis is conducted with daily data, which aims to precisely measure volatility, drawdowns, and recovery dynamics. Nevertheless, this high frequency may also amplify short-term variations that are not necessarily relevant for long-term investors. Rolling measures are the most affected as they may reflect short-term variability rather than structural differences between portfolios.

After that, diversification is assessed through correlation, which is known to be unstable over time. For reminder, the literature, notably Asness (2024) and Silverman (2021), mentioned that correlations between asset classes is likely to increase during periods of market stress. Although this study complements static correlations with rolling windows, this measure is not the best proxy for diversification. Furthermore, correlation differences are assessed using standard t-tests on rolling average correlations. While Fisher transformations would theoretically be more appropriate for correlation-based inference, the present analysis relies on averages computed over many rolling windows. By the Central Limit Theorem, these averages tend toward normality, which likely mitigates most of the potential bias. Consequently, the limitation is acknowledged, but the overall conclusions are unlikely to be substantially altered.

Additionally, the results underline the role of periodic rebalancing in diversified portfolios. Without rebalancing, asset weights drift over time, as the best-performing assets mechanically gain a larger share of the portfolio. For example, in the 60/40 portfolio, equities increase from 60.0% to 84.4% of the portfolio value by the end of the sample. A similar dynamic is observed across resilient portfolios. In the All Seasons portfolio, gold rises from 7.5% to 18.6%, while equities increase from 30.0% to 55.0%. Within the Permanent portfolio, gold becomes the dominant component, increasing from 25.0% to 49.7%. The same mechanism is observed in the Golden Butterfly and Golden Ratio portfolios, where gold reaches 38.2% and 27.5% respectively at the end of the period. A pure buy-and-hold strategy can significantly modify the initial risk profile over time, which progressively increases the weight of the best-performing assets. The portfolios analyzed in this thesis should therefore be interpreted as non-rebalanced

approximations of the original resilient portfolio strategies. Comparing buy-and-hold resilient portfolios with dynamically rebalanced strategies could help in further research to determine whether active adjustments improve downside resilience during periods of market stress.

Although there exist some methodological limitations, they are unlikely to substantially alter the overall conclusions of the thesis. Certain asset classes are represented through proxies or ETFs due to data availability constraints, which may slightly affect long-term performance comparisons. Similarly, the use of a broad corporate bond total return index for intermediate-term bonds may introduce a small exposure to credit risk compared to a pure intermediate-term bond. These limitations mainly affect the precision of the estimates, but results stay economically consistent across portfolios, market regimes, and investor perspectives.

Moreover, the results related to drawdowns and recovery dynamics are still path-dependent. A procedure is applied to reduce dependence on rolling windows, but is not sufficient to totally eliminate serial correlation. Finally, some differences between portfolios are economically meaningful but not statistically, which limits the reliability of conclusions.

In summary, these limitations do not invalidate the results, but they have to be taken into consideration during the interpretation. Making assumptions is necessary, but it is still a simplified representation of reality. So, the findings should be seen as indicative, and doors are open to further research that could address those constraints.

9. Conclusion

This thesis focuses on assessing whether resilient portfolios provide better diversification and improved downside protection compared to the traditional 60/40 allocation across different market environments, and how these results evolve when adopting a Eurozone investor perspective. The findings provide a nuanced answer.

Resilient portfolios do not necessarily outperform the 60/40 portfolio in terms of profitability. In fact, performance is relatively comparable across portfolios over the long term. However, the key difference lies in the ability of resilient allocations to limit extreme losses, reduce the frequency of drawdowns, and improve their stability. This suggests that resilience is not about maximizing returns, but about controlling risk across diverse macroeconomic environments.

From a diversification standpoint, while the 60/40 is historically known for its negative stock-bond correlations, this relationship becomes less stable nowadays. Inversely, resilient portfolios

rely on a diversification based on various asset classes, leading to more stable, although slightly higher, correlation structures. This suggests that diversification should not be evaluated solely based on correlation levels, but rather on how assets interact across different economic regimes.

The analysis of downside risk strengthens the relevance of resilient strategies. Across both short and medium-term horizons, these portfolios consistently reduce the importance and variability of drawdowns compared to the benchmark. Among them, the Permanent Portfolio is the most balanced allocation, combining effective protection against losses with good recovery dynamics. Conversely, more growth-oriented portfolios, such as the Golden Ratio, offer higher returns against weaker downside resilience. However, when considering recovery dynamics and risk-adjusted performance, it can be noted that, although resilient portfolios tend to exhibit results that are economically meaningful, statistical tests indicate that these differences are not always significant. Thus, measuring resilience becomes complex.

Introducing the Eurozone investor perspective does not fundamentally alter the portfolio ranking, but it modifies their risk-return profiles. Exchange rate fluctuations tend to increase volatility and can diminish diversification benefits, because of the introduction of a common source of risk across assets. Consequently, resilience is affected by currency movements in terms of magnitude. So, international investing transforms and does not eliminate the properties of portfolio resilience. Future research could investigate more geographically diversified portfolio constructions in order to assess whether broader international exposure improves portfolio resilience across different market structures and monetary environments.

Finally, the major bear market episodes analysis suggests that resilient portfolios generally perform better during periods of market stress. Their diversified structure allows them to better absorb shocks, although the degree of protection varies depending on the crisis and the portfolio. The idea remains to evaluate resilience in a dynamic way, across different economic contexts.

This thesis therefore contributes to the existing literature by showing that resilient portfolios offer a meaningful alternative to the traditional 60/40, not by delivering higher returns, but by improving investor's experience, through better downside control, namely. It is also essential to take currency risk into account. Future research could extend this work by incorporating transaction costs, alternative asset classes or indices. In addition, exploring a broader geographical diversification would permit to better understand how resilience works.

10. Appendices

10.1. Appendix 1. Returns and Risk

Table 1. Returns and Risk results

US dollar perspective				
Portfolio	Cumulative return	CAGR	Volatility	Ulcer Index
All Seasons	471.96%	7.73%	8.31%	5.82
Permanent	613.53%	8.75%	9.12%	5.57
Golden Butterfly	642.12%	8.94%	10.33%	5.52
Golden Ratio	724.51%	9.43%	11.22%	6.91
60/40	645.12%	8.95%	12.42%	8.19
Euro perspective				
All Seasons	381.46%	6.94%	10.96%	6.37
Permanent	500.63%	7.96%	10.85%	6.47
Golden Butterfly	524.69%	8.14%	12.00%	5.52
Golden Ratio	594.05%	8.62%	12.73%	6.23
60/40	527.22%	8.16%	14.57%	8.91
Δ (Euro - USD)				
All Seasons	-90.50 pp.	-0.79 pp.	+2.65 pp.	+0.55
Permanent	-112.90 pp.	-0.79 pp.	+1.73 pp.	+0.90
Golden Butterfly	-117.43 pp.	-0.80 pp.	+1.67 pp.	+0.00
Golden Ratio	-130.46 pp.	-0.81 pp.	+1.51 pp.	-0.68
60/40	-117.90 pp.	-0.79 pp.	+2.15 pp.	+0.72

This table compares return and risk metrics across portfolios under both US and Eurozone investor perspectives. While cumulative returns or CAGR are lower in the euro-area perspective, volatility and Ulcer Index tend to increase.

10.2. Appendix 2. Growth of one unit

Table 2. Growth of one USD

Portfolio	Final Value of 1 USD Invested	Cumulative return
All Seasons	5.7196 USD	+471.96%
Permanent	7.1353 USD	+613.53%
Golden Butterfly	7.4212 USD	+642.12%
Golden Ratio	8.2451 USD	+724.51%
60/40	7.4512 USD	+645.12%

Figure 1. Growth of one USD

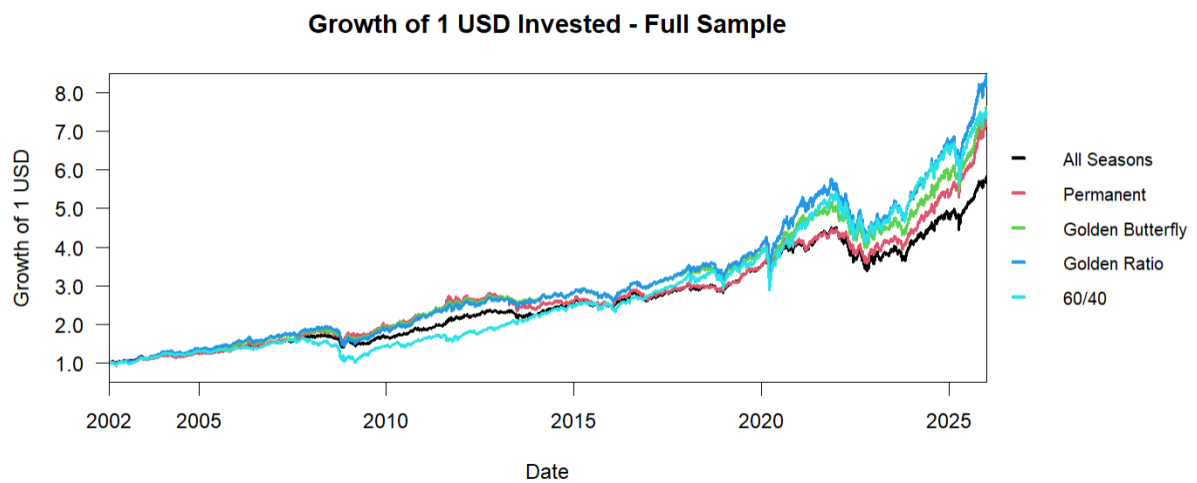
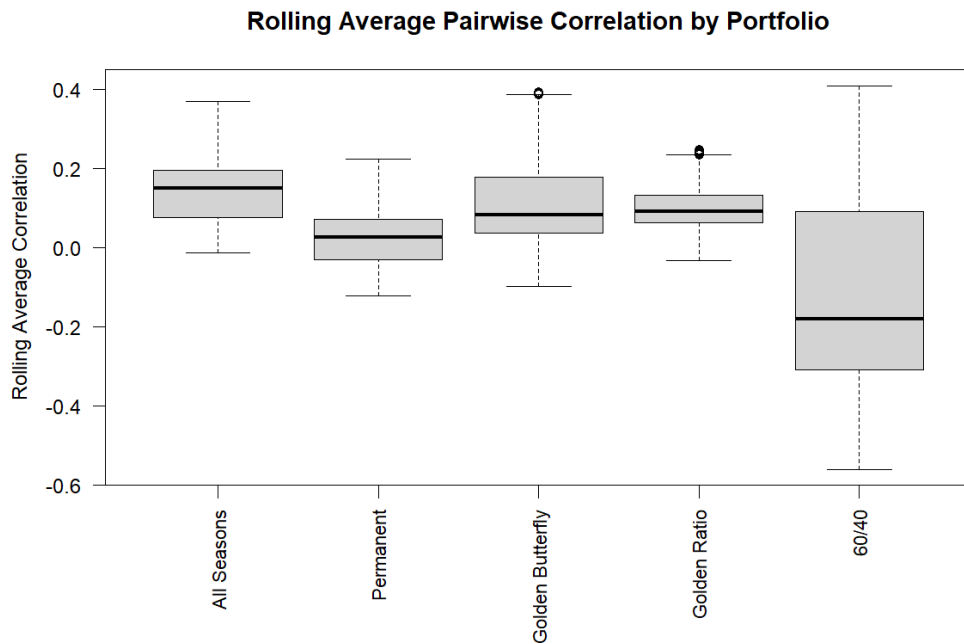


Table 2. and *Figure 1.* illustrate the long-term growth of one US dollar invested across portfolios over the full sample period. Although all portfolios experience major market stress episodes, differences in long-term compounding progressively become visible over time. The Golden Ratio, Golden Butterfly, and 60/40 portfolios exhibit the strongest cumulative growth, while the All Seasons follows a more defensive and smoother trajectory.

10.3. Appendix 3. Correlations

Figure 2. Rolling average pairwise correlation



The distribution of rolling correlations provides an insight into the stability of diversification across time. While most resilient portfolios have low and stable correlations, the 60/40 portfolio shows a lower median and a wider dispersion, going into negative values. This would mean that its diversification properties depend on the regime.

Table 3. Comparison of average pairwise correlations between US and Eurozone

Portfolio	#Assets	Average Pairwise Correlation (US dollar)	Average Pairwise Correlation (Euro)	Δ (Euro - USD)
60/40	2	-0.1047	0.2335	+0.3382
Permanent	4	-0.0070	0.2174	+0.2244
Golden Ratio	6	0.0842	0.2478	+0.1636
Golden Butterfly	5	0.0886	0.2452	+0.1566
All Seasons	5	0.1296	0.2476	+0.1180

Table 3. reports the average pairwise correlations between portfolio assets under US and Eurozone investor perspectives. The last column reports the change in correlations once returns are expressed in euro terms.

Table 4. Comparison of rolling average correlations between US and Eurozone investors

Portfolio	Mean Rolling Correlation (US Investor)	Mean Rolling Correlation (Eurozone Investor)	Δ (Euro - USD)
60/40	-0.1259	0.2927	+0.4186
Permanent	0.0287	0.2417	+0.2129
Golden Ratio	0.0969	0.2657	+0.1688
Golden Butterfly	0.1119	0.2718	+0.1599
All Seasons	0.1425	0.2747	+0.1322

Table 4. reports rolling average pairwise correlations between portfolio assets under US dollar and Eurozone investor perspectives. The last column reports the difference between both currency frameworks.

10.4. Appendix 4. Drawdown Series

Figure 3. Drawdowns over the entire period for US investors

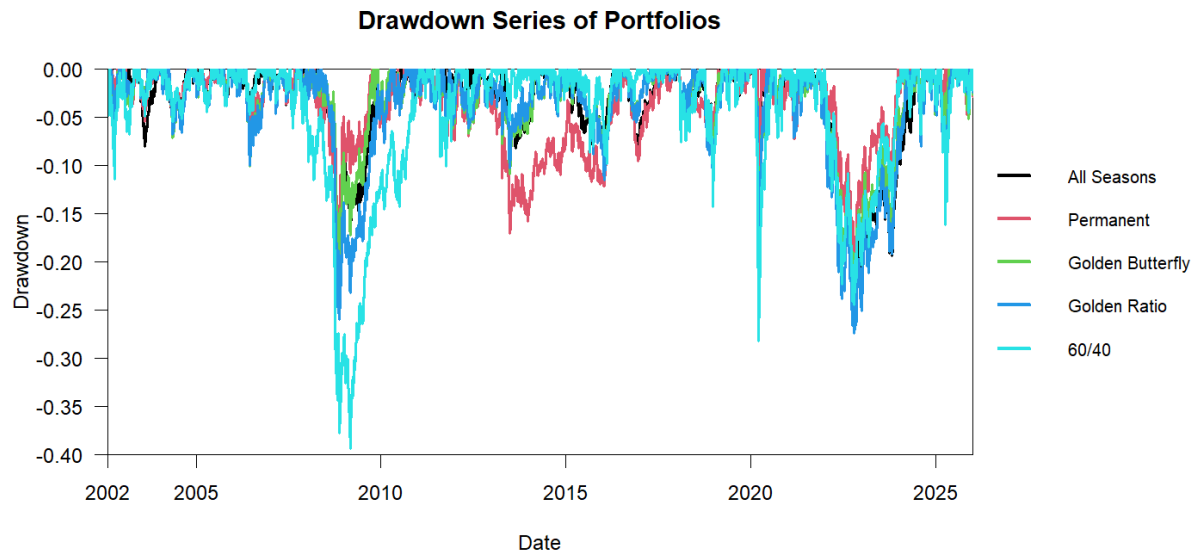
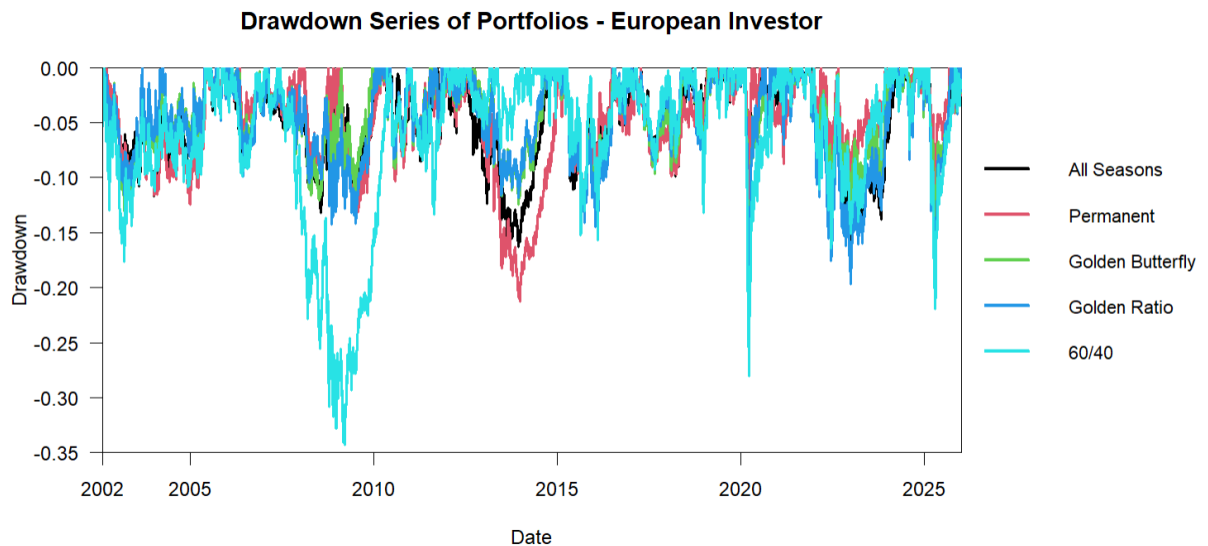


Figure 4. Drawdowns over the entire period for Eurozone investors



These figures report the evolution of portfolio drawdowns over the full sample period for US and Eurozone investors. They illustrate the depth, persistence, and frequency of drawdowns across portfolios under different currency perspectives.

10.4.1. Rolling MDD

Figure 5. Rolling MDD over a 3-Month window for US investors

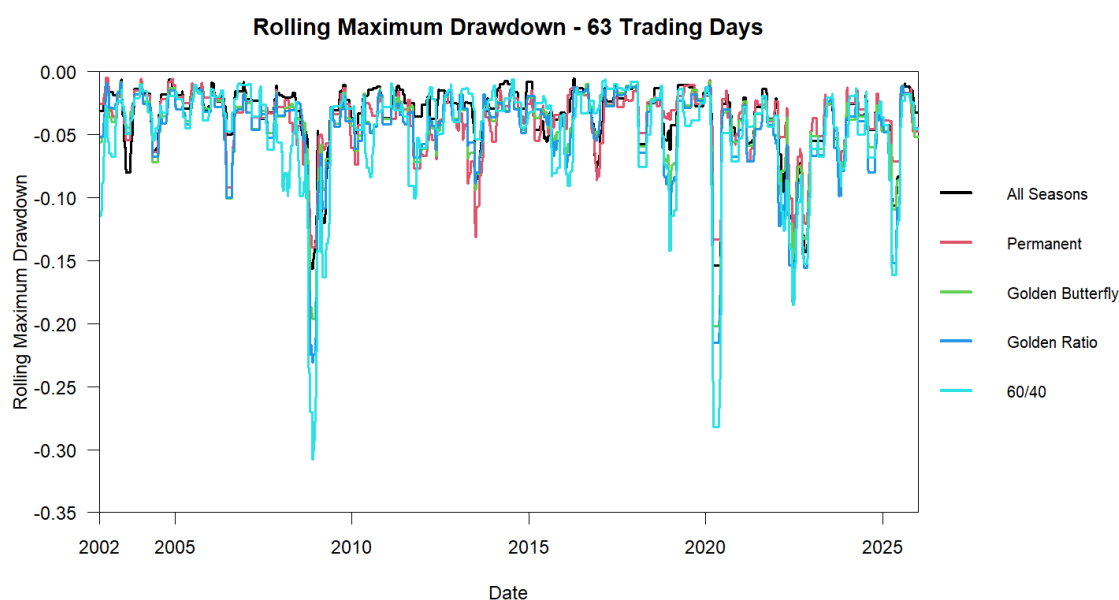
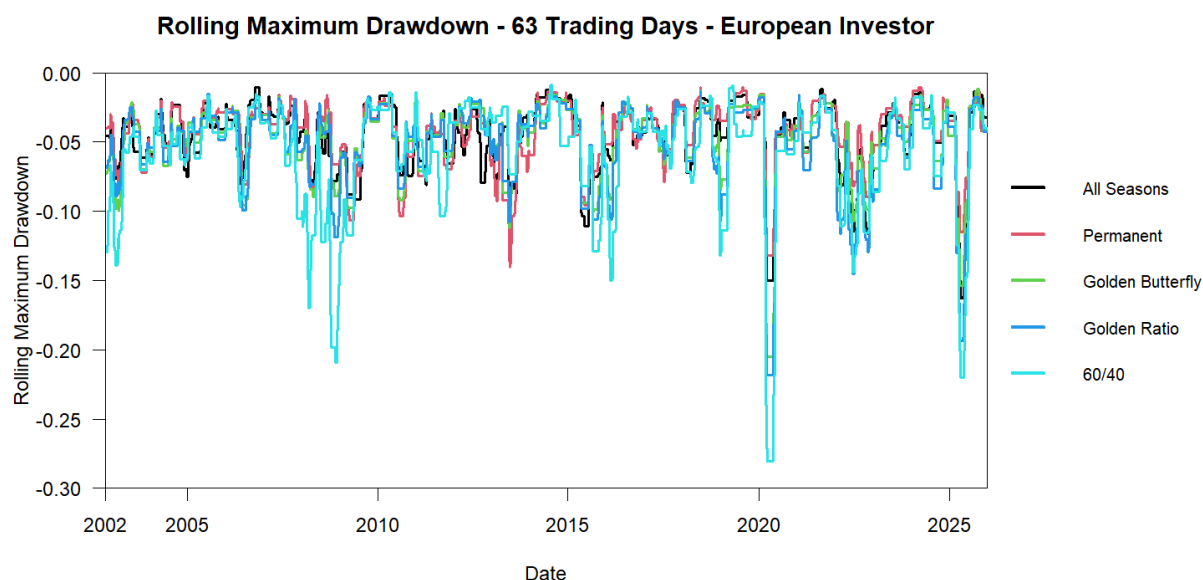


Figure 6. Rolling MDD over a 3-Month window for Eurozone investors



Those figures report 63-day rolling MDD for US and Eurozone investors over the full sample period. Major stress periods, particularly around 2008 and 2020, are clearly visible. Drawdowns appear slightly more persistent for Eurozone investors, although some of the most extreme drawdown episodes seem less severe in euro terms. Across both currencies, resilient portfolios generally continue to exhibit shallower drawdowns than the 60/40 benchmark.

Figure 7. Rolling MDD over a 6-month window for US investors

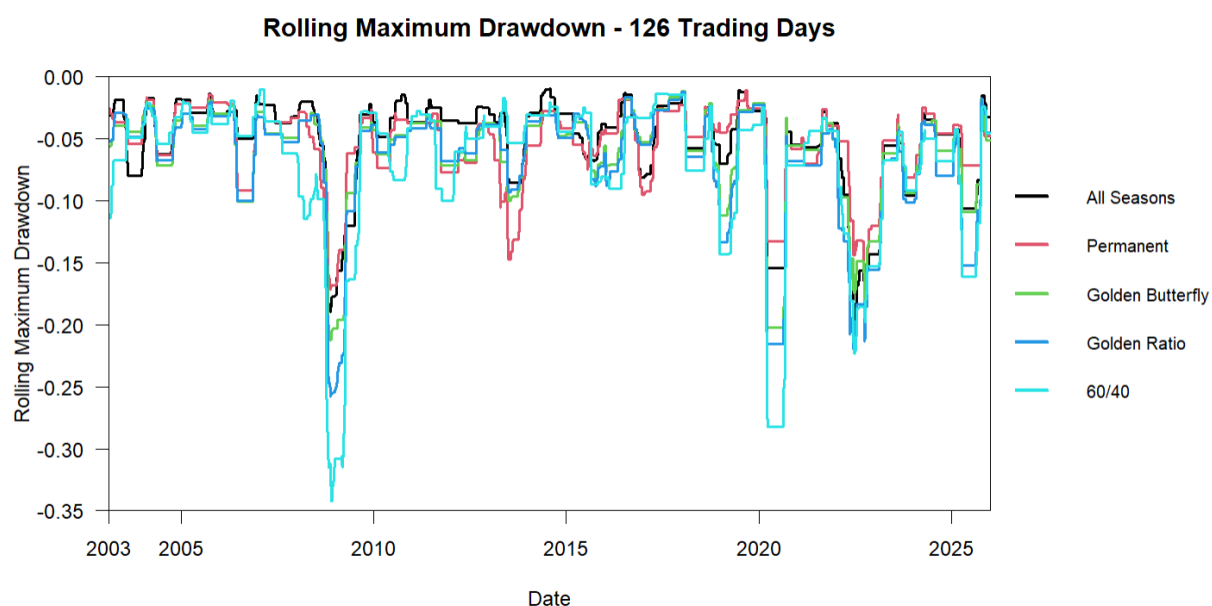
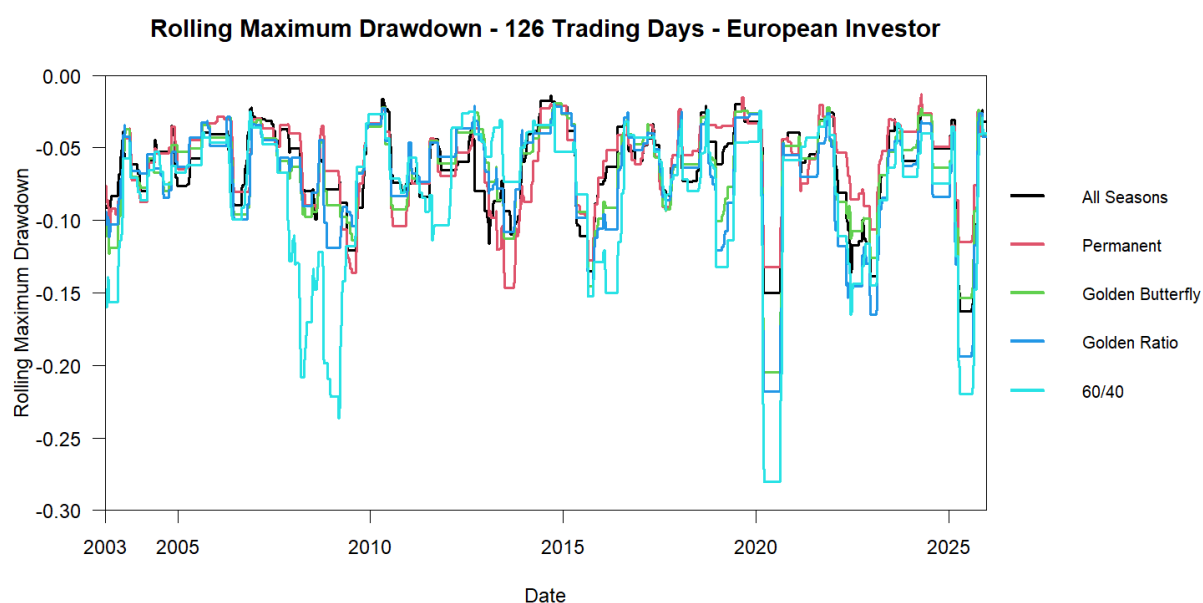


Figure 8. Rolling MDD over a 6-month window for Eurozone investors



These figures report 126-day rolling MDD for US and Eurozone investors over the full sample period. Major stress periods, particularly around 2008 and 2020, remain clearly identifiable. Compared to the 63-day window, drawdowns appear more persistent and smoother over time. Drawdowns also tend to appear slightly more persistent for Eurozone investors, although some of the most severe episodes appear less pronounced in euro terms. Across both currencies, resilient portfolios generally continue to exhibit shallower drawdowns than the 60/40.

Moving from a 63 to a 126-day rolling window places more emphasis on persistent market stress rather than short-term shocks. Drawdowns become smoother and longer lasting, which makes differences between portfolios easier to observe over time. Across both currency perspectives, the 60/40 portfolio generally continues to exhibit the deepest drawdowns, while resilient portfolios display more stable patterns. Differences between US and Eurozone investors also appear more progressive under the 126-day window.

Table 5. Rolling MDD over 3 and 6-months windows for US dollar and Euro perspectives

US dollar perspective					
3-Month window (63 trading days)					
Portfolio	Mean Rolling MDD	Median Rolling MDD	Worst Rolling MDD	SD Rolling MDD	Δ Mean with benchmark
All Seasons	-3.62%	-2.78%	-15.66%	2.89%	+1.36 pp.
Permanent	-3.95%	-3.30%	-13.97%	2.50%	+1.12 pp.
Golden Butterfly	-4.39%	-3.58%	-20.22%	3.13%	+0.59 pp.
Golden Ratio	-4.76%	-3.65%	-23.06%	3.67%	+0.23 pp.
60/40	-5.01%	-3.58%	-30.77%	4.56%	
6-month window (126 trading days)					
All Seasons	-5.27%	-3.76%	-19.94%	3.84%	+1.95 pp.
Permanent	-5.57%	-4.58%	-17.73%	3.25%	+1.59 pp.
Golden Butterfly	-6.21%	-4.93%	-21.28%	4.02%	+1.06 pp.
Golden Ratio	-6.82%	-5.30%	-25.77%	4.84%	+0.50 pp.
60/40	-7.26%	-4.99%	-34.22%	6.07%	
Euro perspective					
3-Month window (63 trading days)					
All Seasons	-4.56%	-3.88%	-16.29%	2.56%	+1.36 pp.
Permanent	-4.36%	-3.68%	-14.01%	2.34%	+1.56 pp.
Golden Butterfly	-4.85%	-4.20%	-20.47%	2.80%	+1.07 pp.
Golden Ratio	-5.16%	-4.26%	-21.80%	3.19%	+0.76 pp.
60/40	-5.92%	-4.61%	-28.01%	4.16%	
6-month window (126 trading days)					
All Seasons	-6.40%	-5.87%	-16.29%	3.16%	+1.90 pp.
Permanent	-6.07%	-5.34%	-14.63%	2.96%	+2.23 pp.
Golden Butterfly	-6.73%	-6.04%	-20.47%	3.48%	+1.57 pp.
Golden Ratio	-7.23%	-6.32%	-21.80%	4.03%	+1.07 pp.
60/40	-8.30%	-6.69%	-28.01%	5.34%	

This table reports rolling MDD statistics over 3 and 6-month windows for both US and Eurozone investors. Resilient portfolios generally exhibit lower mean and worst rolling drawdowns than the 60/40 benchmark. For example, under the 6-month US dollar window, the 60/40 portfolio reaches a worst rolling drawdown of -34.22%, compared with -19.94% for the All Seasons portfolio and -17.73% for the Permanent portfolio. Drawdowns also tend to be slightly more persistent for Eurozone investors, although the most extreme episodes sometimes appear less severe in euro terms. The relative ranking between portfolios nevertheless remains broadly unchanged across both currency perspectives.

These results are consistent with the graphical evidence presented previously. Shorter rolling windows mainly capture abrupt market shocks, while longer windows better reflect persistent stress periods and recovery dynamics. Overall, resilient portfolios continue to display more stable downside profiles than the benchmark for both US and Eurozone investors.

10.5. Appendix 5. Drawdown duration and recovery

Table 6. Drawdown duration and recovery across portfolios for US and Eurozone investors

Number of Drawdowns			
Portfolio	US	Euro	Δ (Euro - USD)
All Seasons	296	170	-126
Permanent	277	169	-108
Golden Butterfly	300	208	-92
Golden Ratio	313	210	-103
60/40	369	221	-148
Maximum Drawdowns			
All Seasons	-24.99%	-16.29%	+8.70 pp.
Permanent	-19.84%	-21.26%	-1.42 pp.
Golden Butterfly	-22.90%	-20.47%	+2.43 pp.
Golden Ratio	-27.43%	-21.80%	+5.63 pp.
60/40	-39.30%	-34.28%	+5.02 pp.
Longest Drawdowns (days)			
All Seasons	618	991	+373
Permanent	930	692	-238
Golden Butterfly	588	547	-41
Golden Ratio	626	724	+98
60/40	817	728	-89
Average Drawdown (days)			
All Seasons	17.56	32.34	+14.78
Permanent	19.02	32.59	+13.57
Golden Butterfly	17.46	26.23	+8.77
Golden Ratio	16.66	25.90	+9.24
60/40	13.67	24.21	+10.54
Longest Recovery (days)			
All Seasons	413	386	-27
Permanent	751	253	-498
Golden Butterfly	356	269	-87
Golden Ratio	393	294	-99
60/40	465	551	+86
Average Recovery (days)			
All Seasons	9.37	14.38	+5.01
Permanent	11.12	16.02	+4.90
Golden Butterfly	9.20	13.17	+3.97
Golden Ratio	9.01	12.88	+3.87
60/40	6.98	13.35	+6.37
Average Peak-to-Through Duration (days)			
All Seasons	8.18	17.89	+9.71
Permanent	7.89	16.49	+8.60
Golden Butterfly	8.25	13.01	+4.76
Golden Ratio	7.63	12.98	+5.35
60/40	6.68	10.87	+4.19

Table 6. summarizes drawdown and recovery characteristics across portfolios for US and Eurozone investors. It reports frequency, depth, and duration of drawdowns, together with recovery dynamics and peak-to-trough durations. Compared with US investors, Eurozone ones generally experience fewer but longer-lasting drawdowns and recovery periods. Across most measures, resilient portfolios continue to exhibit less severe downside profiles than the 60/40 benchmark.

Consistent with previous figures and rolling drawdown measures, 60/40 portfolio generally exhibits the deepest losses across both currency perspectives. Resilient portfolios tend to display more stable downside behavior, although some drawdown and recovery periods remain relatively persistent, particularly for Eurozone investors.

10.6. Appendix 6. Risk-adjusted performance

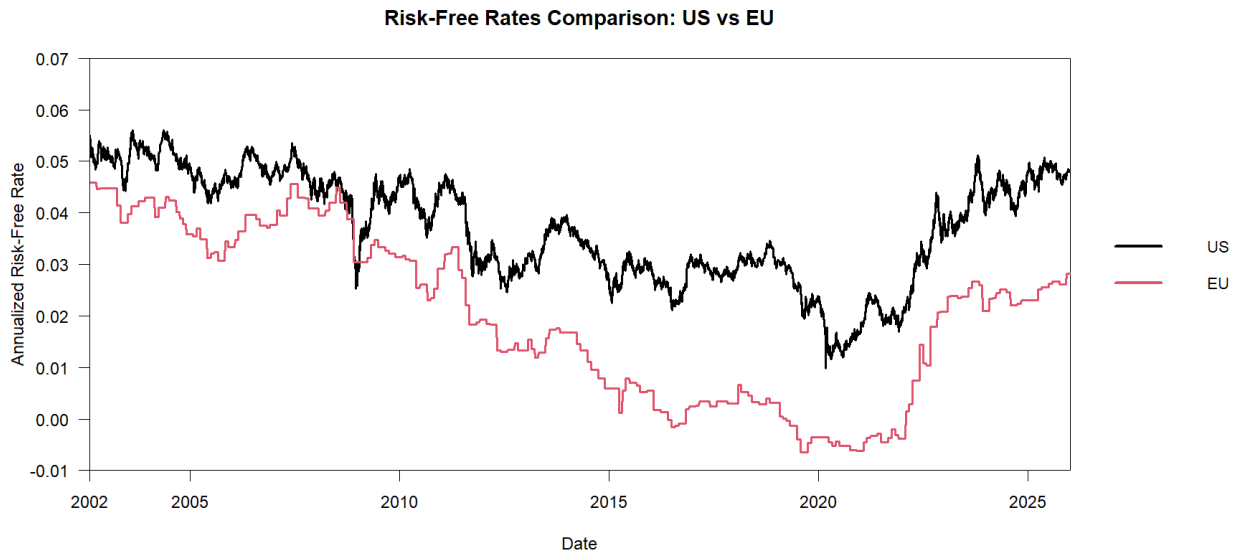
Table 7. Risk-adjusted performance across portfolios for US and Eurozone investors

Sharpe ratio			
Portfolio	US dollar perspective	Euro perspective	Δ (Euro - USD)
All Seasons	0.5089	0.4935	-0.0153
Permanent	0.5761	0.5854	+0.0093
Golden Butterfly	0.5361	0.5543	+0.0182
Golden Ratio	0.5428	0.5654	+0.0226
60/40	0.4667	0.4812	+0.0145
Sortino ratio			
All Seasons	1.351	0.967	-0.384
Permanent	1.392	1.116	-0.276
Golden Butterfly	1.257	1.027	-0.230
Golden Ratio	1.225	1.026	-0.200
60/40	1.063	0.870	-0.193
Calmar ratio			
All Seasons	0.3093	0.4262	+0.1169
Permanent	0.4411	0.3742	-0.0668
Golden Butterfly	0.3902	0.3976	+0.0074
Golden Ratio	0.3437	0.3957	+0.0520
60/40	0.2278	0.2379	+0.0101

This table reports the main risk-adjusted performance measures across portfolios for US and Eurozone investors. Sharpe ratios measure return relative to total volatility, Sortino ratios focus on downside risk, while Calmar ratios compare return with MDD. Overall, resilient portfolios generally display more stable risk-adjusted profiles than the benchmark across both currency perspectives. Differences between US and eurozone investors remain relatively moderate, although euro-based investors tend to exhibit slightly lower Sortino ratios and, in several cases, higher Calmar ratios.

10.7. Appendix 7. Risk-free rate comparison between the US and the Euro Area

Figure 9. Risk-free rate comparison between the US and the Euro Area



This figure illustrates the evolution of risk-free rates in the United States and the Euro Area over the sample period. Although both regions follow similar monetary cycles, US rates generally remain higher, while Euro Area rates become negative for several years after 2015. These differences may influence the level of risk-adjusted performance measures across currency perspectives.

10.8. Appendix 8. Portfolio extremes with dates

Table 8. Portfolio extremes with dates across portfolios for US and Eurozone investors

US perspective								
Portfolio	Worst Day Date	Worst Day (%)	Best Day Date	Best Day (%)	Worst Year	Worst Year (%)	Best Year	Best Year (%)
All Seasons	2020-03-18	-4.97	2025-04-09	5.64	2022	-20.29	2019	20.63
Permanent	2013-04-15	-4.47	2025-04-09	5.04	2022	-13.99	2025	34.16
Golden Butterfly	2020-03-12	-5.38	2025-04-09	5.79	2022	-16.02	2025	28.56
Golden Ratio	2020-03-12	-5.60	2025-04-09	7.57	2022	-21.85	2025	26.33
60/40	2020-03-16	-8.39	2025-04-09	7.77	2008	-26.40	2019	25.92
Euro perspective								
All Seasons	2015-12-03	-4.57	2025-04-09	4.41	2022	-15.67	2014	29.65
Permanent	2013-04-15	-4.39	2025-04-09	3.82	2013	-15.51	2024	27.76
Golden Butterfly	2020-03-16	-5.31	2008-11-13	4.83	2022	-11.15	2010	29.54
Golden Ratio	2020-03-16	-5.86	2025-04-09	6.33	2022	-17.32	2010	29.88
60/40	2020-03-16	-8.99	2025-04-09	6.52	2008	-22.78	2021	28.99

This table reports the main daily and yearly portfolio extremes across both US dollar and Eurozone investor perspectives, together with their corresponding dates. It highlights the magnitude and timing of extreme gains and losses rather than their duration.

10.9. Appendix 9. Worst-case drawdowns and recovery behavior across portfolios

Table 9. Worst drawdown episode and recovery behavior across portfolios for US and Eurozone investors

US dollar perspective							
Portfolio	Start Date	Trough Date	Recovery Date	Drawdown Depth	Peak-to-Trough (Days)	Recovery duration (Days)	Total Duration (Days)
All Seasons	2021-12-28	2022-10-20	2024-06-17	-24.99%	205	413	618
Permanent	2021-11-15	2022-10-20	2023-12-26	-19.84%	234	294	528
Golden Butterfly	2021-11-10	2022-10-14	2024-03-20	-22.90%	232	356	588
Golden Ratio	2021-11-09	2022-10-14	2024-05-13	-27.43%	233	393	626
60/40	2007-10-10	2009-03-09	2011-01-14	-39.30%	352	465	817
Average				-26.89%	251.20	384.20	635.40
Median				-24.99%	233	393	618
Euro perspective							
All Seasons	2025-02-11	2025-04-21	2025-10-07	-16.29%	48	117	165
Permanent	2012-07-26	2013-12-30	2015-01-05	-21.26%	355	253	608
Golden Butterfly	2020-02-21	2020-03-18	2020-11-13	-20.47%	19	166	185
Golden Ratio	2020-02-21	2020-03-18	2020-08-03	-21.80%	19	95	114
60/40	2007-06-18	2009-03-19	2010-05-14	-34.28%	439	289	728
Average				-22.82%	176	184	360
Median				-21.26%	48	166	185

This table focuses on the worst drawdown episode experienced by each portfolio and illustrates portfolio behavior under extreme market stress. While resilient portfolios generally limit the magnitude of extreme losses, they do not necessarily recover faster than the benchmark.

10.10. Appendix 10. S&P 500 bear market episodes

Table 10. Identification of bear market episodes

Bear Market Episode	Peak Date	Bear Market Trigger (-20%)	Market Bottom	Recovery Date	S&P 500 MDD
Subprime Crisis	09 Oct 2007	15 Jul 2008	09 Mar 2009	13 Sep 2012	-55.36%
COVID-19 pandemic	19 Feb 2020	12 Mar 2020	23 Mar 2020	06 Aug 2020	-34.16%
Inflation crisis	27 Dec 2021	13 Jun 2022	12 Oct 2022	18 Dec 2023	-25.68%

Table 11. Portfolio behavior during S&P 500 bear market episodes

US Investors					
Subprimes Crisis (2007-2012)					
Portfolio	Cumulative Return	Final Value 1 unit (\$ or €)	Annualized Volatility	Max Drawdown	Worst Day
All Seasons	42.74%	1.4274\$	8.76%	-18.99%	-2.28%
Permanent	63.95%	1.6395\$	11.10%	-18.57%	-3.35%
Golden Butterfly	51.59%	1.5159\$	11.88%	-21.55%	-4.23%
Golden Ratio	45.87%	1.4587\$	12.13%	-25.97%	-4.07%
60/40	16.08%	1.1608\$	14.75%	-39.30%	-5.87%
COVID-19 pandemic (2020)					
All Seasons	10.71%	1.1071\$	16.11%	-15.43%	-4.97%
Permanent	14.79%	1.1479\$	15.55%	-13.31%	-3.94%
Golden Butterfly	8.95%	1.0895\$	22.28%	-20.22%	-5.38%
Golden Ratio	11.47%	1.1147\$	23.98%	-21.53%	-5.60%
60/40	2.27%	1.0227\$	33.47%	-28.23%	-8.39%
Inflation crisis (2022-2023)					
All Seasons	-8.17%	0.9183\$	12.66%	-24.99%	-3.32%
Permanent	-0.84%	0.9916\$	11.12%	-19.80%	-3.07%
Golden Butterfly	-3.48%	0.9652\$	13.52%	-21.32%	-3.53%
Golden Ratio	-5.27%	0.9473\$	16.15%	-25.98%	-3.87%
60/40	-0.76%	0.9924\$	16.34%	-24.43%	-3.54%

Eurozone Investors					
Subprimes Crisis (2007-2012)					
All Seasons	56.47%	1.5647€	13.13%	-12.05%	-4.10%
Permanent Portfolio	79.72%	1.7972€	13.65%	-13.60%	-3.84%
Golden Butterfly	66.17%	1.6617€	13.98%	-11.37%	-4.09%
Golden Ratio	59.90%	1.5990€	13.84%	-12.91%	-4.07%
60/40	27.25%	1.2725€	17.05%	-32.54%	-6.53%
COVID-19 pandemic (2020)					
All Seasons	1.21%	1.0121€	15.77%	-14.97%	-3.76%
Permanent	4.94%	1.0494€	15.55%	-13.20%	-2.78%
Golden Butterfly	-0.40%	0.9960€	22.23%	-20.47%	-5.31%
Golden Ratio	1.91%	1.0191€	23.99%	-21.80%	-5.86%
60/40	-6.50%	0.9350€	33.56%	-28.01%	-8.99%
Inflation crisis (2022-2023)					
All Seasons	-4.81%	0.9519€	12.69%	-16.09%	-2.60%
Permanent	2.79%	1.0279€	11.19%	-10.63%	-2.28%
Golden Butterfly	0.05%	1.0005€	13.12%	-12.60%	-2.97%
Golden Ratio	-1.80%	0.9820€	15.48%	-18.57%	-3.43%
60/40	2.88%	1.0288€	16.01%	-16.47%	-3.90%

Table 10. identifies the main bear market episodes used in the analysis, namely the subprime, Covid-19, and the inflation crisis. *Table 11.* reports portfolio behavior during these periods for both US and Eurozone investors, including cumulative return, volatility, MDD, and worst daily performance. The results highlight that resilient portfolios generally experience less severe drawdowns and more stable downside behavior than the 60/40 benchmark during major stress episodes. Differences between US and Eurozone investors nevertheless remain visible, as exchange-rate fluctuations affect both the magnitude and persistence of losses across crises.

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Abstract

This thesis investigates whether resilient portfolios generate better downside protection and diversification capabilities than the traditional 60/40 portfolio across different macroeconomic environments. Four resilient portfolios are examined: All Seasons, Permanent, Golden Butterfly, and Golden Ratio. These allocations are compared with a 60/40 benchmark from July 2002 to December 2025 using daily data.

The analysis combines return performance, but downside risk and recovery dynamics. Several indicators are considered, such as volatility, maximum drawdowns, rolling drawdowns, recovery duration, correlations, and risk-adjusted performance measures. The study also compares results from both a US investor perspective and a Eurozone investor perspective in order to assess the impact of currency exposure on portfolio resilience.

The results indicates that resilient portfolios typically exhibit lower and more stable drawdowns than the 60/40 portfolio, especially under circumstances of market stress. Among all the portfolios studied, the Permanent portfolio emerges as the allocation providing the best downside protection, whereas the Golden Ratio portfolio achieves the highest long-term return at the cost of higher risk exposure. In addition, the findings imply that, in order to achieve proper diversification, one should not consider solely the average correlation, but also the stability of portfolio behavior during adverse market conditions.

Overall, the research presented in this thesis demonstrates the potential of resilient portfolios to act as viable long-term investment alternatives.