Navigating market turbulence: The power of minimum volatility strategies

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May 2025

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1. Introduction

2025 has been marked by heightened market volatility. The US stock markets declined by approximately 14% in March and April 2025 from their peak in February 2025, driven by concerns over the economic impact of US tariffs. In such uncertain environments, low-volatility stocks take center stage, offering investors a way to mitigate risk while remaining invested in the market. Moreover, as market turbulence intensifies, minimum volatility strategies (defined in more detail below) provide a defensive approach that helps cushion portfolios against sharp market declines without giving up much of the upside in bull markets.

The effectiveness of this protection can be seen from Table 1 below. This shows the annualized performance of the STOXX USA 900, the STOXX USA 900 Minimum Variance Unconstrained, and the STOXX USA 900 Minimum Variance portfolios. The figures were computed from the daily returns for the period between February 24, 2025, and April 18, 2025. The table reveals how the two STOXX USA 900 Minimum Variance portfolios reduced the annualized realized volatility and maximum drawdown of the STOXX USA 900 by about 50% during this period. The STOXX USA 900 Minimum Variance Unconstrained index also out-performed the STOXX USA 900 by 38.58% (annualized), with an impressive information ratio (IR) of 1.55 for the period.

Table 1: Annualized performance

	STOXX USA 900	STOXX USA 900 Minimum Variance Unconstrained	STOXX USA 900 Minimum Variance
Active return	0	38.58%	33.11%
Tracking error	-.	24.88%	21.41%
Information ratio	-	1.55	1.55
Return	–57.98%	–19.4%	–24.88%
Risk	39.24%	21.56%	23.69%
Sharpe ratio	–1.48	–0.9	–1.05
Maximum drawdown	–16.99%	–8.72%	–9.68%

Source: STOXX.

In this paper, we demonstrate that minimum volatility strategies do an excellent job of reducing the down-side risk during crisis periods in equity markets across different regions. This aligns with Warren Buffett's famous maxim that the first rule of investing is "Never lose money" and the second rule is "Never forget rule no. 1" – an approach that emphasizes the importance of capital preservation and risk management.

Minimum volatility (also known as minimum variance) strategies are designed to build portfolios with the lowest possible risk, as measured by the standard deviation of the portfolio returns, while ensuring proper diversification and tradability by using targeted country and sector exposure, liquidity, and turnover constraints in the portfolio model. These strategies are based on the low volatility anomaly – the well-documented phenomenon in which lower-risk stocks deliver higher risk-adjusted returns over the long

term than their higher-risk counterparts. This challenges traditional finance theories such as the capital asset pricing model (CAPM), which suggests that higher risk should be rewarded with higher returns. Academic literature suggests the following two explanations for the low volatility anomaly:

1) Leverage aversion (Black, 1972) (Frazzini & Pedersen, 2014): Investors such as asset owners and pension funds are not permitted to short stocks and are also required to be leverage-constrained. Therefore, they choose to increase their expected return by increasing the allocation to high-beta stocks, thereby driving up the latter's price.

2) Investors overpay for high-flying, risky stocks with lottery-like payoffs, where risk is either measured by low beta as provided by a minimum variance portfolio (Clarke, de Silva, & Thorley, Minimum-Variance Portfolios in the U.S. Equity Market, 2006) and (Blitz, 2007) or by low idiosyncratic volatility (Ang, Xing, & Zhang, 2006), (Ang, Xing, & Zhang, 2009).

Recent surveys of low volatility as a smart beta factor appear in (van Vliet & de Koning, 2017) and (Alquist, Frazzini, A. Ilmanen, & Pedersen, 2020).

The key element in a global minimum volatility strategy is a parsimonious factor risk model such as the Axioma World-Wide factor risk model that forecasts risk for equities listed on the global market.

A cross-sectional regression model of the form

$r = Bf + \epsilon$

is run every day where r is the vector of asset returns, f is the vector of factor returns, and ϵ is the vector of asset specific returns. The universe for the cross-sectional regression is the world market including large, medium, and small cap stocks covering more than 99% of the available market-cap. It is assumed that the various components of ϵ are uncorrelated with the components of f and with each other. Moreover, B is the asset by factor exposure matrix whose elements denote each asset's exposure or sensitivity to a particular factor.

The factors in the global model include:

- Market factor that captures the return of a global market portfolio such as the <u>STOXX World AC All-Cap</u> index.
- Style factors that encapsulate the financial characteristics of an asset like a company's size, debt levels, and liquidity. These characteristics are computed from a mixture of market and fundamental (i.e., balance sheet) data.
- Industry factors that reflect a company's line of business.
- Country factors associated with the risk of doing business with a particular country.
- Currency factors that capture the exchange rates across different global currencies including USD and EUR.

A factor risk model $Q = (B \, \Omega B^T + \Delta^2)$ is then estimated from the cross-sectional regression model that is run every day where:

B = Exposure matrix, its elements denote each asset's exposure to a particular factor
Ω = Factor covariance matrix that is estimated from the covariance of the factor returns
Δ^2 = Specific variance matrix that is estimated from the variance of the asset specific returns

Key characteristics of minimum volatility strategies are as follows:

- **Minimum portfolio risk –** The portfolio is designed to have the lowest possible ex ante volatility as provided by a parsimonious factor risk model from a vendor such as Axioma. The objective function can be written as:

  Minimize: $w^T (B \, \Omega B^T + \Delta^2) \, w$

  where:
  w = Index weights
  B = Exposure matrix, its elements denote each asset's exposure to a particular factor
  Ω = Factor covariance matrix from Axioma Risk Model
  Δ^2 = Specific variance matrix from Axioma Risk Model

- **Emphasis on low beta stocks –** Stocks with lower sensitivity to market movements are overweighted in the portfolio. This is because the market factor is the major source of systematic risk for a well-diversified portfolio.

- **Accounting for asset correlations –** The strategy accounts for correlations among assets to deliver the portfolio with the lowest ex ante risk.

- **Risk premia and diversification –** Minimum volatility portfolios tilt on smart beta factors such as low beta and low idiosyncratic volatility with proven risk premia. In addition, minimum volatility portfolios with their low beta have a high tracking error (TE) to market cap benchmarks, providing a diversification benefit for other smart beta portfolios (such as Quality) that track the benchmark closely.

- **Downside protection in crisis periods –** Minimum volatility portfolios are defensive portfolios that out-perform during periods of heightened volatility. Examples of the latter are the dot-com crisis in early 2000, the global financial crisis in 2008–2009, the COVID-19 shock in 2020–2021, and the inflationary crisis of 2023, in which central banks across the world sharply increased interest rates at the same time.

- **Improved realized Sharpe ratio –** Minimum volatility portfolios outperform a market-weighted bench-mark in bear markets while slightly underperforming the benchmark in bull markets, thus producing better realized Sharpe ratios (the realized return per unit of realized risk) over a holding period of 10 years or more.

STOXX offers two ways to implement low volatility strategies, including the following:

1. **Minimum Volatility/Variance portfolio:** This strategy involves constructing a portfolio that minimizes the ex ante volatility provided by the parsimonious Axioma regional factor risk model.

2. **Low Volatility portfolio:** In this case, a portfolio is constructed that offers the lowest factor exposures to the market sensitivity and idiosyncratic volatility factors in the Axioma risk model.[1]

The first approach minimizes portfolio volatility by considering both individual volatilities and correlations and is considered more effective in reducing total portfolio risk. The second approach does not require a sophisticated risk model but rather focuses on an expected return that does not consider correlations between stocks. We will focus solely on minimum volatility portfolios in this paper.

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[1] The Axioma Market Sensitivity asset exposure is the market coefficient obtained by regressing the historic time-series of an asset's return against the market return and an intercept term. The Axioma Volatility factor gives a measure of the asset's idiosyncratic volatility. It is calculated as the square root of the 125-day average of the asset's absolute return divided by the cross-sectional volatility of the market. This score is then regressed cross-sectionally against the market sensitivity factor and the cross-sectional volatility score is the residual from this regression.

Recent literature on minimum volatility portfolios indicates that:

• They are not sufficiently diversified (Clarke, de Silva, & Thorley, Minimum-Variance Portfolio Composition, 2011).
• They are heavily concentrated on small and less actively traded names (Siu, 2015).

Section 2 shows how the STOXX Minimum Variance portfolios incorporate diversification and tradability constraints in the portfolio model to address these two shortcomings.

STOXX offers the following unconstrained minimum volatility indices across different regions:

• STOXX USA 900 Minimum Variance Unconstrained
• STOXX Global 1800 Minimum Variance Unconstrained
• STOXX Europe 600 Minimum Variance Unconstrained
• STOXX North America 600 Minimum Variance Unconstrained
• EURO STOXX Minimum Variance Unconstrained
• STOXX Canada 240 Minimum Variance Unconstrained
• STOXX Japan 600 Minimum Variance Unconstrained
• STOXX Asia/Pacific 600 Minimum Variance Unconstrained
• STOXX Global 1800 ex USA Minimum Variance Unconstrained
• STOXX Global 1800 ex Japan Minimum Variance Unconstrained
• STOXX Global 1800 ex Australia Minimum Variance Unconstrained
• STOXX Australia 150 Minimum Variance Unconstrained
• STOXX China 900 Minimum Variance Unconstrained
• STOXX China 900 Minimum Variance Unconstrained AM

In addition, STOXX offers the following constrained minimum volatility indices across different regions:

• STOXX USA 900 Minimum Variance
• STOXX Global 1800 Minimum Variance
• STOXX Europe 600 Minimum Variance
• STOXX North America 600 Minimum Variance
• EURO STOXX Minimum Variance
• STOXX Canada 240 Minimum Variance
• STOXX Japan 600 Minimum Variance
• STOXX Asia/Pacific 600 Minimum Variance
• STOXX Global 1800 ex USA Minimum Variance
• STOXX Global 1800 ex Japan Minimum Variance
• STOXX Global 1800 ex Australia Minimum Variance
• STOXX Australia 150 Minimum Variance
• STOXX China 900 Minimum Variance
• STOXX Emerging Markets 800 LO Minimum Variance

The constrained minimum volatility portfolios are constructed by adding the following supplementary constraints to the unconstrained Minimum Variance portfolio model:

• Sector and country active exposure constraints are designed to promote diversification and to ensure that the Minimum Variance portfolio tracks the benchmark.
• Non-volatility style active exposure constraints are designed to ensure that the Minimum Variance portfolio does not take unintended Value, Momentum, Quality, and Small Size tilts.

The remainder of this paper is structured as follows:

Section 2: STOXX Minimum Variance indices offers a dive into the construction of the unconstrained and constrained STOXX Minimum Variance indices, including a detailed description of the various constraints in the portfolio model.

Section 3: Long-term outperformance presents the historical performance of the STOXX Global 1800 Minimum Variance Unconstrained and Constrained indices from January 2004 to March 2025, demonstrating that they deliver portfolios with lower volatility than the STOXX Global 1800 without reducing performance. The STOXX Global 1800 Minimum Variance portfolio also outperforms the STOXX Global 1800 by 1.57% (annualized) over this period. Similar results are found across other regions such as the STOXX USA 900 and the STOXX Europe 600.

Section 4: Comparing unconstrained and constrained strategies contrasts the unconstrained and the constrained Minimum Variance strategies by comparing their performance and exposures over a shorter period (May 2012 – March 2025) that does not include the GFC of 2008–2009.

Section 5: Performance attribution adds transparency to the sophisticated quantitative portfolio construction process by using factor-based performance attribution to show that the improved realized performance of the STOXX Global 1800 Minimum Variance portfolio comes from its low exposure to the Market Sensitivity and Volatility factors in the model.

Section 6: Conclusions offers a summary of this paper's key contributions.

2. STOXX Minimum Variance indices

The STOXX Minimum Variance indices use the constituents of the STOXX market capitalization-weighted benchmark indices, including the STOXX Global 1800 index and regional and country indices. They are constructed using the Axioma Portfolio Optimizer, the objective being to minimize the ex ante risk as given by the Axioma regional factor model. The table below compares the constraints applied to the STOXX Minimum Variance Unconstrained and Constrained indices, which are available for different regions. The unconstrained version has fewer constraints, whereas the "regular" version applies industry, country, and factor constraints to ensure that the resulting Minimum Variance portfolio does not deviate excessively from the parent benchmark.[2]

The Minimum Variance Unconstrained index is rebalanced monthly, while the regular index is rebalanced quarterly on the 3rd Friday in March, June, September, and December.

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[2] The unconstrained Minimum Variance portfolio can result in concentrated portfolios with sector and country biases due to estimation errors in the covariance matrix used in portfolio construction. The additional constraints regularize the Minimum Variance model to correct for these biases and concentration risk.

Table 2: Comparing the Unconstrained and Constrained Minimum Variance models

Constraint	Minimum Variance Unconstrained	Minimum Variance
Individual capping	4.5% / 8% / 35%, minimum 3 bps	4.5% / 8% / 35%, minimum 3 bps
Effective number of assets	30% of parent benchmark	30% of parent benchmark
Rebalancing and maximum turnover	Monthly, 5%	Quarterly, 7.5%
Liquidity requirement	Weighted average days-to-trade	Weighted average days-to-trade
Country/industry exposure	None	Within 5% of parent benchmark
Factor exposure (except Size/Volatility)	None	Within 0.25 std dev of parent benchmark

Source: STOXX.

Individual capping: A component cannot have a weight of more than 8%, and the sum of all components with individual weights of at least 4.5% cannot exceed 35%. These constraints ensure that the portfolio satisfies the UCITS (5%/10%/40%) requirement.

Lower bound on the effective number of assets in the portfolio: The effective number of assets for an index ("effective names") is the reciprocal of the Herfindahl index, and is defined as:

$$H = \frac{1}{\sum w^2}$$

The effective names constraint in the model prescribes that the effective names of the Minimum Variance portfolio should contain at least 30% of the effective names of the parent benchmark, i.e.,

$$H_{MinVar} \geq H_{Base} \times 30\%$$

This constraint ensures that the Minimum Variance portfolio is sufficiently diversified and alleviates the concentration issues articulated in (Clarke, de Silva, & Thorley, Minimum-Variance Portfolio Composition, 2011).

Maximum turnover: The unconstrained version has a 5% one-way or 10% two-way turnover constraint. This means that up to 5% of the portfolio is sold to purchase other components in each review, and the annualized turnover is 120%. The regular version has a 7.5% one-way or 15% two-way constraint, and the annualized turnover is 60%.

Minimum liquidity requirement: The minimum liquidity requirement recognizes that Minimum Variance portfolios may sometimes prefer to hold slightly less liquid stocks and ensures that there is no material buildup in illiquid positions in individual segments of the portfolio. The weighted average days-to-trade d_s for a given group of holdings S is defined as:

$$d_s = \sum_{i \in S} w_i \times \frac{h_i}{ADV_i}$$

where $h_i = w_i \times N$ represents the holdings for stock I, b_i represents the weights in the corresponding capitalization-weighted benchmark index, and ADV_i represents its 20-day average daily trading volume.

Stocks in the benchmark index are ranked by trading volume, and liquidity constraints are imposed on the stocks in the two least liquid quintiles. The weighted average days-to-trade (WDTT) of the positions contained in each quintile Q may not be more than 10 times the weighted average days-to-trade of the same stocks held at corresponding benchmark weights, and this can be written as:

$$\sum_{i \in Q} w_i \times \frac{w_i \times N}{ADV_i} \leq \gamma \times \sum_{i \in Q} b_i \times \frac{b_i \times N}{ADV_i}$$

where N is the portfolio notional value. An important feature of the minimum liquidity constraint is that the portfolio reference size can be factored out from both sides of equation, making this constraint independent of the portfolio notional size. Moreover, the WDTT constraint is imposed only on the two least liquid quintiles to prevent mixing stocks with different liquidity profiles.

The parameter γ is set to 10.

This version of the minimum liquidity constraint was first presented in (Siu, 2015) and ensures that the final Minimum Variance portfolio is tradeable by controlling the average days-to-trade for the portfolio to be within a certain fraction of the average days-to-trade of the liquid parent index.

Country, industry, and factor exposure: These constraints are not applied to the unconstrained version of the index. For the constrained version, the total exposure to each country and industry is calculated for the parent benchmark index, and the percentage exposure of the Minimum Variance index must be within 5% of this number. The parent index's exposure to each factor is computed and the Minimum Variance index is constrained to be within one-quarter of a standard deviation of that figure. These constraints ensure that the Minimum Variance index is closely tracking the parent index.

For our analysis, we selected the STOXX Global 1800 Minimum Variance indices for two distinct periods. The first runs from January 2004 to March 2025, providing a long-term perspective that includes the 2008 global financial crisis, one of the most severe recessions in modern history. The second period, starting in May 2012, captures the longest bull market in modern history, allowing us to assess the performance of minimum volatility strategies during extended market expansions.

3. Long-term outperformance

Our analysis demonstrates that minimum volatility strategies consistently reduce risk while maintaining competitive returns over the long run and across regions. By examining data for the period from January 2004 to March 2025, we can assess their effectiveness across different market environments, including periods of extreme drawdowns (such as during the global financial crisis) and extended bull markets.

The findings highlight that the STOXX Global 1800 Minimum Variance indices have significantly lower total portfolio risk and drawdowns compared to the STOXX Global 1800. The table below shows the annualized risk and return metrics for the STOXX Global 1800 Minimum Variance Constrained and Unconstrained indices, illustrating the superior Sharpe ratios for the two strategies that are about 1.5 times the Sharpe ratio for the benchmark index.

**Table 3: Annualized performance of the STOXX Global 1800 Minimum Variance portfolios**

	STOXX Global 1800	STOXX Global 1800 Minimum Variance	STOXX Global 1800 Minimum Variance Unconstrained
Active return	–	1.57%	−0.19%
Active risk	–	8.52%	11.02%
Return	8.34%	9.91%	8.15%
Risk	15.77%	11.77%	10.38%
Sharpe ratio	0.53	0.84	0.79
Maximum drawdown	−58.23%	−43.46%	−31.89%

Source: STOXX.

The reduction in risk is evident across both strategies, with the Minimum Variance Unconstrained index strategy achieving the lowest annualized volatility of 10.38% compared to 15.77% for the benchmark. Also, both Minimum Variance indices exhibit lower drawdowns than the benchmark. The constrained version exhibits a higher annualized active return of 1.57% and a better risk-adjusted performance, with a higher Sharpe ratio of 0.84.

The outperformance generated by the STOXX Global 1800 Minimum Variance index relative to the benchmark is revealed in the two exhibits below, with Figure 1 showing how USD 100 invested in the three indices in December 2003 has grown until March 2025 and Figure 2 showing the cumulative active returns over the same period.

Figure 1: Index levels
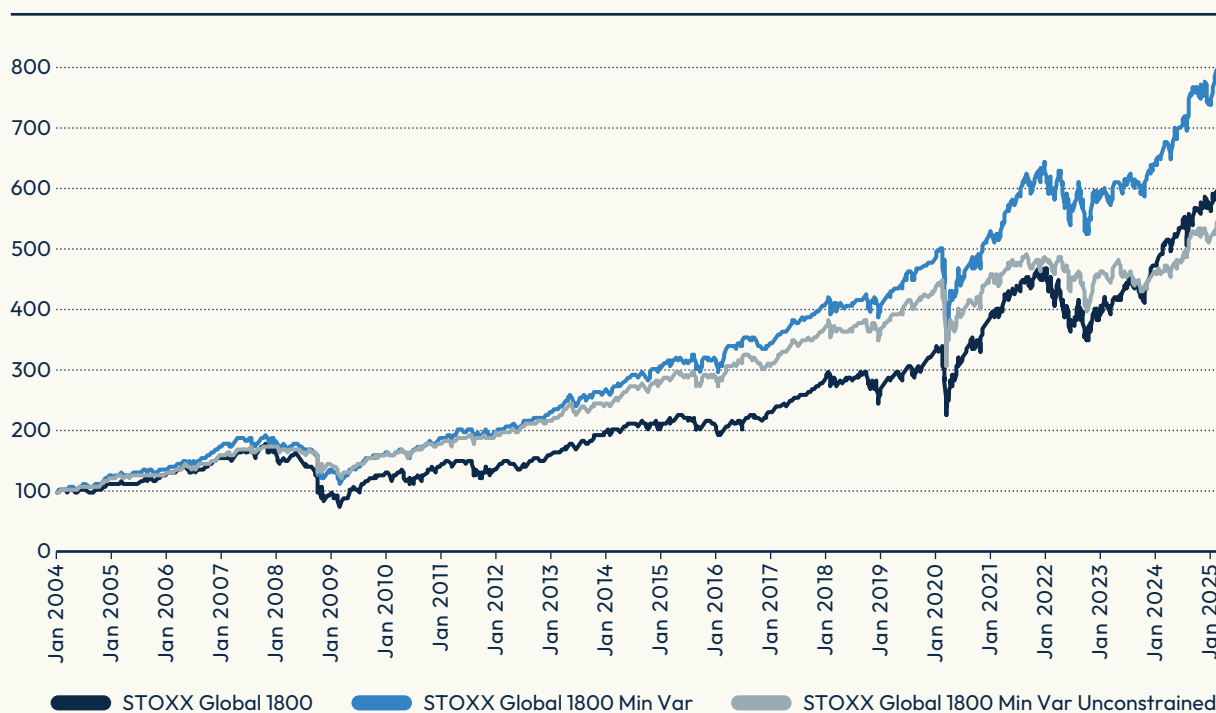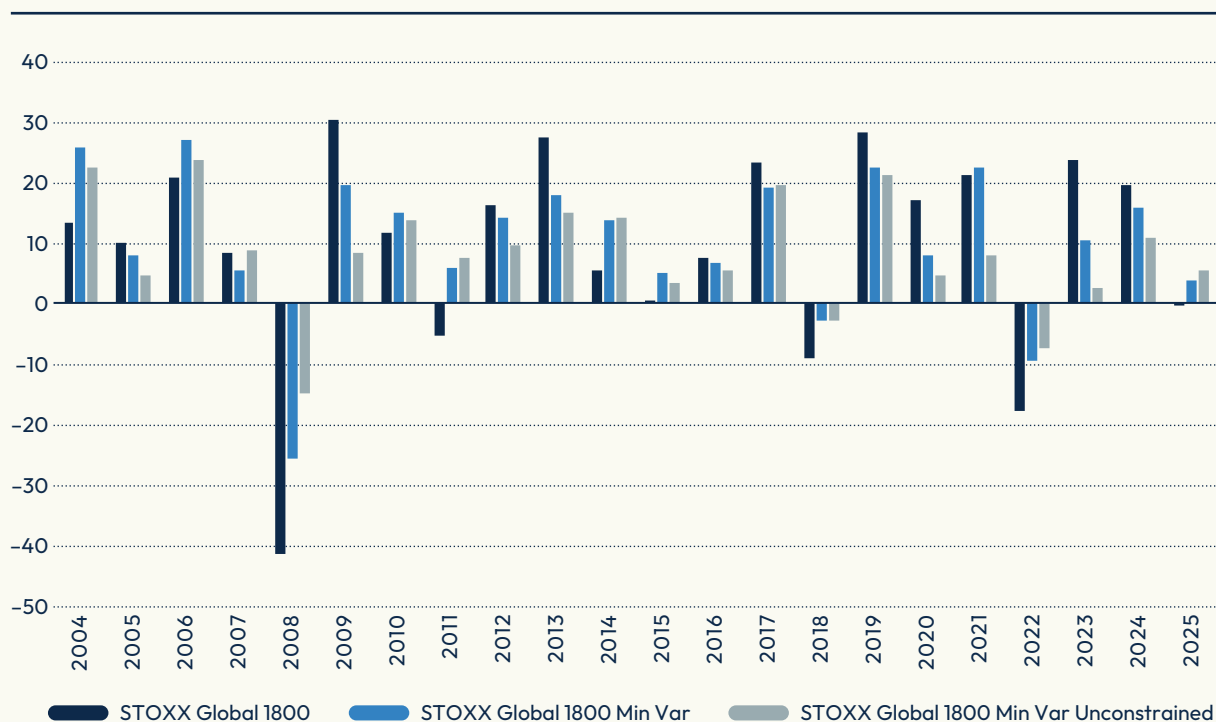

Source: STOXX.

Figure 2: Cumulative active return
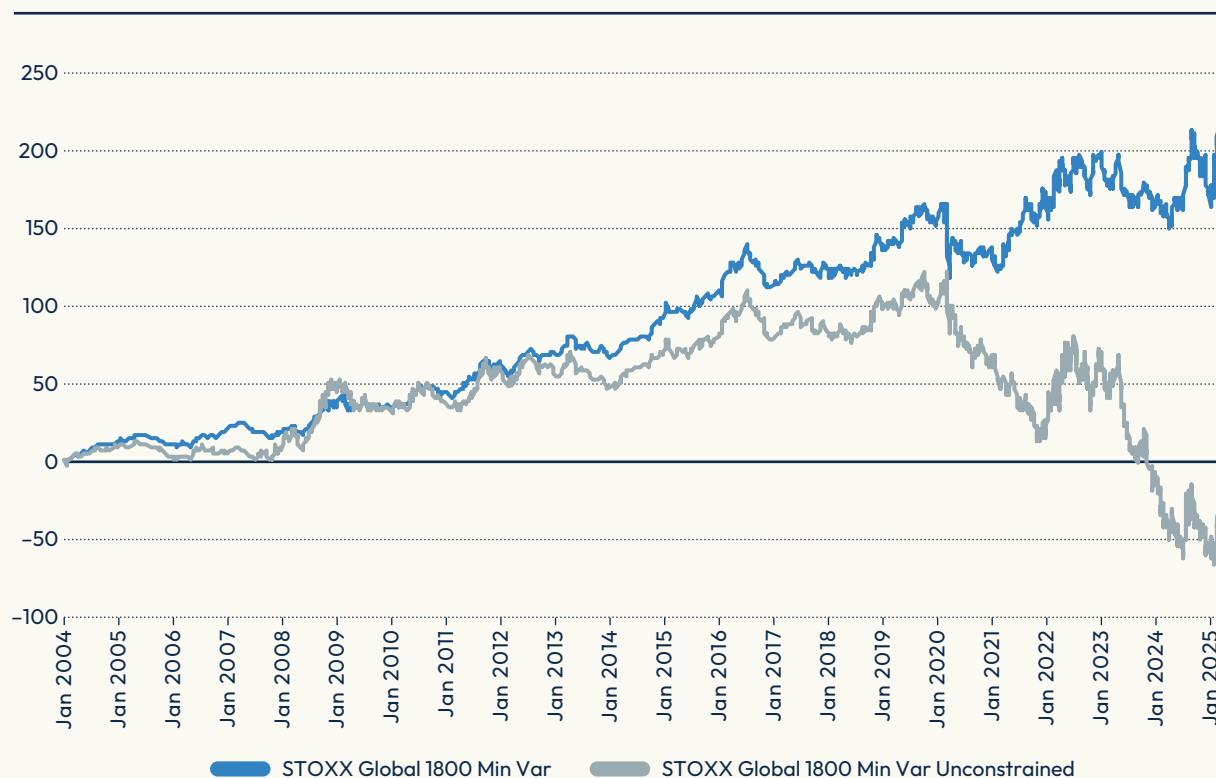
Source: STOXX.

Minimum volatility strategies tend to outperform during periods of market turmoil, as is illustrated in Figure 3 on page 12. This shows outperformance during periods of high volatility such as the 2008 global financial crisis, the 2010–2011 European debt crisis, the 2018 market downturn driven by inflation fears and rising interest rates, the 2022 bear market triggered by aggressive central bank rate hikes and the 2025 volatility spike following the announcement of US import tariffs. These periods highlight the defensive nature of minimum volatility strategies, which help cushion losses when markets experience heightened uncertainty.

Figure 3: Annual performance

Legend: STOXX Global 1800 | STOXX Global 1800 Min Var | STOXX Global 1800 Min Var Unconstrained

Source: STOXX.

Notably, the STOXX Global 1800 Minimum Variance Unconstrained index delivered a 6-month annualized return of 5.7%, outperforming both the benchmark and the Minimum Variance Constrained index.

The outperformance generated by the Minimum Variance indices is also evident when analyzing individual regions, such as those represented by the STOXX USA 900 and STOXX Europe 600. See Tables 4 and 5 below for more details. The STOXX USA 900 Minimum Variance Constrained index delivered an annualized active return of 0.57%, while the unconstrained version underperformed with −0.46%. In contrast, the STOXX Minimum Variance Europe 600 showed stronger returns, with the constrained version returning 0.64% and the unconstrained version significantly outperforming at 2.52%.

Table 4: Annualized Performance of STOXX USA 900 Minimum Variance Indices (June 2002 to March 2025)

	STOXX USA 900	STOXX USA 900 Minimum Variance	STOXX USA 900 Minimum Variance Unconstrained
Active return	–	0.57%	−0.46%
Active risk	–	7.82%	10.70%
Return	9.89%	10.46%	9.44%
Risk	19.05%	14.67%	12.90%
Sharpe ratio	0.52	0.71	0.73
Maximum drawdown	−55.18%	−45.21%	−36.86%

Source: STOXX.

Table 5: Annualized Performance of STOXX Europe 600 Minimum Variance Indices (June 2002 to March 2025)

	STOXX Europe 600	STOXX Europe 600 Minimum Variance	STOXX Europe 600 Minimum Variance Unconstrained
Active return	-	0.64%	2.52%
Active risk	-	7.67%	10.89%
Return	6.68%	7.32%	9.20%
Risk	18.38%	13.34%	11.02%
Sharpe ratio	0.36	0.55	0.83
Maximum drawdown	−58.37%	−50.10%	−37.13%

Source: STOXX.

Both the Minimum Variance Constrained and Unconstrained indices deliver higher Sharpe ratios, lower risk, and smaller drawdowns across different regions than their respective benchmarks, underscoring their effectiveness in reducing volatility while maintaining competitive returns. The results presented above show that low volatility strategies tend to thrive during periods of heightened market uncertainty. In recent months, the indices have consistently outperformed their high volatility counterparts, further demonstrating their resilience and defensive characteristics in turbulent market conditions.

4. Comparing unconstrained and constrained Minimum Variance strategies

A lot of the outperformance of the STOXX Global 1800 Minimum Variance indices was concentrated in 2008 with the benchmark losing 40% and the unconstrained index only 14%. We conduct a second analysis over a shorter period (May 2012 to March 2025) to see how these indices performed in a period that does not include the global financial crisis of 2008-2009.

The performance is summarized in Table 6. Both Minimum Variance indices underperform the parent index during this period but have a much lower realized volatility. The STOXX Global Minimum Variance strategy outperforms the parent on the Sharpe ratio: 1.02 versus 0.82 for the parent. On the other hand, the unconstrained Minimum Variance strategy has the lowest realized volatility: 9.71% versus 13.90% for the parent index.

Figure 4 shows how USD 100 invested in the two Minimum Variances and the parent index on May 21, 2012, grows until March 20, 2015.

Table 6: Annualized Performance of STOXX Global 1800 Minimum Variance Indices (May 2012 to March 2025)

	STOXX Global 1800	STOXX Global 1800 Minimum Variance Unconstrained	STOXX Global 1800 Minimum Variance
Active return	–	−3.36%	−0.73%
Active risk	–	8.83%	6.67%
IR	–	−0.38	−0.11
Return	11.37%	8.01%	10.63%
Risk	13.90%	9.71%	10.43%
Sharpe ratio	0.82	0.82	1.02
Maximum drawdown	−33.76%	−31.51%	−31.95%

Source: STOXX.

Figure 4: Annual performance (May 2012 to March 2025)
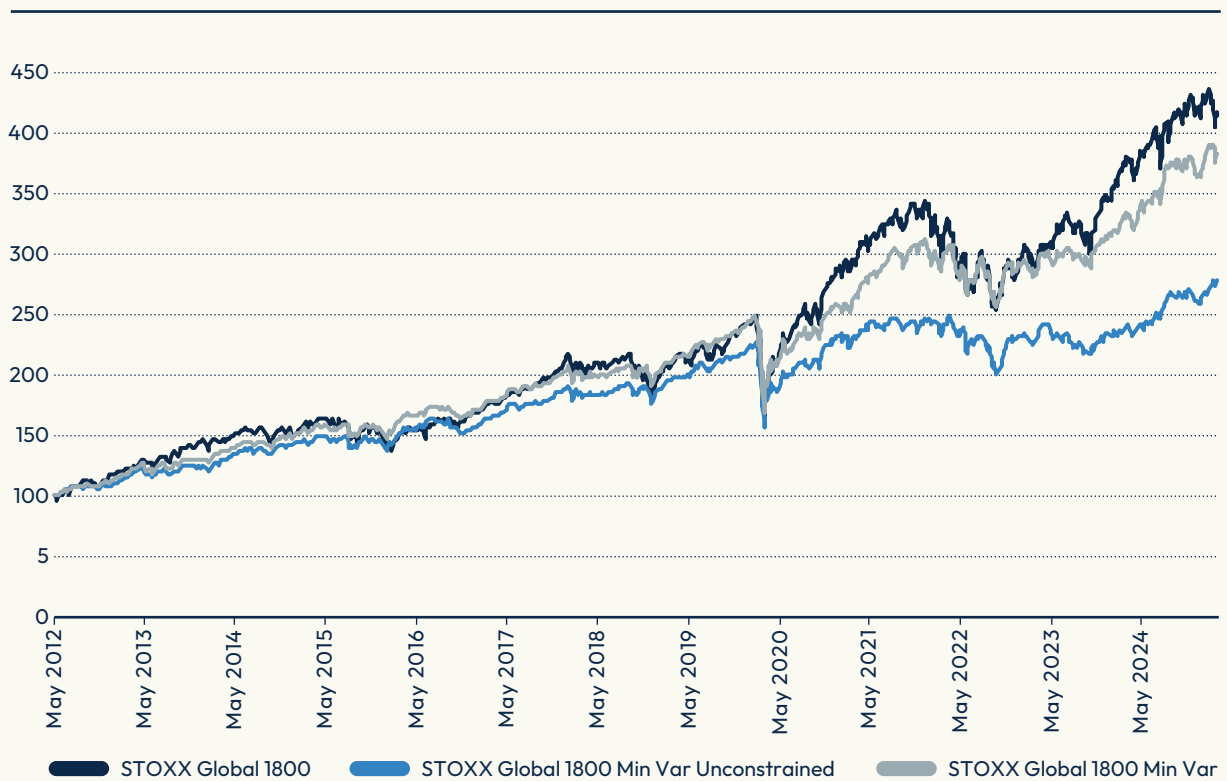
Source: STOXX.

The STOXX Global 1800 Minimum Variance Unconstrained is a purer Minimum Variance index as it has fewer constraints. Figure 5 shows the daily stacked ex ante TE for the two STOXX Global 1800 Minimum Variance indices superimposed with the ex ante risk of the STOXX Global 1800 index. The unconstrained Minimum Variance index sharply deviates from the parent index in periods of markets stress. The ex ante TE for the unconstrained Minimum Variance portfolio is greater than that for the constrained portfolio, and the difference in the two TEs increases when the ex ante risk, as seen by the Axioma risk model, also increases.

Figure 6 shows the average daily active style exposures for the two Minimum Variance indices. The unconstrained index has larger negative exposures to Market Sensitivity, Volatility, and Size. In addition, the unconstrained index also takes a significant positive active exposure to the Dividend Yield factor that is double the active exposure of the unconstrained portfolio.

Figure 7 shows the average daily active sector exposures for the two Minimum Variance indices. The unconstrained Minimum Variance index takes larger active exposures on defensive sectors such as Consumer Staples and Utilities while taking a much larger negative exposure to emerging sectors such as Information Technology and cyclical sectors such as Industrials and Financials.

The unconstrained portfolio is well suited for volatility reduction but the resulting portfolio can under-perform the benchmark sharply in bull markets. The constrained Minimum Variance portfolio reduces the benchmark volatility while also tracking it closely in bull markets.

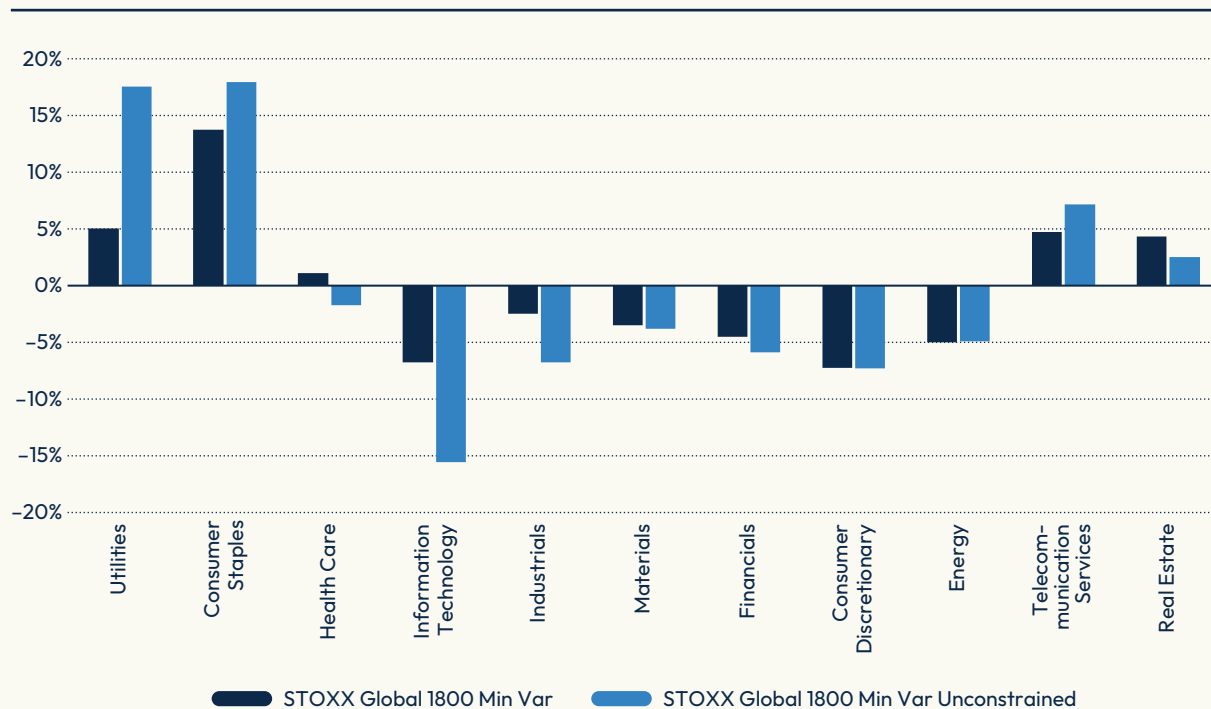**Figure 5: Ex ante TE for unconstrained and constrained indices**

Legend: STOXX Global 1800 Min Var | STOXX Global 1800 Min Var Unconstrained | STOXX Global Ex Ante Risk
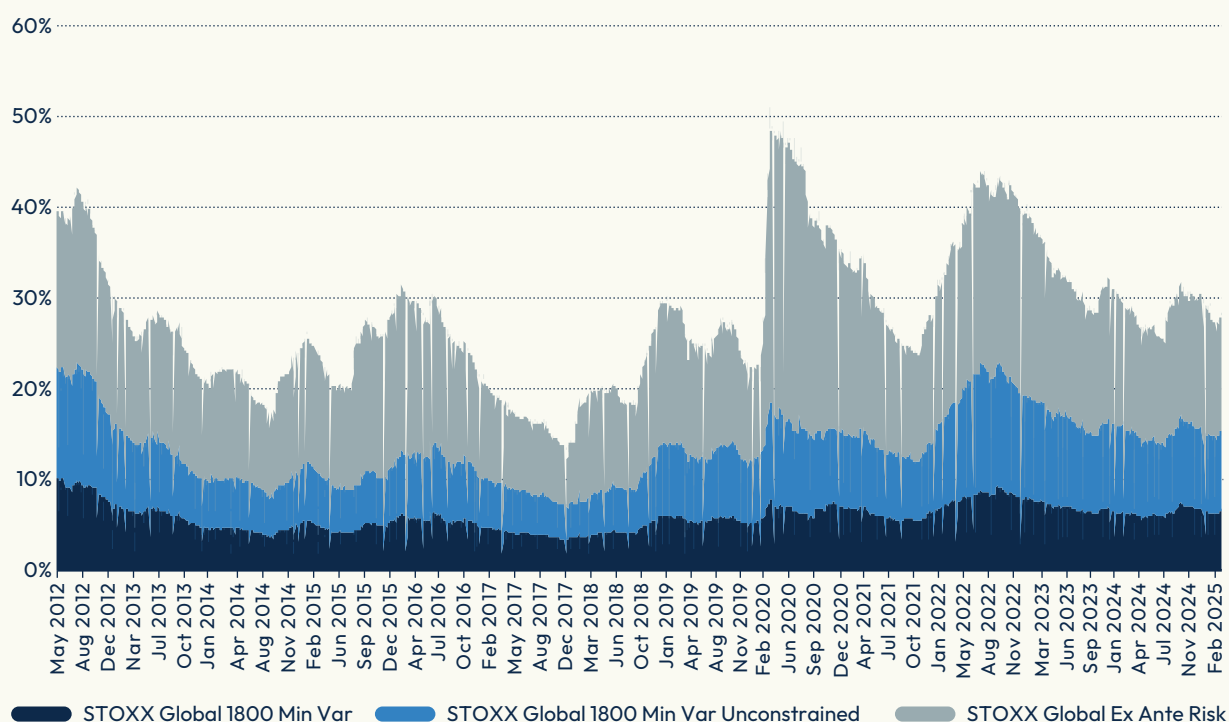
Source: STOXX.

Figure 6: Active style exposures for the unconstrained and constrained indices
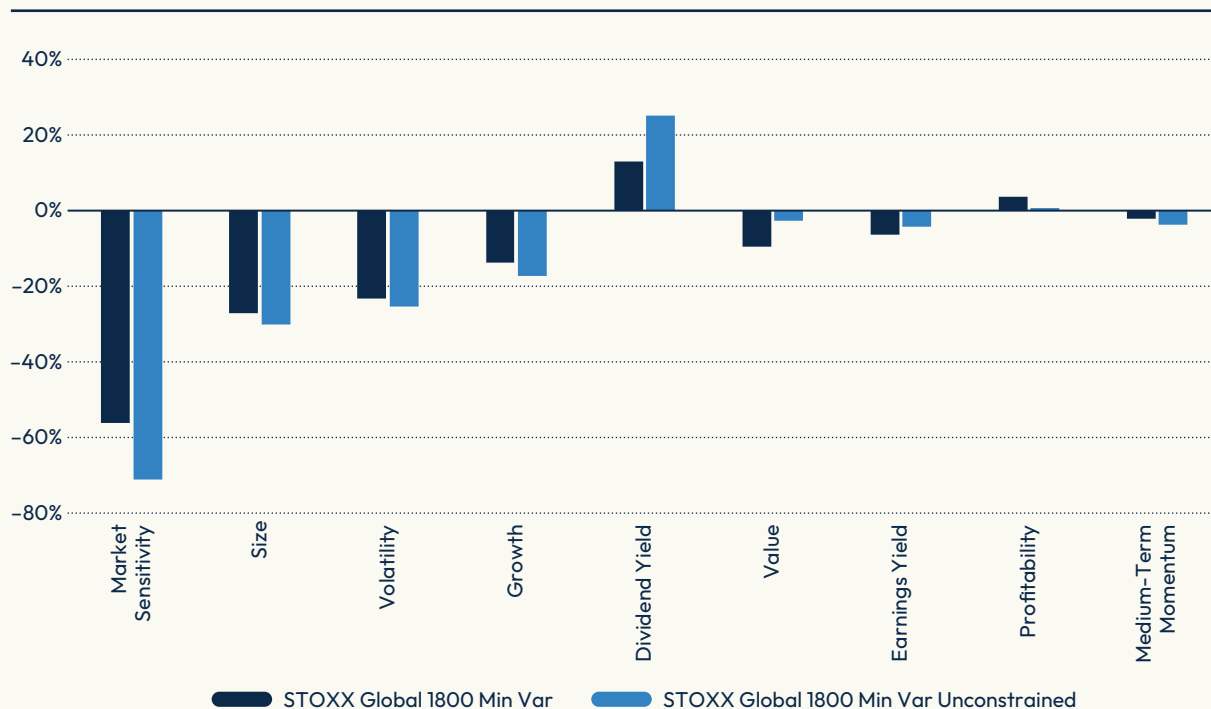
Source: STOXX.

Figure 7: Active sector exposures for the unconstrained and constrained indices

Source: STOXX.

5. Performance attribution – Drivers of performance

A second analysis was conducted over a shorter period (May 2012 to March 2025) to see how the STOXX Global 1800 Minimum Variance index performed outside of the global financial crisis. The table below presents the results of a factor-based performance attribution that was run daily for the period between May 21, 2012, and March 20, 2025, using the Axioma World-Wide 4 Medium Horizon risk model.

The factor-based performance attribution decomposes the realized active return of the STOXX Global 1800 Minimum Variance index over that of the STOXX Global 1800 parent into a portion that can be explained by the factors in the Axioma WW4MH model (the "factor contribution") and the remaining portion, known as the "specific contribution". This decomposition of the active return is given in Table 7 below and can also be seen pictorially in Figure 8.

Table 7: Factor performance attribution for the STOXX Global 1800 Minimum Variance Index with the Axioma WW4MH model

| Source of return	Contribution	Average exposure	Risk	IR	T-Stat
Portfolio	10.63%	-	10.43%	-	-
Benchmark	11.39%	-	13.90%	-	-
Active	−0.76%	-	6.67%	−0.11	−0.41
Specific return	−0.64%	-	2.97%	−0.21	−0.78
Factor contribution	−0.12%	-	5.52%	−0.02	−0.08
Style	0.69%	-	3.86%	0.18	0.66
Dividend Yield	0.00%	12.94%	0.14%	0.03	0.11
Earnings Yield	−0.02%	−6.33%	0.10%	−0.18	−0.66
Growth	−0.05%	−13.83%	0.18%	−0.28	−1.01
Market Sensitivity	−0.01%	−56.27%	2.56%	0.00	−0.01
Momentum	−0.18%	−2.19%	0.42%	−0.43	−1.55
Profitability	0.08%	3.65%	0.09%	0.89	3.24
Size	0.14%	−27.18%	1.08%	0.13	0.47
Value	−0.23%	−9.57%	0.15%	−1.56	−5.67
Volatility	0.98%	−23.21%	1.18%	0.83	3.00
Country	−0.34%	−0.56%	1.78%	−0.19	−0.69
Industry	−0.45%	−0.56%	1.76%	−0.25	−0.93
Currency	−0.01%	−0.17%	0.86%	−0.01	−0.04

Source: STOXX.

During this period, the STOXX Global 1800 Minimum Variance index delivered a Sharpe ratio of 1.02 (higher than the benchmark's 0.82), highlighting its superior risk-adjusted returns. The annualized active return was −76 bps, with the underperformance being attributable to the specific active return. Conversely, style factors made a positive contribution of 69 bps, reinforcing the role of the low volatility risk premium in shaping the index's performance.

The active return decomposition reveals that the main drag on performance comes from the specific active return (−0.64%). Specifically, the volatile "Magnificent Seven" stocks (Apple, Amazon, Meta, Microsoft, NVIDIA, and Tesla, which are underweighted in the Minimum Variance index portfolios) were among the stocks contributing to the negative active specific return.

In addition, the factor return contribution (−0.12%) has been broken down into style, country, industry, and currency contributions in the attribution.

- The Minimum Volatility portfolio primarily loads up on three style factors: Low Market Sensitivity (−56.27%), Low Idiosyncratic Volatility (-23.21%) and Small Size (-27.18%). There is also a positive active exposure to Dividend Yield. Style factors (+0.69%) contributed positively to the active return, with 98 bps coming from a negative tilt of 23.21% to the Volatility (idiosyncratic volatility) factor. The t-stat of 3 indicates that this contribution is statistically significant. The large low beta tilt of −56.27% to the Market Sensitivity factor, on the other hand, does not bring any additional return. There is also a 14 bps contribution from the Small Size tilt of −27.18% . Finally, small negative tilts to the Axioma Medium-Term Momentum and Value factors results in 41 bps of underperformance. Figure 9 shows the decomposition of the style return across the different style factors in the Axioma WW4MH model.

- The industry active return contribution is −45 bps, with the underperformance coming from an over-weighting of defensive sectors (Consumer Staples, Utilities and Materials). These sectors exhibit stable earnings in various economic conditions and are also resilient to downturns in the market, making them attractive to minimum volatility portfolios. However, in stable times, they underperform the market, unlike cyclical or emerging sectors such as Information Technology, Telecommunications, and Consumer Discretionary.

- The country active return contribution is −34 bps, with the underperformance coming from an over-weighting of less volatile countries such as Japan.

**Figure 8: Common factor contributions**
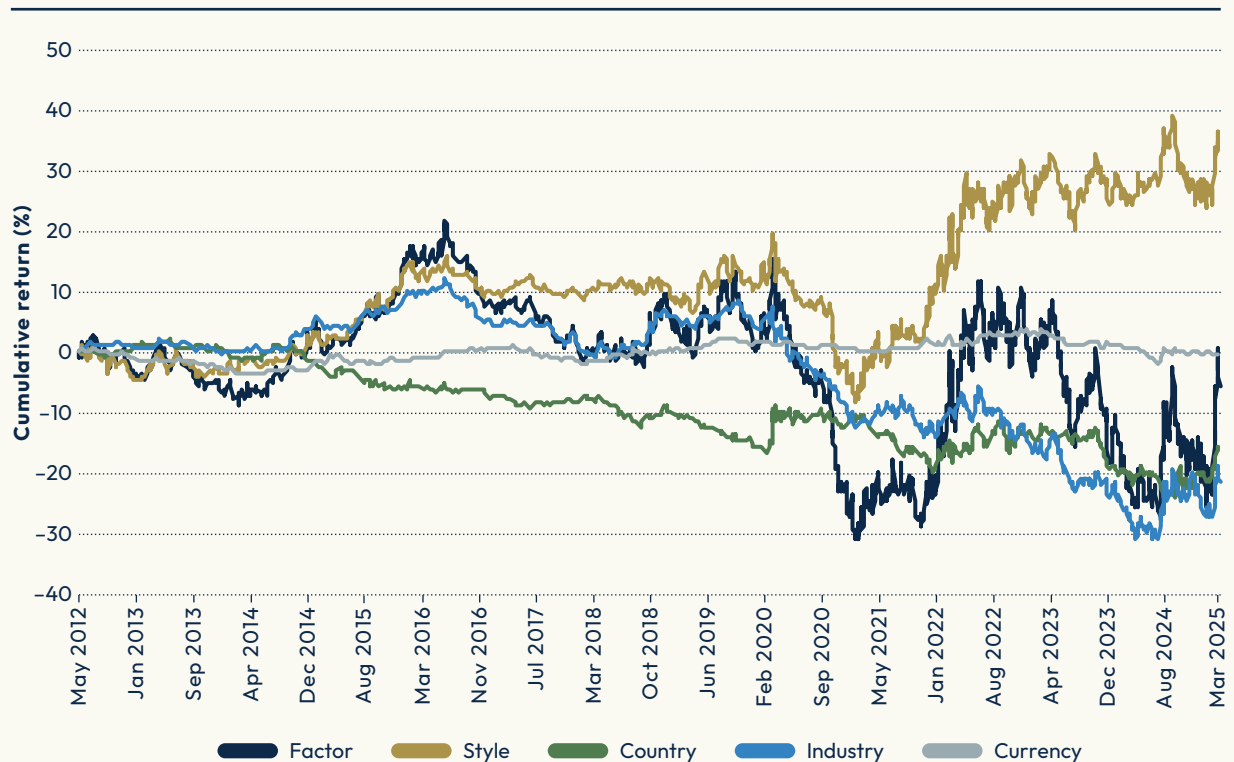
Source: STOXX.

Figure 9: Style contributions
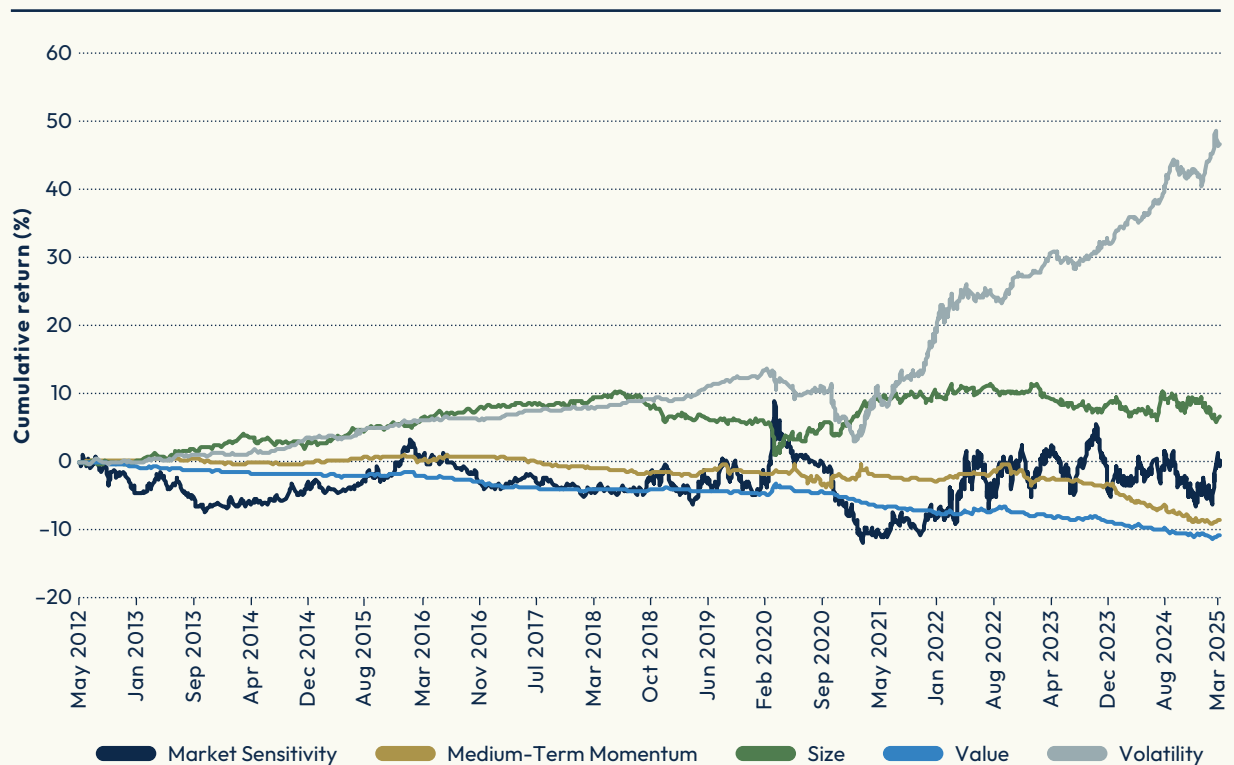
Source: STOXX.

Figure 10 shows the cumulative return contributions attributable to sectors. Energy, Industrials and Materials are the three sectors with the highest return contribution. In contrast, Information Technology, Real Estate and Telecommunication Services were the sectors with the highest negative contributions.

Figure 10: Sector contributions
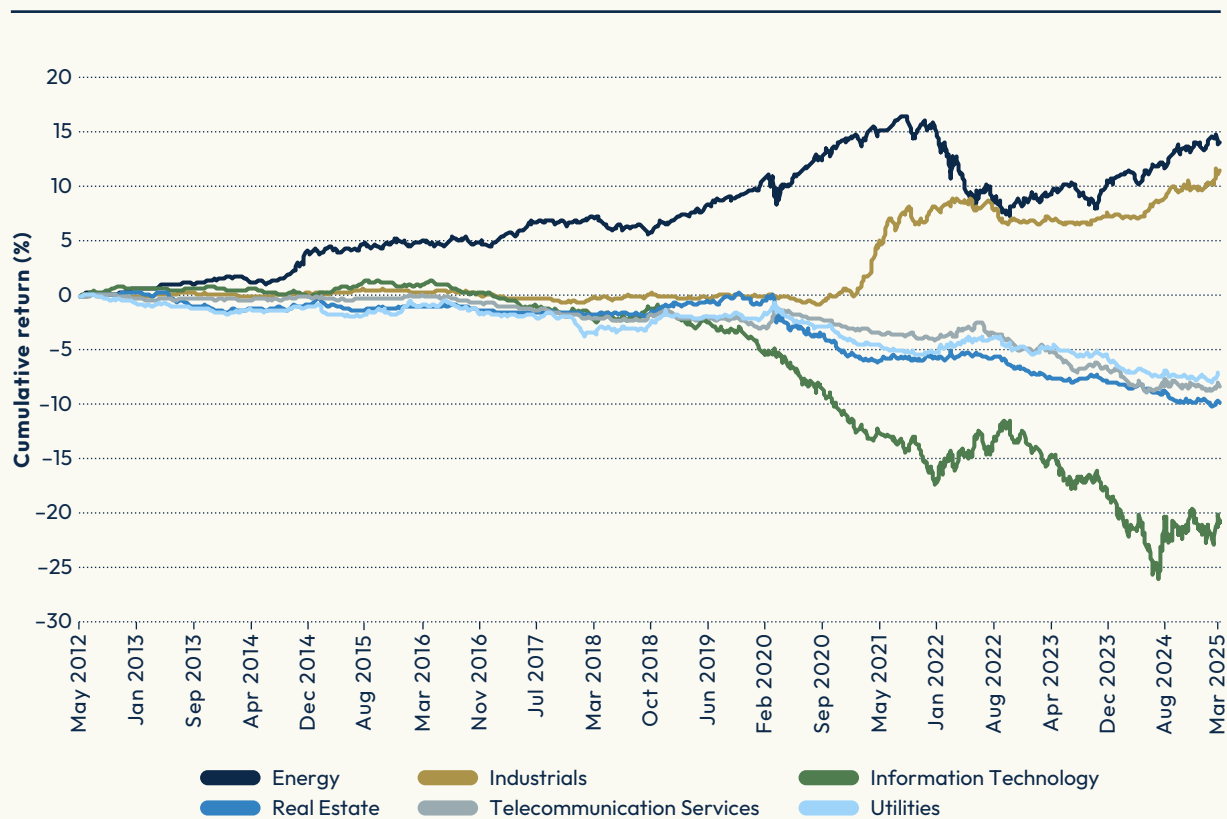
Source: STOXX.

6. Conclusions

Minimum volatility strategies offer superior risk-adjusted returns with lower drawdowns for long-term investors. They were an attractive option in periods of heightened volatility such as the global financial crisis of 2008–2009 and remain so in the conditions we are experiencing today. A rough rule of thumb is that over a 10-year period or longer, the minimum volatility portfolio delivers the return of parent benchmark with two-thirds the benchmark volatility giving a Sharpe ratio that is 1.5 times that of the benchmark. The findings of this analysis reaffirm the role of minimum volatility strategies as a powerful defensive tool in portfolio management.

The empirical evidence shows that:

- The STOXX Global 1800, STOXX USA 900, and STOXX Europe 600 Minimum Variance Index have outperformed their benchmarks in terms of risk-adjusted returns, delivering a higher Sharpe ratio and lower drawdowns.

- The constrained minimum volatility strategy provided superior long-term performance compared to the unconstrained version, benefiting from sector, country, and factor constraints that improved diversification.

- Low-volatility stocks tend to outperform high-volatility stocks in turbulent markets, as has been seen during major crises such as the global financial crisis (2008), the European debt crisis (2010–2011), the market downturn of 2018, the bear market of 2022, and the tariff-driven volatility of 2025.

- Factor attribution analysis for the period between May 2012 and March 2025 highlights that the negative tilt to the idiosyncratic volatility (Axioma Volatility) factor was the primary driver of outperformance.

- Sector contributions show that defensive sectors such as Consumer Staples, Utilities, and Telecommunication Services provided stability, whereas reduced exposure to cyclical sectors such as Information Technology and Real Estate, that have outperformed in recent years, contributed negatively to performance.

The ability of minimum volatility indices to protect against major drawdowns and deliver stable returns underscores their importance in a well-diversified investment strategy. As uncertainty remains a key theme in financial markets, minimum volatility investing continues to be an essential approach for risk-conscious investors seeking downside protection without sacrificing returns.

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