SOCIETE GENERALE
Cross Asset Research

Quant Outlook

The 2026 playbook for the systematic investor

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With thanks to **Layla Berraho** for her contributions to this report.

■ Diversification is central to the systematic strategy story. We want to generate returns that are less correlated to market beta, we want to find hedges that do not simply cancel out our returns, and we want to exploit market inefficiencies where we find them.

■ We think a diversified approach is important amid a market environment in which most major equity indices are at all-time highs, asset volatilities are compressed, strong profit growth is forecast globally, and more interest rate cuts are expected from the Fed and other central banks. However, there are concerns lurking in the background – the AI story may disappoint, equity benchmarks are too concentrated, equity valuations are high, governments face rising interest repayment burdens, and geopolitics is unpredictable.

■ This Quant Outlook includes our 2026 playbook, and much of our thinking as we start the year begins with diversification, for which we have introduced new measures in the form of portfolio and investment universe dimensionality. Many of the strategies we like (FX & Commodity Carry, Rates Slope Trend, ML Mean-Reversion) have strong diversification benefits.

■ We primarily need returns of course and see a variety of ways to exploit concentrated and bullish markets. Systematic stock picking, using traditional and machine learning models, is one way. In volatility markets, selling upside volatility on the S&P 500 provides a unique return profile. And we continue to monetise anxiety by selling gap risk where and when we see the greatest opportunities: in FX mainly on the yen, and in US equities when they start to price downside concerns a little more aggressively.

■ Hedging remains important as always – there are too many unknowns for investors to be truly comfortable. The 'AI bubble or not?' story will rumble on in 2026, when the burden of proof will be higher than in 2025 and when there is a long list of private AI companies waiting to go public, diluting already listed technology companies. This could cause a dispersed, unruly sell-off in stock markets. We discuss ways to hedge this theme without simply hedging the market itself.

■ Rates volatility declined significantly in 2025, very much in line with the broader rates market – gently declining yields and stable curves. However, rates volatilities, especially at the longer end, remain reactive to news flow that could cause a rates re-pricing. We find value in hedging with strategies that buy long-dated rates volatility.

■ A significant equity sell-off, given high valuations and the extremely concentrated nature of the market, is a notable concern. However, how this decline occurs, if it does, is difficult to predict. Consequently, we refresh our analysis of tail hedges. We also discuss the idea of fixed leverage short-dated puts to hedge a slow sell-off. And we continue to like dynamic VIX futures-based strategies to hedge a highly volatile but ultimately limited market decline, like the one in March-April last year.

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Executive summary

After a strong 2025, investors appear in a positive mood despite all the ongoing macro and policy noise. There is precious little talk of recession, and consensus expects very strong and broad profit growth this year, coupled with more interest rate cuts. This positive outlook is reflected in low levels of implied volatility across asset classes, compressed credit spreads, and most equity indices at all-time highs. So, the starting point for 2026 in many ways could not be more positive.

Yet equity valuations are extended, governments are overspending and, probably most importantly, equity markets are highly concentrated and too reliant on the continued success of one theme (AI). Consequently, the benchmark 60/40 portfolio allocation has become poorly diversified. As many discovered in 2025, having too much exposure to the US was also problematic, and with the yen continuing to weaken and Japanese government bond yields rising fast, there is plenty to concern us across markets in 2026.

Diversification is at the core of our thinking about systematic investment strategies. We want to find alternative sources of return that complement the 60/40 allocation and cost-effective hedges that target areas where we have the most concern and provide protection when the unexpected comes along. Many of our strategy choices for 2026 are driven by their diversification benefit to a traditional portfolio mix of equity, bonds and credit, which we show in the table below.

In September 2025, we introduced a measure of portfolio diversification called Effective Portfolio Dimensionality. In this Outlook, we extend the idea of independent dimensions of risk to the investment universe, allowing us to assess the diversification (dimensionality) benefit of adding any number of strategies to any universe. In the table below, we look at the benefit of adding each of our strategies in turn to a traditional universe, as we discuss later in the Outlook.

Ranking strategies by diversification benefit to a traditional equity and bond universe. The diversification benefit for a strategy is always between 0 and 1, reflecting whether it is able to add up to a full dimension of independent risk (1) or none (0)

Strategy	Diversification benefit	Carry/Hedge/Comparator	Ticker
Rates Slope Trend	0.99	Hedge	SGIXRSTE
Commodity Carry	0.97	Carry	SGIXV57E
Commodity Value	0.96	Carry	SGICCOVA
Multi-Asset Trend	0.96	Hedge	SGMDXATL
Equity ML Mean Reversion	0.95	Carry	SGEPMRWU
FX Value	0.93	Hedge	SGIX3FVE
Synthetic Down Var EUR	0.92	Hedge	SGIXTRSE
Downside S&P Gap Risk	0.92	Carry	SGIXSTEP
Bitcoin	0.91	Comparator	XBTUSD
IR Volatility (Forward)	0.88	Hedge	SGIXEVR4
FX Gap Risk (USDJPY)	0.88	Carry	SGIHOPUJ
Upside S&P Volatility Carry	0.85	Carry	SGIXUFLY
Equity Pure Factor	0.85	Carry	Forthcoming
FX Gap Risk (EURJPY)	0.84	Carry	SGIHOPEJ
FX Carry + Value	0.83	Carry	Combination
Synthetic Down Var US	0.80	Hedge	SGIXTTRU
Dynamic VIX Futures Hedge	0.78	Hedge	SGIXVIPR
FX Carry	0.77	Carry	SGIXFC3E
IR Volatility (Spot)	0.77	Hedge	SGBVV1ER
Gold	0.72	Comparator	SPGCGCTR
VIX Spread	0.67	Carry	SGMDVIS
Commodities (GSCI)	0.67	Comparator	SPGCESTR
VIX Spread Constant Maturity	0.35	Carry	SGIXVSPR
Short VIX	0.29	Carry	SGIXV1MS

Source: SG Cross-Asset Research/Quant, Bloomberg

As we see in the table, the reason investors should hold commodities, gold, and possibly bitcoin, is the diversification benefits they provide, which we can now quantify and compare with our preferred list strategy list for 2026. Being exposed to the shifting US yield curve via trend comes top of the list alongside other well-known diversifiers such as commodity carry, multi-asset trend and equity mean reversion, and we continue to recommend all four as part of a QIS portfolio.

Although diversification is important, returns are paramount. Equity factor strategies performed strongly last year, and we expect more of the same this year, while FX Carry also performed well in 2025, and has enough carry to warrant attention. It's important to understand the purpose of strategies in portfolios, and so in the table below, we describe the why and the how of our preferred strategies across the fuzzy sets of Returns, Diversifiers, and Hedges.

**QIS with a purpose: the Why and How of our selected strategies**

| Returns	Why	How	Index
FX Carry	Carry buffer remains robust, subdued levels of cross-asset volatility a tailwind for risk-on carry trades	Long/short strategy on G10+EM currencies	SGIXFC3E, SGIXFC4E
FX Gap Risk (JPY)	The yen remains under pressure despite higher JGB yields due to fiscal and political uncertainty in Japan	Selling short-expiry, deep-OTM JPY calls to monetise the gap risk premium	SGIHOPUJ, SGIHOPEJ
Commodity Carry	Despite geopolitical turmoil, crude oil markets, which are a significant component of the universe, are expecting the largest storage build in 2026 since COVID	Diversified systematic shorting of term structures across the commodity universe	SGIXV57E
Upside S&P Volatility Carry	Gently rallying or rangebound US equities remain the most likely scenarios, and are supportive for short upside gamma positions	Systematically selling short-dated OTM S&P 500 calls and delta-hedging them intra-day	SGIXUFLY
Downside Equity Gap Risk	While gap risk pricing is currently subdued, there are many catalysts for a higher volatility regime in which the short-dated equity far left tail fattens	Systematically selling short-dated deep OTM S&P 500 or Nasdaq 100 puts	SGIXSTEP, SGIXS2EP, SGIXST3P
VIX Carry	The VIX futures curve is steep and concave, driven by low realised volatility and demand to hedge equity sell-offs through long VIX ETPs	Systematically sell one-month constant maturity VIX futures to play rolldown to spot, or a slope trade to benefit from the concave VIX curve	SGIXV1MS, SGIXVSPR, SGMDVIS
Equity Pure Factors	Significant dispersion in stock fundamentals and lots of macro noise creating a good environment for systematic stock picking	A global long/short pure factor equity strategy	Forthcoming
Diversifiers			
Multi-Asset Trend	Positive equity market positioning and growth outlook	Trend following across equities, commodities, FX and fixed income	SGIXXATR, SGMDXATL
Rates Slope Trend	Curve steepening due to higher inflation expectations and the Fed keeping the near end on hold, or stagflation, or rebuilding of term premia are the main risks to the status quo base case	Trend following on the US 2s20s slope, which should benefit from risk scenario of steepening	SGIXRSTE
Equity Mean Reversion	Macro noise creates cross-sectional stock volatility, which is painful but often short-lived	Weekly ML-based mean reversion strategy	SGEPMRWU
Commodity Value	In an environment of elevated geopolitical risk, directionally diversified time spread exposures mitigate the one-way risk in Commodity Carry	Dynamic positioning of time spreads based on producer/consumer flows and price	SGICCOVA
FX Value	Defensive strategy with long JPY exposure, combined with FX Carry to benefit from diversification while monetising the high carry in G10+EM	Long/short strategy on G10 currencies, combined with FX carry	SGIX3FVE + SGIXFC3E, or SGIXFXCV
Hedges			
Synthetic Down Var USD	Equity markets at all-time highs and exposed to tail risk	Systematically replicate a long-dated variance swap on the S&P 500 but only on the downside	SGIXTTRU
Synthetic Down Var EUR	European equity markets pricing in a benign outlook while exposed to global contagion and idiosyncratic European risks	Systematically replicate a long-dated variance swap on the EURO STOXX 50 but only on the downside	SGIXTRSE
US Rates Volatility	Long-dated US rates volatility has declined significantly, and is likely to jump upwards in market stresses that could cause rates re-pricing	Go long long-dated rates volatility, potentially combined with a short gamma funding position	SGBVV1ER, SGIXEVR4
Delta-Hedged Single Stock Puts	Concentration risk has left equity markets overly exposed to a narrow group of stocks	Systematically buy OTM puts on several single stocks and delta-hedge	SGIXCREW
Dynamix Long VIX futures	The possibility of a highly volatile but ultimately limited equity sell-off remains high given the numerous outstanding macro catalysts	Dynamically sized long VIX futures where the position is scaled up as volatility rises	SGIXVIPR

Source: SG Cross Asset Research/Quant

Introduction

2025 was full of challenges, but generating returns was not one of them. Not only did MSCI World return another 20% on top of last year's similar gains, but returns were also widespread, with World ex-US equities outperforming for a change, particularly when viewed in USD terms. The Magnificent Seven/AI Hyper-scalers, or whatever the prevailing label is for the leading mega-cap names these days, dominated the conversation, index market capitalisation, profits, and increasingly US GDP growth. However, better stock returns were seen elsewhere.

**Despite the inevitable focus on the US equity market, the rest of the world has seen the best performance in 2025**
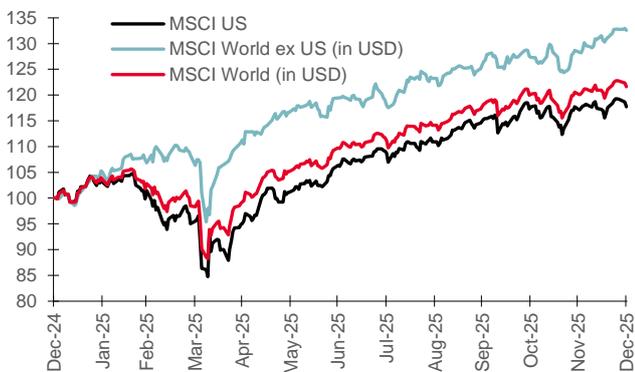
Non-US equity markets had their best year versus US equities since 1993 (MSCI World ex US vs MSCI US in USD, total returns)

Source: SG Cross Asset Research/Quant, MSCI
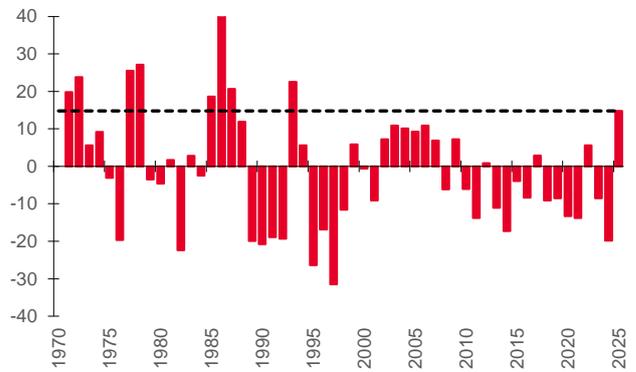
Global bond and credit markets were also remarkably resilient in the face of tariffs, political interference, ballooning government debt and sticky inflation, but helped by interest rate cuts, though importantly, not in Japan.

2025: a challenging start but a robust post 'liberation day' rally
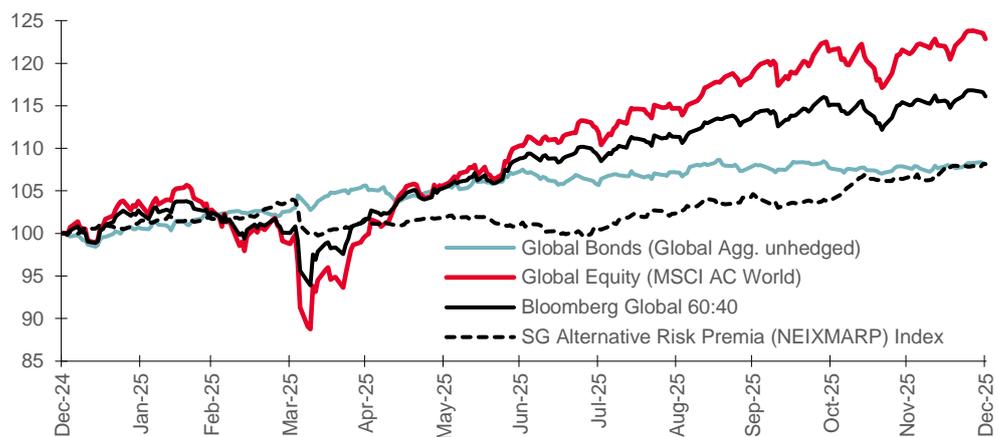

Source: SG Cross Asset Research/Quant, Bloomberg

We enter 2026 with public equity and credit markets looking expensive, with credit spreads compressed near historical lows and equity valuations near historical highs, courtesy, largely, of the expensive and dominant US equity market.

**Investment grade credit spreads are near historical lows**
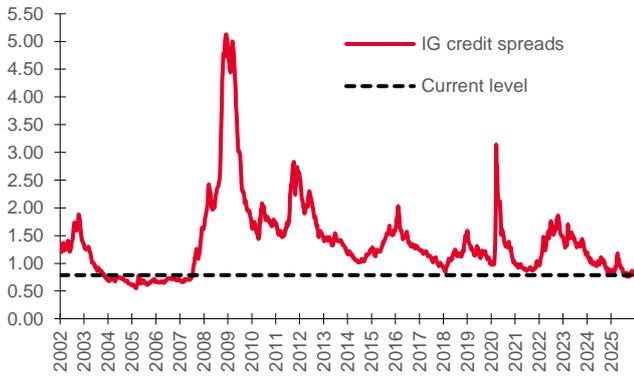
Source: SG Cross Asset Research/Quant, Bloomberg

As are high yield credit spreads

Source: SG Cross Asset Research/Quant, Bloomberg
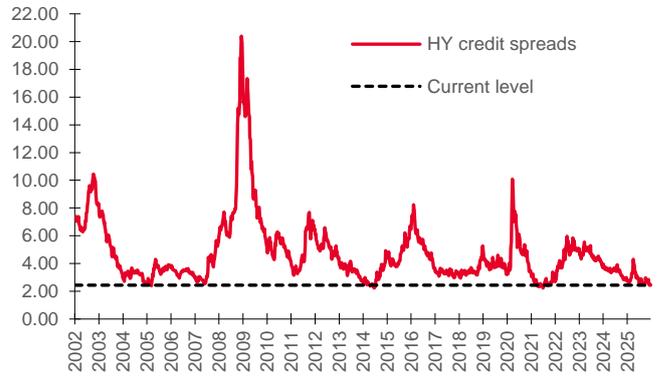
The US now makes up over 70% of the MSCI World index, and the average US stock in the index is almost four times as big as the average non-US stock. So, whilst better returns were seen outside of the US during 2025, and there remain cheaper equity valuations elsewhere, equities overall do have a valuation problem to contend with at some point.

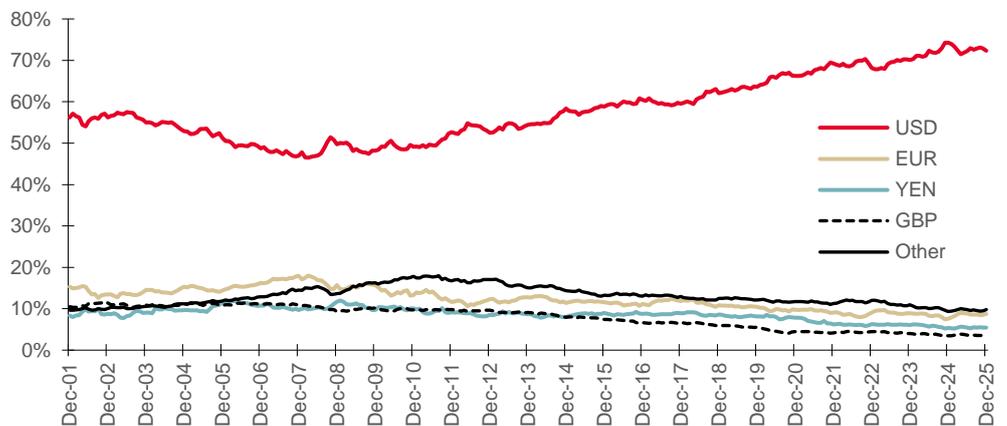**US stocks dominate MSCI World (% of overall market cap)**
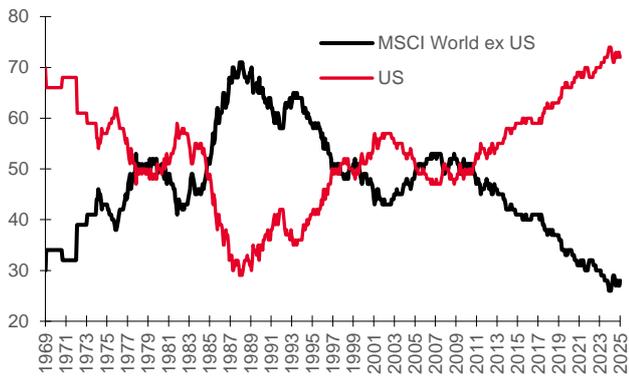
Source: SG Cross Asset Research/Quant, Factset

The average US stock constituent in MSCI World is 3.8x larger than the average non-US stock constituent

**Alongside US equity risk, the global non-US investor is holding considerable US dollar FX risk**

Source: SG Cross Asset Research/Quant, Factset

16 January 2026

As has been well reported, a significant amount of the US market success has been driven by a very successful, narrow group of stocks to the extent that both MSCI World and the S&P 500 are more heavily biased towards the top 10 largest stocks than they have been historically, in both market-cap and profit terms. So, whether an investor believes in their continued success or not, this represents a significant concentration risk in most portfolios.

This dominance also comes with higher valuations, which assume continuing profit outperformance. So not only are future earnings disappointments a concern, but so is the possible valuation de-rating that may accompany it. Essentially, investors are overly exposed in price, profit, and valuation terms to these 10 names.

The top 10 stocks represent a record amount of MSCI World profits and market capitalisation
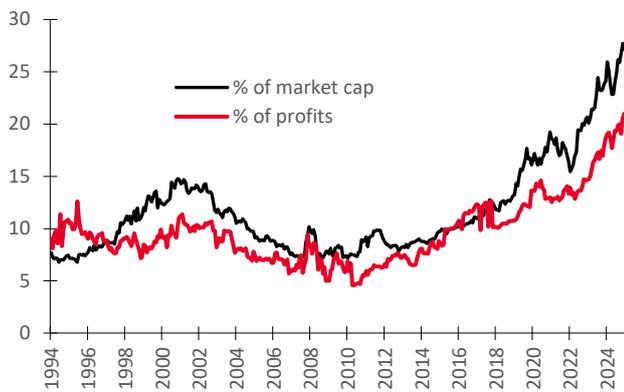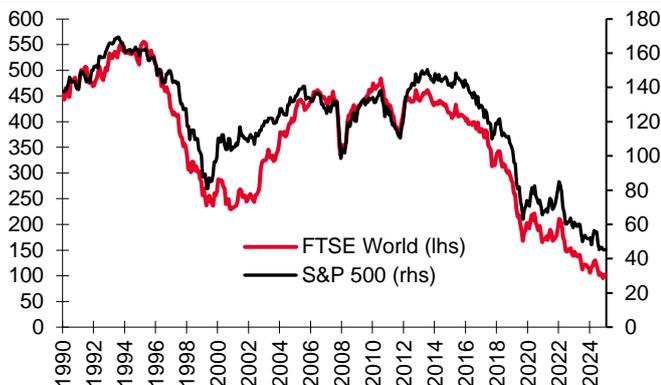

Source: SG Cross Asset Research/Quant

Whilst very profitable, the Top 10's success is very much incorporated into higher valuations – MSCI World
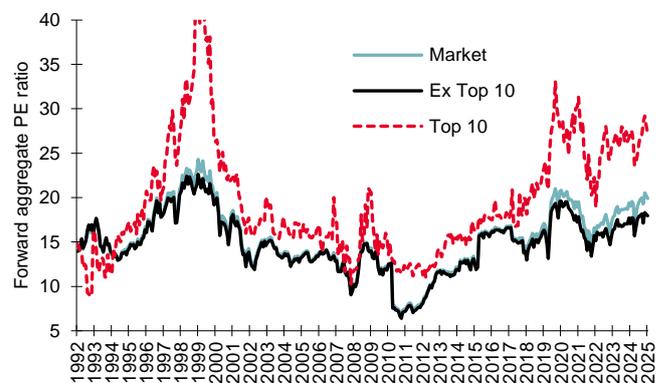

This lack of diversification comes through in our measures of the effective number of constituents (ENC ratio), which continue to hit record lows. Today, owning the S&P 500 is equivalent to holding an equal-weighted portfolio of just 45 names. Not only does that dramatically limit the diversification available by holding the index, but in practical terms (for example tracking error), it often means that owning these stocks is unavoidable, irrespective of their fundamental outlook.

Effective number of constituents (Inverse HHI)

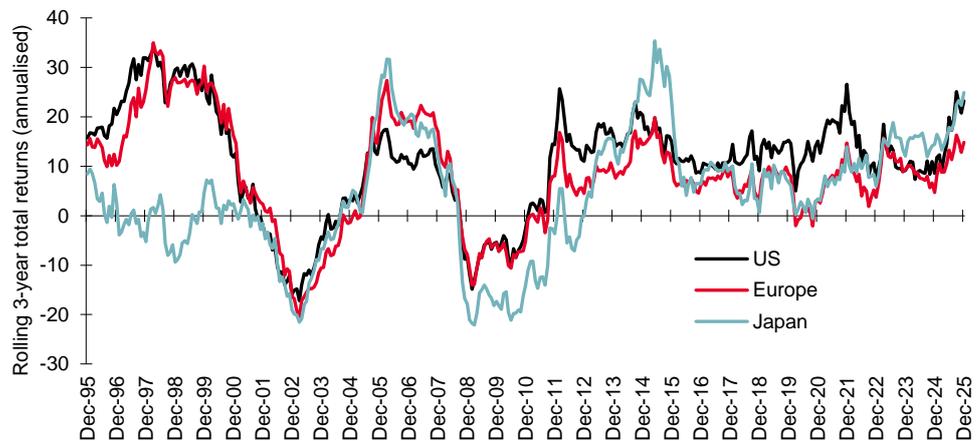Source: SG Cross Asset Research/Quant

Not holding the top 10 stocks in the S&P 500 or MSCI World leads to a very high tracking error
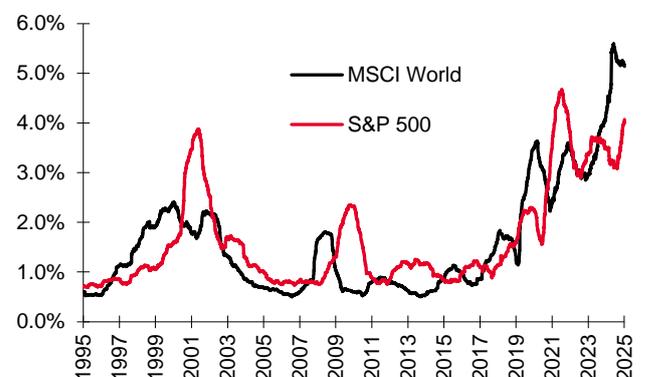
Portfolio diversification is often the reason investors are attracted to quantitative investment strategies (QIS) in the first place, as a source of uncorrelated returns and the ability to hedge unwanted risks. We dedicate a significant amount of this publication to this very topic.

But it is fair to say that it has been an incredible few years for equity investors, with both the US and Japan averaging over 20% annualised over the last three years, and even low-growth Europe managing 15% per annum. So, in that context, a lot of our conversations are about how systematic strategies can complement traditional portfolios.

Equity investors have seen very strong returns over the last three years (MSCI indices, 3-year total returns in local currency terms, annualised)


Source: SG Cross Asset Research/Quant, MSCI

The direction of profits ultimately sets the tone for equity markets, and whilst you see periods when prices move ahead of profit growth, as has been the case over the last few years, if profit growth is accelerating, equities generally move higher and vice versa. So, with a very bullish 14% consensus EPS growth forecast in both the US and in the World ex-US in 2026 (*the highest expected forward growth rate outside of exiting a profit recession since 1998!*), most investors appear positive about the year ahead. But with great expectation and high valuation, the burden of proof is on delivery, and what is highly unusual about this year is that markets are expecting very strong profit growth while also assuming the US and other central banks will continue cutting interest rates.

Where profits go, prices follow. MSCI World yoy price change versus change in 12m forward EPS expectations
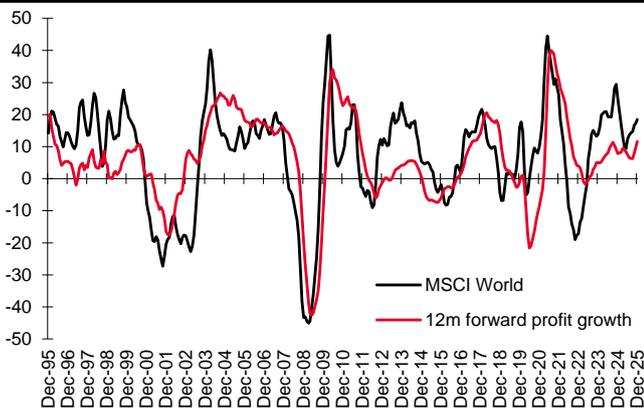

To see double-digit profit growth and interest cuts is highly unusual (US profit growth with expectations vs US rates)

Source: SG Cross Asset Research/Quant
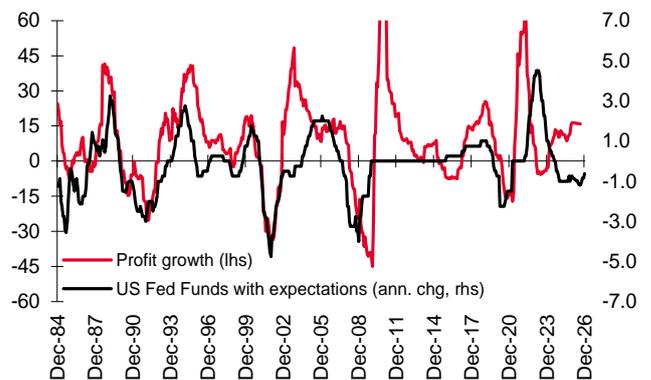
So, after such a solid year for asset returns, should we continue dancing, or should we start shuffling towards the door? We have a variety of ways of measuring the market mood, and our most popular is our long running SG sentiment indicator, which includes measures of equity, FX and rate-implied volatility, as well as Eurozone peripheral spreads, the Gold to Silver ratio and credit risk. *All of them declined during the year, some significantly so.*

The SG Sentiment Index hit zero just after 'Liberation Day', signalling a risk-on reversal, and then rarely re-visited a risk-off period thereafter
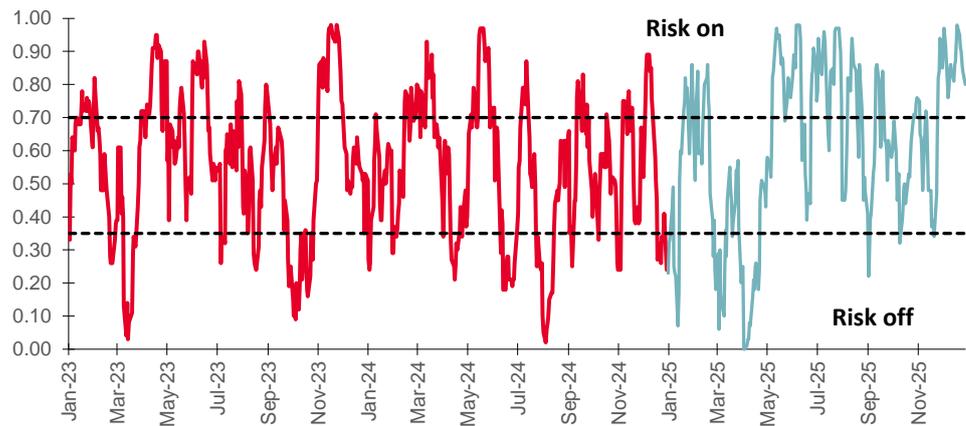
Source: SG Cross Asset Research/Quant

Although implied equity volatility and credit risk both finished below where they started 2024, it was the collapse in FX and rates volatility post the tariff-induced volatility of April, that has persisted. Our rates volatility includes bonds in the US, Eurozone, UK and Japan and all – with the notable exception of long-date Japanese bonds – saw a decline in implied volatility, many significantly so. Who would have expected the unsettling of global trading to have resulted in less volatile currency and rates markets?

Implied equity and credit volatility remain near the lows
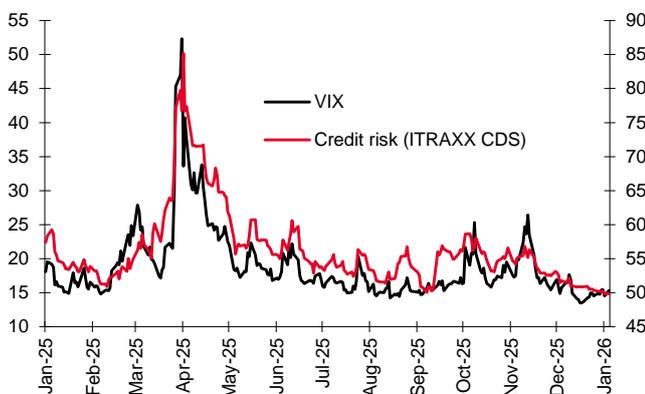
And there has been a sharp drop in rates and FX volatility
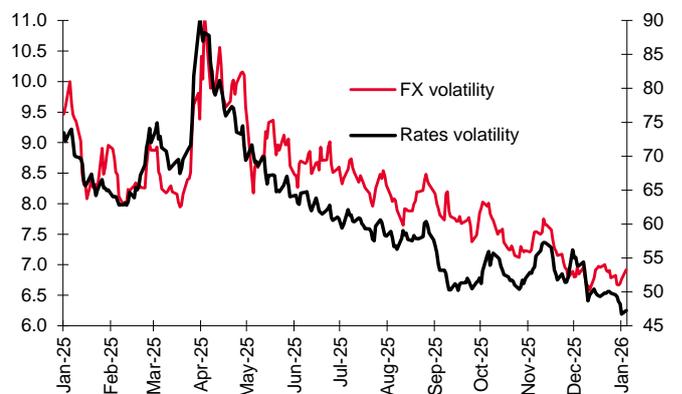
Source: SG Cross Asset Research/Quant, Bloomberg

This decline in market volatility was accompanied by significant central bank easing, with continuous cutting throughout the year, including 25 cuts across the 10 developed market central banks, with only Japan hiking rates. This represents the most significant cumulative reduction since 2009.

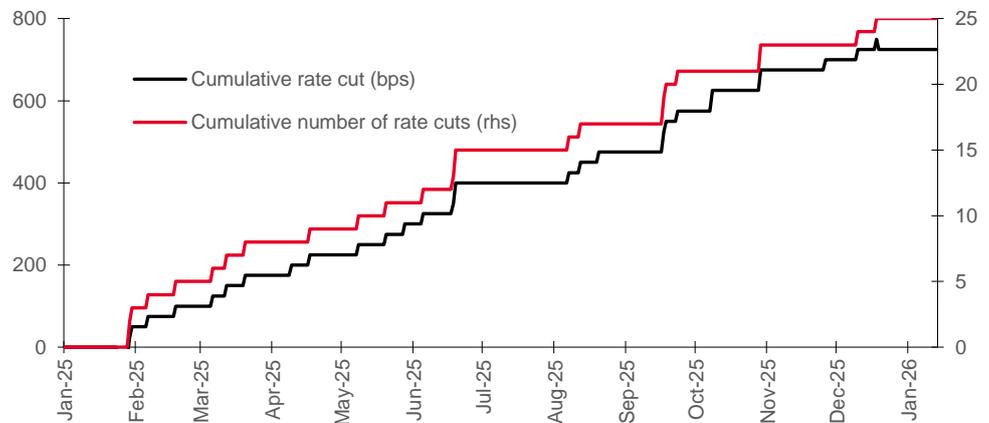**2025 saw the most significant cuts in interest rates across the top 10 major developed market central banks since 2009!**

Source: SG Cross Asset Research/Quant, Bloomberg

Alongside all this central bank easing, forward expectations for US interest rates have stabilised at around 3%, with the volatility of those expectations also dropping. In addition, following a year of rising from negative territory, the term premium on US treasuries traded in a tight range from the middle of 2025 onwards. So, interest rate expectations and term premia have settled back in a range of what was considered "normal" before quantitative easing.

US 12-month forward interest rate expectations have stabilised around 3.0%
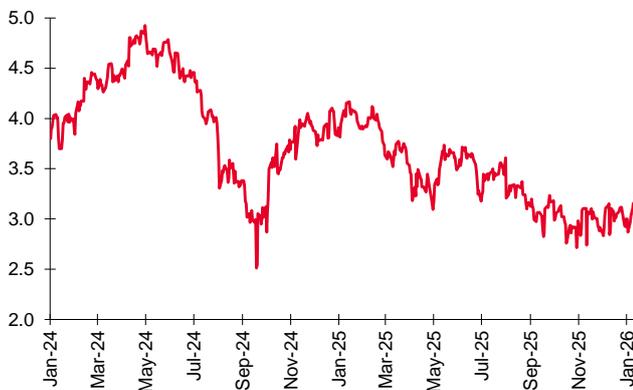
And the US 10-year treasury term premium has been in a narrow range through the second half of 2025

Source: SG Cross Asset Research/Quant, Bloomberg

However, as Albert Edwards observed in his Favourite charts to start the year, whilst rate markets may have normalised, government spending and debt levels have not, and governments still have to grapple with significant public sector deficits and interest bills that continue to rise as zero-interest-rate-era debt is rolled over.

Both US and China have public sector deficits at c.8% of GDP
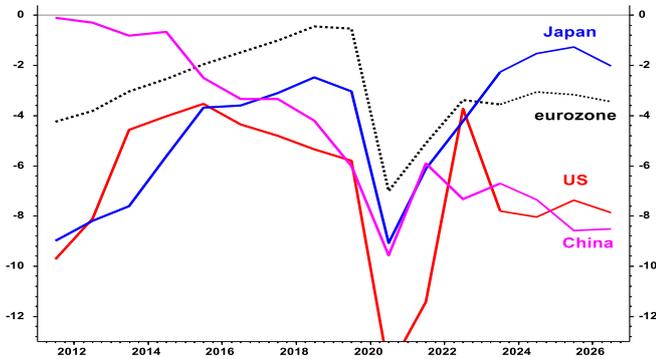
But the US interest bill on public debt is in a league of its own
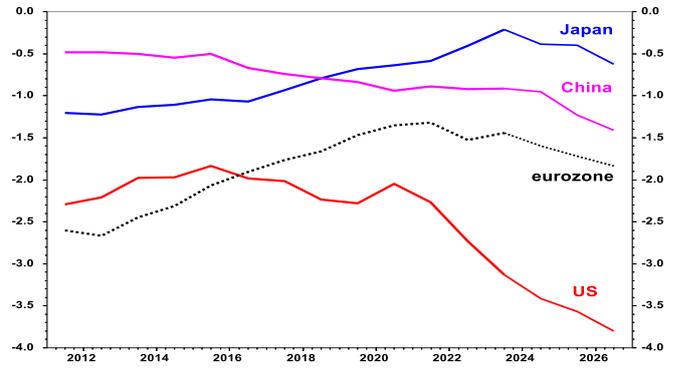
Source: DataStream, IMF

The flip side to these record interest bills for governments is a big rise in interest received by investors, which is a key feature of both markets and the global economy post COVID. Fixed income investors, having been starved of income and even having suffered from negative yields at one point, suddenly found themselves receiving regular cashflows, which they could spend or reinvest.

Assets have flowed into money market funds and fixed income yield instruments, even with interest rates declining, creating more cashflows and more to reinvest. As a rough estimate below, a global 60/40 has gone from returning US$2.5tn per annum pre-COVID to double that amount in 2025.
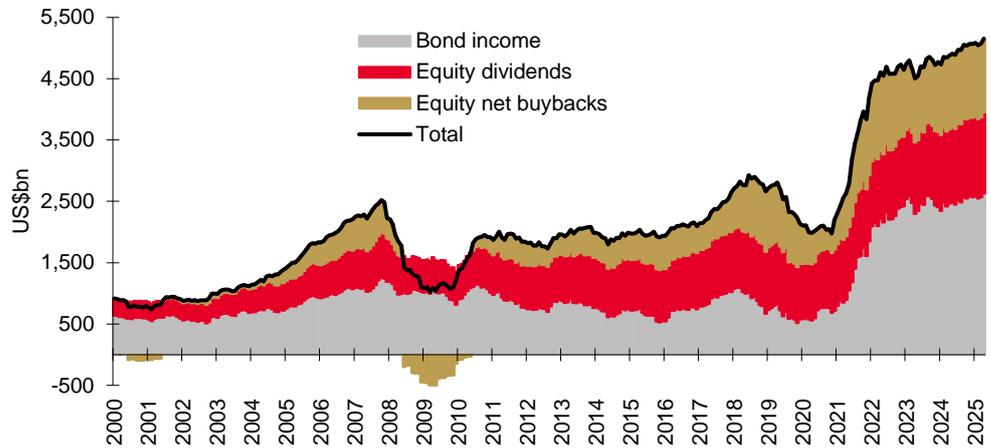
An estimate of global investor cashflows from the developed market 60/40 portfolio

Source: SG Cross Asset Research/Quant, Bloomberg

The problem is as this newfound cashflow tries to find a home in the equity market, with the S&P 500 having seen a continuous reduction in the share count for the last 20 years, there is a lot more demand and decreasing supply, pushing up valuations. *This is the major contrast to the TMT bubble, when at the peak, issuance was 6-8% from an abundance of IPOs.*

Today, a lot of the AI story is happening outside of public markets. This will change if the mountain of supply from companies waiting to IPO comes to the market. A rough estimate is a market-cap equivalent to 3-4% of the S&P 500 is hoping to list in the US this year, which means dilution for existing stocks in the index and more choice for investors.

Unlike during TMT-bubble, there has been little in the way of new issuance in the S&P 500. This may change in 2026

The Nasdaq composite saw net issuance equivalent to 4% of the market cap of the index in 2025

Source: SG Cross Asset Research/Quant, LSE Workspace
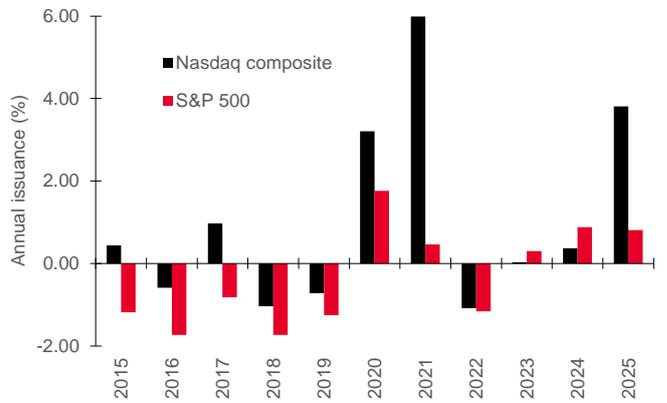
The creation of new investment products to satisfy this investor demand has accelerated in recent years. More and more ETFs are coming to the market, with increasingly exotic structures and net issuance of products such as auto calls hitting new highs in 2025. Increasingly, these are based on single stocks, with the growth mainly coming from the technology sector and high-volatility stocks.

A final piece of the puzzle is retail speculation in parts of the equity market, which is having an increasing impact on cross-sectional returns and pricing of single-stock volatility. There was a significant increase in the volume of options traded last year, which again focused on the most volatile stocks and where their biggest impact was felt in the US small cap space. This pick-up in speculative activity amongst individual equities drove the outperformance of higher volatility stocks and was consistent with the performance of other retail-investor favourites such as bitcoin. Again, this is simply indicative of a market that is awash with liquidity.

Speculative bubble? 2025 saw a dramatic pick-up in the number of options traded on the most volatile US small caps
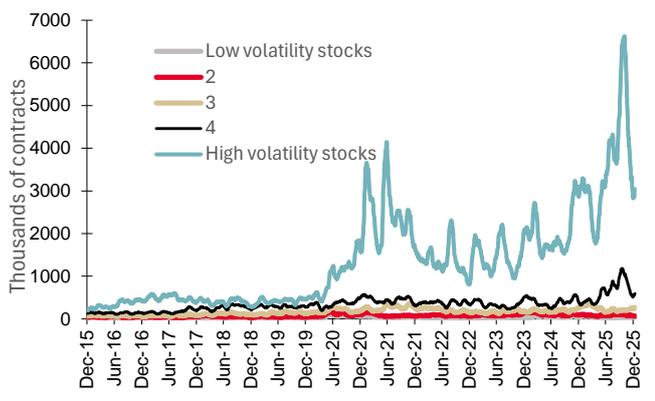
The relative performance of the most volatile US small caps

Source: SG Cross Asset Research/Quant, Factset, Bloomberg

16 January 2026
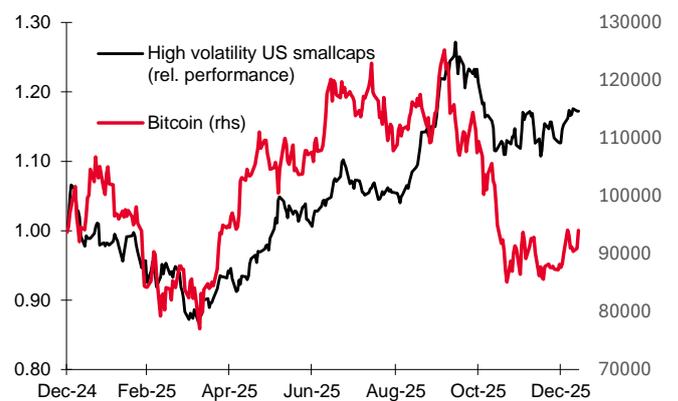
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A look back at 2025 ETF flows: risk-on, not reckless

■ **In 2025, investors embraced risk – but selectively.** Capital rotated aggressively into higher-beta and return-seeking exposures – AI-led equity thematics, small caps, emerging markets, emerging market bonds, high yield credit and crypto ETFs – while leveraged ETFs experienced pronounced outflows. The signal was unmistakable: risk was welcome, but too much complexity was not.

■ **Flows into high yield and emerging market debt ETFs reinforced this thesis.** Investors were willing to move down the credit spectrum and across geographies to capture spread, but without sacrificing liquidity or control. High yield credit benefited from resilient corporate fundamentals and declining default expectations, while EM bonds attracted capital on improving macro stability, attractive real yields and the prospect of global monetary easing later in the cycle. Credit risk was selectively embraced – not indiscriminately chased.

■ At the same time, strong inflows into **option-based income strategies** highlighted a parallel objective: enhancing portfolio yield while remaining invested in risk assets. In an environment of still-elevated rates and episodic volatility, these strategies offered a compelling balance between income generation and managed equity exposure.

■ **Equities followed the same pattern. Narrow thematic ETFs and small caps** benefited from growth optimism. AI dominated inflows, now viewed as a structural growth engine with tangible revenues and cash flows, rather than a speculative theme, making it the preferred expression of upside in a risk-on environment.

■ **Crypto flows displayed a similar dynamic, concentrating on** Bitcoin and Ethereum: Bitcoin as a macro asset and portfolio diversifier, Ethereum as DeFi infrastructure with yield-like staking benefits.

■ Meanwhile, **leveraged ETFs** were abandoned. Volatility drag and path dependency made outcomes unpredictable, driving capital toward cleaner, more efficient expressions of risk.

In 2025, ETF investors were decidedly risk-on, but selective in how they took risk
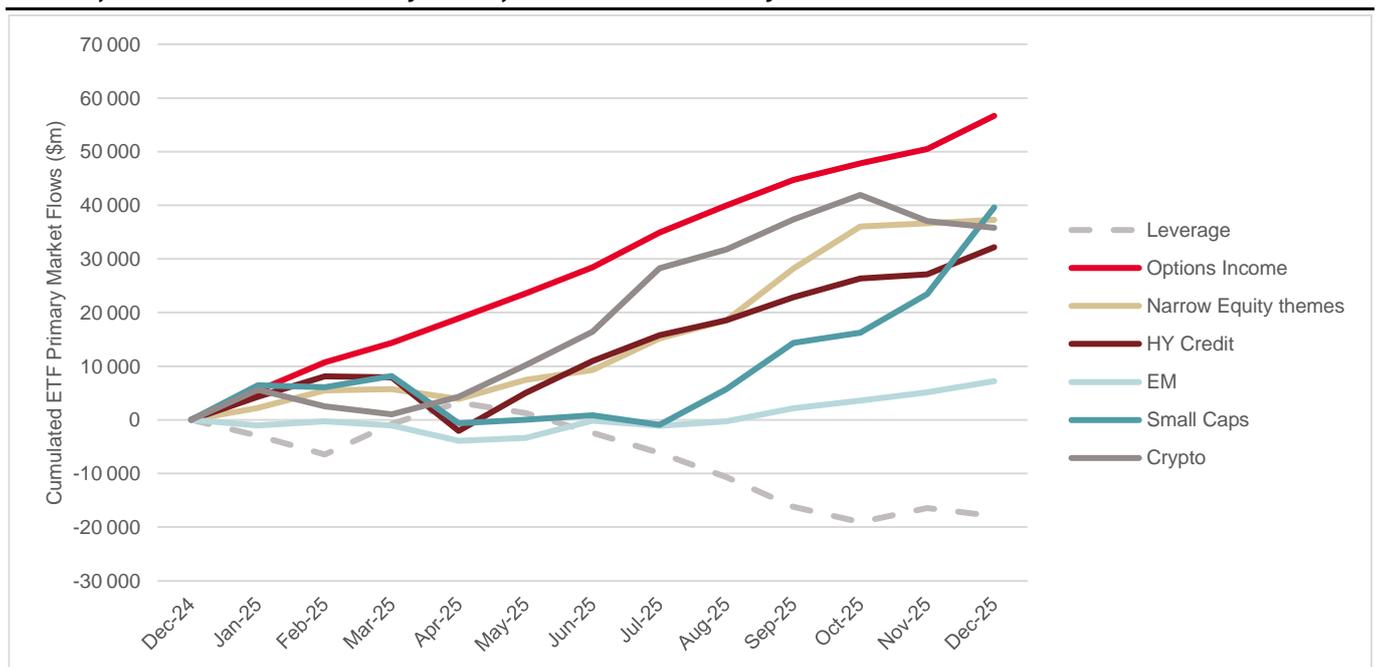
Source: SG Cross Asset Research/ETF

What worked and what didn't in 2025

In the equity market, it was a banner year for Value and Momentum strategies, and with markets making good gains, lower beta and quality equity strategies – still weighed down by elevated QE-era valuations – struggled. With bond market volatility declining throughout most of the year, being short bond volatility proved the most profitable, whilst FX Carry strategies also proved useful. Tail-hedging strategies overall had a mixed year, depending on the implementation.

Best and worst Premialab equity indices in 2025
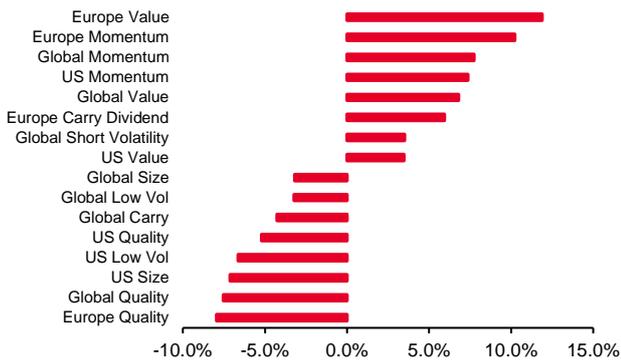
Best and worst Premialab FICC indices in 2025
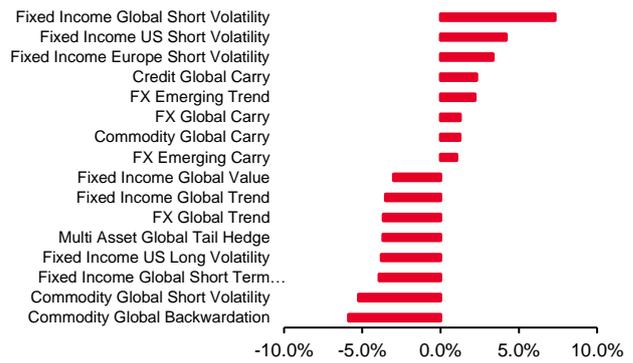
Source: SG Cross Asset Research/Quant, Premialab

Compared to last year's playbook and quant outlook recommendations, with European stock markets driven higher through the re-rating of cheap stocks, our market-hedged European Value strategy saw consistent performance through 2025 with a 10% overall return, just under two times the volatility of the strategy. With the very cheapest stocks in Europe having now re-rated, as we noted in the last Outlook, the easy gains for the strategy are probably behind us. But we remain fans of equity value strategies generally.

FY25 ranked performance of SG systematic strategies

Source: SG Cross Asset Research/Quant, Bloomberg

Carry in G10 and EM currencies delivered a strong performance in 2025, supported by a sustained high carry buffer and exceptional EMFX performance. While EMFX spot returns may face headwinds in 2026 due to shifting macro conditions, the robust carry buffer remains intact, underpinning expectations for positive total returns.

In FX, selling unhedged short-dated deep-OTM JPY call options proved to be highly effective in harvesting the gap risk premium. According to our FX strategists, currency markets have been driven more by growth expectation differentials than monetary policy in recent times. This dynamic has supported a stronger USD against both EUR and JPY, with realised volatility becoming quite subdued in FX. The strategy selling USDJPY downside gap risk rebounded strongly after the 'Liberation Day' drawdown, as yen recovery has failed to materialise amid Japan's fiscal constraints, political uncertainty, and a relatively weaker growth outlook compared to the US. FX value, on the other hand, underperformed due to this yen weakness, given its heavy long JPY exposure (averaging 43% basket weight in 2025).

Long-term implied volatility in rates fell sharply in September alongside long-term rates, driven by weak US data and the unwinding of steepener positions, resulting in a large drawdown for long rates volatility strategies. However, the long forward volatility strategy (VRR) has rebounded strongly since then, consistent with its historical resilience. The forward volatility structure provides a natural buffer against moves in swaption volatility due to its offsetting long and short exposures across the surface, enabling outperformance even when long-term rates volatility is subdued. The current low level of long-term US rates volatility is also an attractive entry point to go long rates spot volatility, given the heightened uncertainty around the Fed's policy path. Risks related to the US labour supply constraints, fiscal dynamics, sticky inflation and Fed independence further support maintaining exposure to long-dated US rates volatility.

If we plot the performance of our strategies classified by the relationship to risk appetite and demand for bonds, the bottom right-hand bubble is where we saw the best performance, which is consistent with positive risk appetite and higher bond yields. Our most defensive strategies, unsurprisingly, given the market conditions in 2025, is where we saw the biggest losses.

Systematic strategy performance in 2025. The size of the bubble equates to performance in return/risk terms, grey is positive, and red is negative
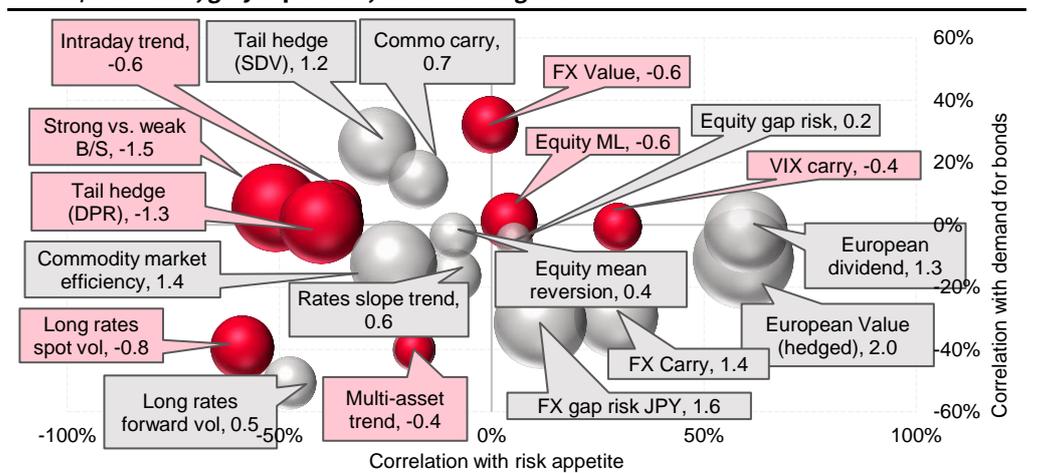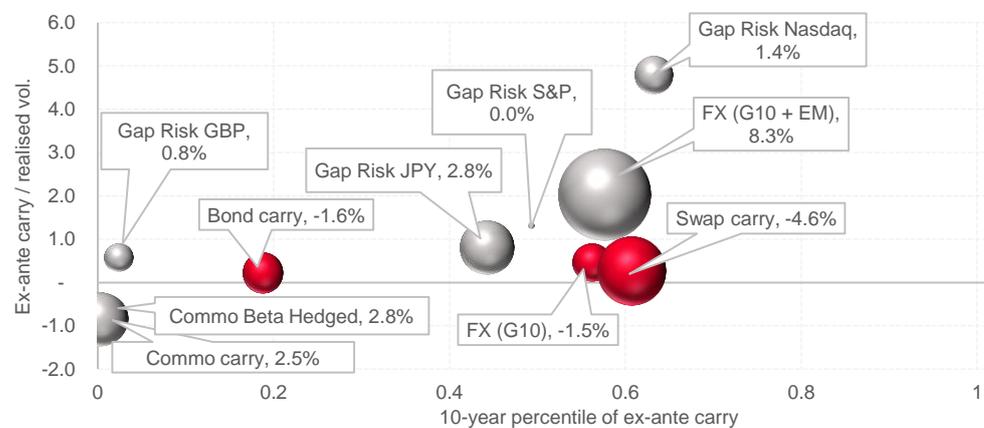

Source: SG Cross Asset Research/Quant, Bloomberg

Finding alternative sources of return

Seeking returns through cross-asset carry

Our Carry Monitor looks at some of the most popular carry strategies across asset classes. It evaluates each carry strategy along two axes: i) the current level of carry in the strategy, as a percentile of the past 10 years on the x-axis; and ii) a measure of ex-ante Sharpe ratio, defined as the ratio between the recent carry and the one-year rolling standard deviation of the strategy along the y-axis. The Carry Monitor as of January 2026 is shown in the graph below. The bubble sizes are proportional to the strategies' 2025 returns. We discuss the most attractive carry strategies currently in the sections below.

Carry Monitor – Evaluating carry opportunities across asset classes

Source: SG Cross Asset Research/Quant, Bloomberg. The bubbles represent the returns of the strategies in 2025

FX carry engine is still going strong

FX carry remains among the top picks of carry strategies going into 2026. In the section on a quantitative approach on currency trading, we highlight that the one-year forward returns of a carry basket in FX show a positive correlation with the level of its ex-ante carry historically. And the ex-ante carry offered by a G10+EM implementation of the strategy is still very attractive at 12.7% p.a. Furthermore, the estimated one-year expected return of the strategy is 8.7%, using Bloomberg analysts' consensus forecasts. For a G10-only implementation, the ex-ante carry is 3.3% p.a. currently, with an estimated one-year expected return of 2.2%, using Bloomberg analysts' consensus forecasts.

The table on the next page highlights the most attractive pockets of carry among G10 and EM currencies, based on a roll of one-month FX forwards. The carry buffer remains particularly strong for EM currencies, and CHF remains quite attractive as a funding currency. Additionally, the subdued cross-asset volatility in markets remains a tailwind for carry trades, and the basket has a very elevated carry-to-vol ratio of 1.93 currently.

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Expected 12-month performance of the carry trade by currency (long position in currency vs USD)

Region	Currency	Implied carry	Carry-to-vol ratio	Consensus spot return (Bloomberg, median)	Expected total return*
G10	AUD	0.0%	0.00	0.0%	-0.1%
	CAD	-1.8%	0.33	2.0%	0.3%
	CHF	-4.2%	0.58	-0.2%	-4.4%
	EUR	-2.6%	0.40	2.9%	0.3%
	GBP	0.1%	0.01	1.0%	1.1%
	JPY	-3.4%	0.36	4.1%	0.7%
	NOK	0.2%	0.02	3.0%	3.2%
	NZD	-0.5%	0.06	0.7%	0.2%
	SEK	-2.1%	0.22	3.4%	1.3%
Latam	BRL	9.1%	0.58	-1.4%	7.7%
	MXN	3.6%	0.34	-2.9%	0.7%
Asia	CNH	-2.5%	0.67	-0.3%	-2.8%
	INR	3.3%	0.78	0.5%	3.8%
	KRW	-1.3%	0.15	4.7%	3.4%
	SGD	-2.9%	0.65	0.6%	-2.4%
	TWD	4.1%	0.52	3.3%	7.4%
CEEMEA	CZK	-0.5%	0.06	2.6%	2.1%
	HUF	2.7%	0.24	3.4%	6.1%
	ILS	0.0%	0.00	-2.6%	-2.5%
	PLN	0.2%	0.02	1.1%	1.3%
	TRY	31.7%	1.74	-11.7%	20.0%
	ZAR	2.9%	0.26	0.4%	3.3%
Strategy (*long top 5, short bottom 5*)		12.7%	1.93	-4.0%	8.7%

Source: SG Cross Asset Research/Quant, Bloomberg.

* The expected total return is based on a long position in the underlying currency versus the USD. It is calculated as the sum of the implied carry and the consensus spot return.

While the yen remains exceptionally weak amid political uncertainty and fiscal debt sustainability concerns, the short JPY position is still at risk of a sharp loss in case of a steep correction. Such a swift JPY recovery may materialise, for example, if market risk sentiment deteriorates significantly. We have discussed mitigating this risk by combining FX carry with the more defensive G10 value in previous research[1]. Such a strategy benefits from diversification while also gaining from the higher level of ex-ante carry offered by the FX carry. The expected 12-month performance of a 40-60 portfolio of FX carry and FX value is shown in the table below.

Expected 12-month performance of a portfolio combining FX carry and FX value

Strategy	Implied carry	Consensus spot return (Bloomberg, median)	Expected total return*
FX carry	12.7%	-4.0%	8.7%
FX value	-0.3%	2.2%	1.90%
Portfolio (40% carry, 60% value)	**4.9%**	**-0.3%**	**4.6%**

Source: SG Cross Asset Research/Quant, Bloomberg

* The expected total return is calculated as the sum of the implied carry and the consensus spot return for the strategy.

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[1] Performance update for systematic strategies in currencies (May 2025): Mixing carry and value styles in currencies.

An upside volatility carry trade

An asset's carry is the expected return assuming that prices stay the same. While the carry doesn't include P&L from market moves, most carry positions – whether earning a running spread in credit or elevated premiums in puts – remain acutely exposed to sudden market crashes, such as those witnessed in February 2018, March 2020, or more recently in April 2025.

Many investors run a portfolio of strategic hedges funded by carry strategies. These carry strategies involve taking risks, often in the direction of the risks being hedged. Upside volatility serves as a novel diversifier for a carry portfolio. By selling a strip of short-dated, out-of-the-money (OTM) calls and employing dynamic intra-day delta hedging, investors can generate a funding stream that is less sensitive to market declines. This provides a defensive carry mechanism that allows strategic hedges to perform without the drag typically associated with correlated funding trades.

Selling short-dated S&P 500 upside volatility carry is less sensitive to equity sell-offs
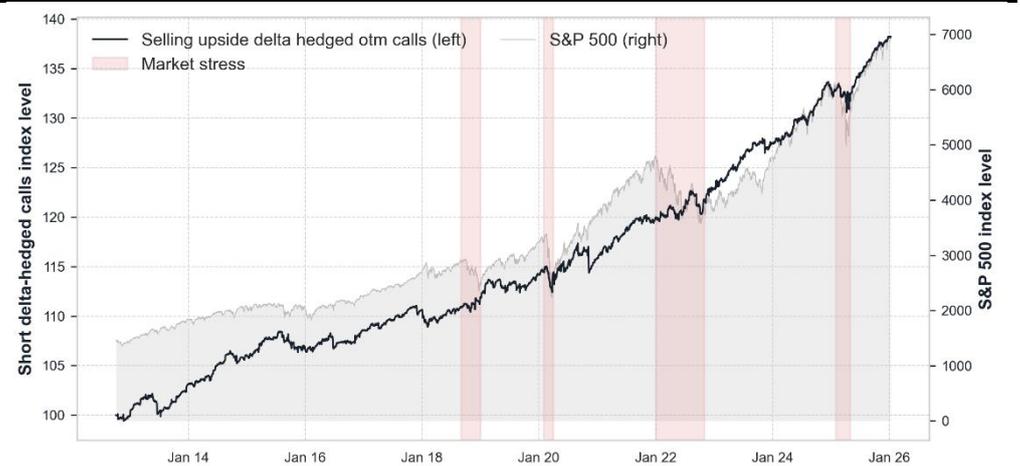
Source: SG Cross Asset Research/Quant

Our analysis here has two main aims:

- To lay out the economics for the strategy, and why it has become especially attractive now.
- To figure out simple rules on when to enter and exit the strategy.

Strategy mechanism

The strategy comprises two legs:

- Systematically sell a strip of OTM short-dated calls with up to five business days to expiry. The calls are chosen such that the premium received from them is not so small that high leverage is needed to receive a meaningful upfront premium.
- Intra-day delta-hedge the calls carried by the strategy.

The most benign scenario for the strategy is a slow, steady rally that enables the volatility risk premium (VRP) embedded in these calls to be monetised. The adverse scenario is a sharp rally in which the delta-hedging is unable to offset the loss of value of the calls sold.

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S&P 500 calls have been pricing in more upside since 2023 than they used to – potentially driven by the influx of retail participants as options expiring every day of the week became available
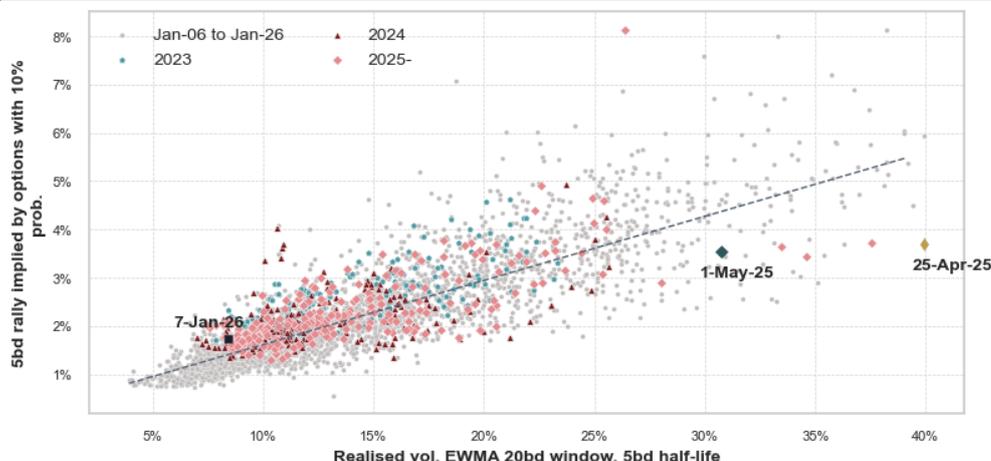
Source: Bloomberg, SG Cross Asset Research/Quant

Short-dated calls have become more expensive since the introduction of daily expiries

The CBOE introduced Tuesday and Thursday expiry S&P 500 weekly ("SPXW") options on 18 April 2022 and 11 May 2022, respectively. Thus, market participants have been able to trade options expiring every day of the business week for about three-and-a-half years now. This period has seen a surge in retail activity in the market. We do not have precise data to characterise retail trading patterns, but we believe that there is material appetite for short-dated OTM calls, often viewed as "lottery tickets". This has likely driven up call premiums.

The chart above shows how pricing of short-dated OTM calls has changed over the past three years. The chart plots our preferred (and highly reactive) measure of realised volatility on the x-axis versus the rally implied by weekly ("5bd") option prices with 10% probability. The data series goes back to 2006. Initially, we only have data for Friday expiries. From August 2016, we have data for Monday, Wednesday and Friday expiries and from late-May 2022 for Tuesday and Thursday expiries as well. The dotted regression line shows the relationship between the option-implied rally and realised volatility from 2006 until just before expiries were available for all weekdays.

The chart shows an interesting pattern. Dots for 2023 (teal), 2024 (brown) and 2025 to early 2026 (pink) mostly lie above the regression line. Since 2023, we see that S&P 500 weekly expiry calls price in more upside than they used to.[2]

Although this means that an opportunity may exist to profitably take the other side, i.e. systematically sell short-dated OTM calls, we prefer to do so with delta-hedging and thus significantly reduce directional risk. This changes the trade into one that aims to earn the volatility risk premium embedded in the options sold.

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[2] Readers will notice a few pink points (for 2025) significantly below the regression line for high realised volatility scenarios. These points represent data after the equity sell-off and accompanying spike in volatility in late-March/early April 2025. (We have marked a couple of points on the chart.) This period was essentially an outlier.

Intra-day delta hedging is extremely important

Delta hedging aims to remove option delta as a P&L contributor and leave option gamma as the main driver instead. Theoretically, the P&L from selling an option and delta hedging it *continuously* is the product of the *prevailing gamma* through time, and the difference between the implied variance that the option was priced at and the realised variance of the underlying, summed over the life of the option. The delta of an option changes over its life, as well as due to market movements. This change is slow for a long-dated option but can be very quick for a short-dated option and especially so in a highly volatile market. The charts below show the evolution of deltas of two to five business day call options beginning on three different dates. All calls had an initial delta of approximately 0.1 (i.e. these are 10-delta calls). We see that the deltas can gyrate wildly from one close to the next as the S&P 500 moves around in a volatile manner. And if the volatility is low, they can decay quickly to zero.[3]

Deltas of short-dated options – observed from close to close – can gyrate wildly as the underlying index moves, or decay quickly to zero
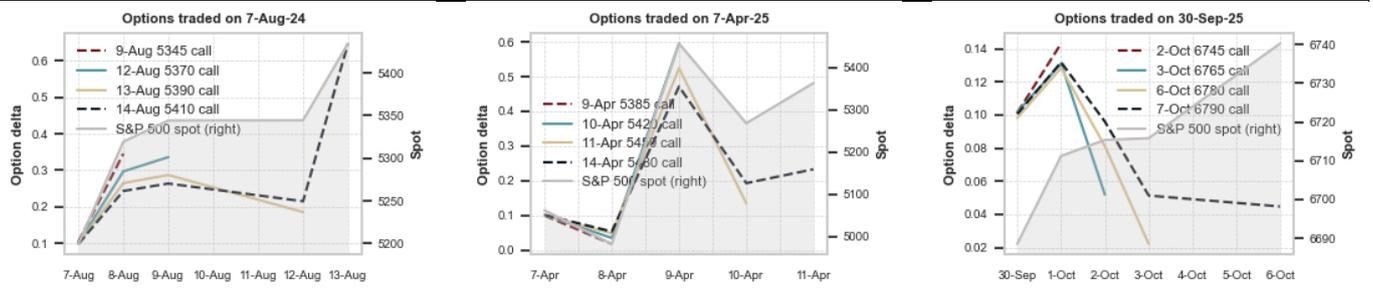
Source: Bloomberg, SG Cross Asset Research/Quant, OptionMetrics

These significant close-to-close movements mean that if delta-hedge rebalancing is done once a day, there is large delta slippage – the index position does not adequately offset the delta of the option. The delta then starts contributing meaningfully to P&L – something we wish to avoid. The solution is to hedge as close to continuously as possible, i.e. intra-day at several points during trading hours.

Holding the strategy *most* of the time is optimal

We try and answer the following question for many of the strategies we discuss in our research: when should an investor keep a position in the strategy, and when should they unwind? For this delta-hedged, short-dated call selling strategy on the S&P 500, the answer is to (a) keep it on most of the time, and (b) unwind after a material sell-off when the risk of a sharp rebound is high.

We mentioned earlier that the theoretical P&L from selling an option and continuously delta-hedging it is the product of (i) the *prevailing gamma* of the option and (ii) the difference between the implied variance that the option was priced at and realised variance of the underlying, (iii) summed over the life of the option. Let us focus on the first quantity here – the option gamma.

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[3] Deltas can also move quickly towards one if there is a sharp rally.

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The gamma at any instant is a function of the strike of the call, the prevailing spot price, the remaining time to expiry, and the prevailing implied volatility level. There are three important points to note:

- Gamma is high when the spot price is close to the option strike.
- The gamma is very reactive close to option expiry – the gamma of an option with a few hours remaining to expiry can move much more violently than that of an option set to expire in several days.
- Gamma is high when implied volatility is low and vice versa.

A smooth rally is the best market environment for the strategy

Our strategy sells deep OTM S&P 500 calls. The gammas of the options sold are at their highest when the S&P 500 rallies such that it is close to their strikes in an environment of low implied volatility. It stands to reason that for the major contributor of strategy performance, i.e. option gamma, to be high, a gentle rally is the ideal environment. Note that this is also the environment in which realised volatility is typically low compared to its implied counterpart, leading to a material difference between implied and realised variance, which the strategy can monetise through delta-hedging.

And of course, when realised volatility is low in a rally, the delta hedge can be rebalanced more smoothly (see charts below, which show how smoothly the delta rises in two recent examples of such a rally). The delta hedge requires being long the index. It accumulates P&L in a smooth rally.

A rally with low volatility means that the delta hedge can accumulate a long position smoothly
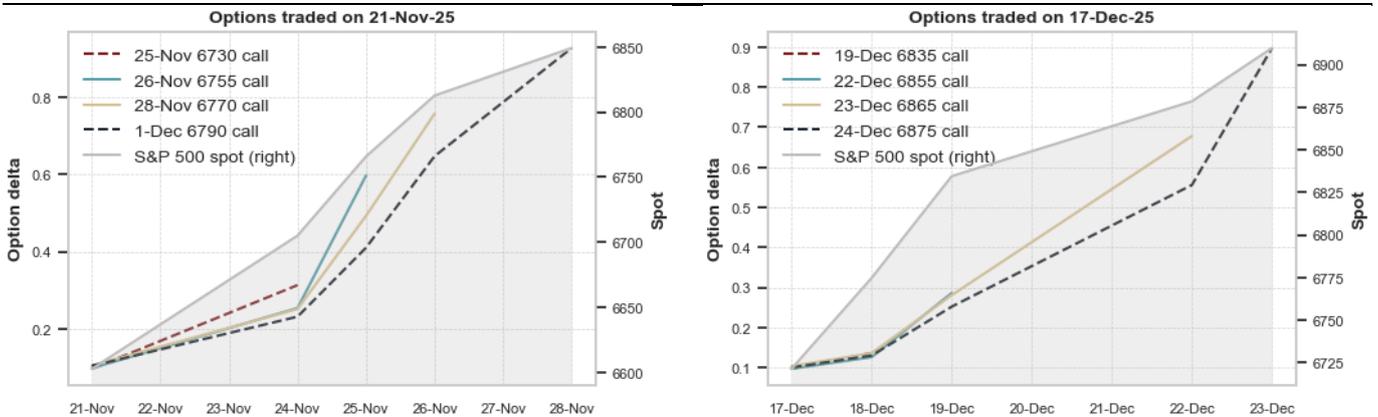
Source: Bloomberg, SG Cross Asset Research/Quant, Optionmetrics

Option gammas rise quickly when spot gets close to strikes
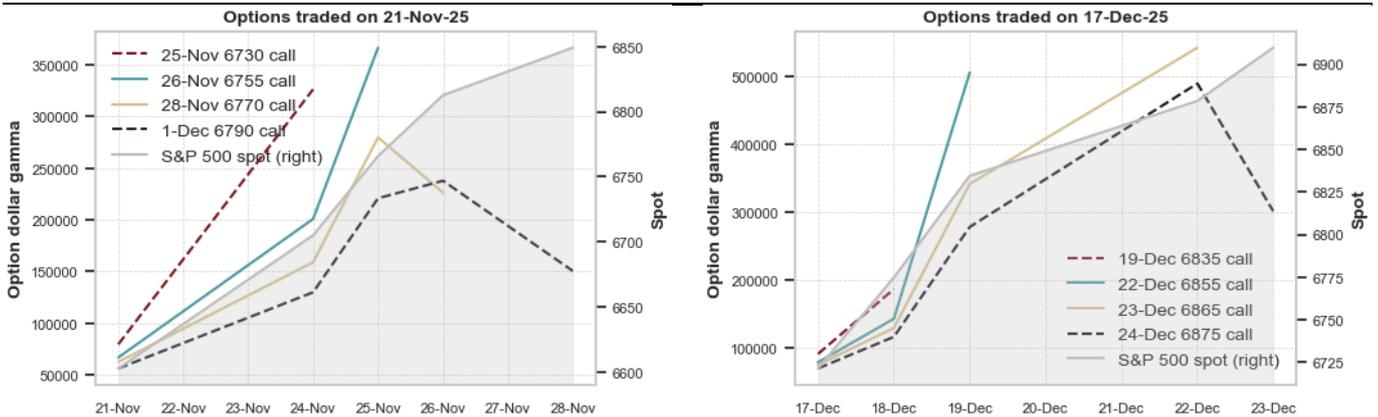
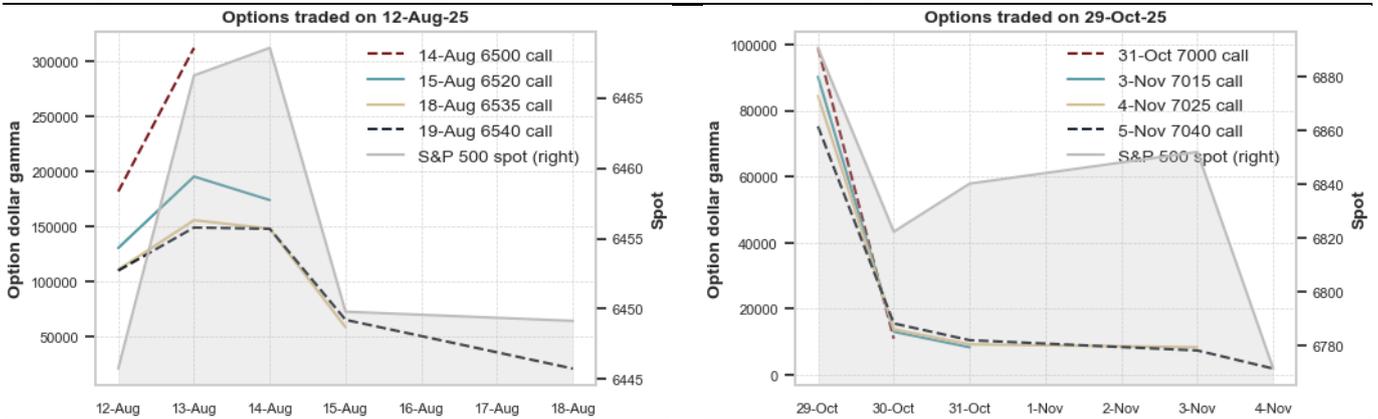Source: Bloomberg, SG Cross Asset Research/Quant, Optionmetrics

A highly volatile rally is the downside scenario for the strategy

A rally with realised volatility can be the worst environment for the strategy. The rally causes the gammas of the call options sold to be elevated as the spot travels close to the option strikes. High realised volatility means that the difference between implied and realised variance could turn materially negative. Combined with high gamma, the option portfolio is more likely to monetise a loss.

A rangebound market or a sell-off lead to the strategy having close to zero performance – the strategy is insensitive to these environments

The chart on the left below shows a recent instance in which the S&P 500 was rangebound, while that on the right shows a sell-off. Gammas of various 10-delta options quickly decline – the P&L on these options can monetise declines quickly.

Option gammas decline quickly in a rangebound market or a sell-off – the strategy accumulates little P&L at these times
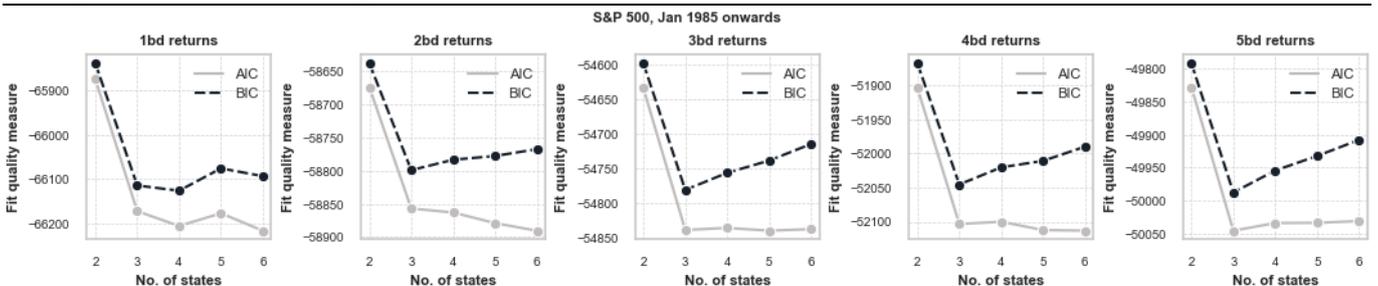

Source: Bloomberg, SG Cross Asset Research/Quant, Optionmetrics

Historical S&P 500 returns show four distinct modes – Smooth and volatile rallies, moderate and tail sell-offs

We now try and understand the main market environments that have historically occurred for the S&P 500. We go back to January 1985 – a couple of years before the 1987 Black Monday crash. We calculate histories of one-, two-, three-, four- and five-business day returns on the index. We fit Gaussian Mixture Models (GMMs) to these time series and find that models with three or four states are good descriptors of market behaviour (see chart below).

Three- and four-state GMMs are good fits for short-term S&P 500 returns

Source: Bloomberg, SG Cross Asset Research/Quant

Typically using three states gives us a state corresponding to a low volatility rally, a moderate sell-off and a last state that represents a sharp tail sell-off. Using four states allows us to see an infrequent but potentially harmful state for the strategy – one corresponding to a sharp, volatile rally. The tables below show the parameters for the four state fits for two- and five-business day returns.[4] Rows corresponding to this state are shaded in light grey.

GMM fit for two business day returns highlighting the volatile rally state

State	Mean two b.d. return	Std. dev. of two b.d. return	State weight
Gentle rally	+0.27%	0.83%	56.9%
Moderate sell-off	-0.76%	1.41%	28.1%
Volatile rally	+1.57%	1.44%	11.2%
Tail sell-off	-0.82%	4.47%	3.9%

Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant

GMM fit for five business day returns highlighting the volatile rally state

State	Mean five b.d. return	Std. dev. of five b.d. return	State weight
Gentle rally	+0.57%	1.22%	55.1%
Moderate sell-off	-1.40%	1.96%	27.2%
Volatile rally	+2.40%	1.85%	13.7%
Tail sell-off	-1.37%	6.48%	4.0%

Source: Bloomberg, SG Cross Asset Research/Quant

A gentle rally – the most favourable state for the strategy – has historically been the most frequent.

P&L impact of the four states

One way to verify our observations regarding the behaviour of the strategy in various scenarios is to do a set of rudimentary simulations of S&P 500 returns over a short period of time. We can translate these simulations into performance of selling short-dated intra-day delta-hedged OTM calls.

Suppose we are trying to understand performance over a short horizon, say two business days. We can do the following:

■ We can simulate intra-day spot moves in each of the aforementioned four states. We use the GMM state parameters mentioned in the first table above (i.e. for two business day returns). Note that the mean and standard deviations are mentioned for a two-day horizon. We need to scale them to use for intra-day moves. We delta-hedge six times a day in our simulations, and so we divide the means mentioned by 2 x 6, and the standard deviations by the square root of 2 x 6.

■ We limit ourselves to a *static* portfolio comprising a call expiring in one business day, and a second expiring in two business days. This is a crude simulation that aims to aid our thinking; we do not introduce extra complexity by trying to replace the expiring one business day option. Our portfolio does not carry options that expire beyond the two-day horizon. This is also unrealistic but does not detract from helping us develop a broad understanding of the strategy's behaviour.

■ We also do not assume changes in implied volatility through the simulation period. This introduces small deviations from reality in option valuations and deltas.

■ Furthermore, since we are only considering a two-option portfolio, its return magnitudes should be smaller than a more realistic one that would carry more option positions.

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[4] We do not show the model parameters for one-, three- and four-business day returns to avoid showing repetitive results.

■ Finally, for each regime we use market data starting on the most recent occurrence of the regime. This means 12 January 2026 for gentle rally, 17 December 2025 for moderate sell-off, 25 November 2025 for volatile rally and 10 April 2025 for tail sell-off.

With the caveats out of the way, we look at the two-day performance distributions for each state. We note the following:

■ The gentle rally state has the expected profile – most of the probability mass is concentrated on the right. The modal performance is positive.

■ The volatile rally state has a significant probability of material downside. Again, this is as per our expectations.

■ The moderate sell-off state has a return distribution *biased to the upside*. This is a function of market prices at the time of entry. A moderate sell-off is typically accompanied by a parallel shift in the implied volatility surface. The strategy receives a higher premium (compared to the typical pricing in a gentle rally) from call selling. As the market declines and the delta position quickly goes to zero, the net impact is a high probability that a significant fraction of the call premium is retained.

■ Finally, the return distribution for a tail sell-off is a little biased to the left, but with a substantial right tail. This makes sense - the strategy sells high premium calls at this time, but the highly volatile market means that the delta position could end up with a significant profit or loss. And this delta position P&L can have a large magnitude compared to initial option premium collected.

The most commonly occurring states, "gentle rally" and "moderate sell-off", have favourable performance distributions while "volatile rally" has the worst in a rudimentary simulation
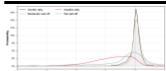
Source: Bloomberg, SG Cross Asset Research/Quant, OptionMetrics

Avoiding the adverse sharp rally

Predicting market moves is impossible. However, we can do the next best thing – we can try and understand the risk of a sharp rally and so decide when to unwind a position in the strategy and thus reduce the chances of a material drawdown.

The chart below shows the rolling 12-month count of material five business day rallies. It also shows the largest rally in each rolling 12-month period. We see a large cluster of such rallies during periods of market distress – the Great Depression of the 1930s, the mid-1970s, the Dot-com bust, the GFC, the Eurozone crisis, COVID-19, the slow sell-off of 2022 and after the April 2025 Trump trade unwind. This points to a simple heuristic – unwind the strategy following a material sell-off to avoid the high probability of whiplash. This rule gives the investor one advantage: we

expect the strategy to have small positive or negative P&L as the market sells off. Unwinding at this time means that the investor does not have to do an expensive forced unwind.

This is also a sensible approach for an investor using the strategy to fund a hedge for a market drawdown. The hedge should gain in the material sell-off, but the funding leg comprising the short short-dated call strategy should have relatively small positive or negative P&L. Unwinding the funding strategy at this point would allow the investor to have nearly the full benefit of hedge performance.

We cannot and do not expect this simple heuristic to help avoid all sharp rallies, especially those that occur in benign markets on the back of unexpected positive news. But it should help reduce losses at a significant minority of instances.

Large, volatile rallies have typically occurred during periods of stress, and often following material sell-offs
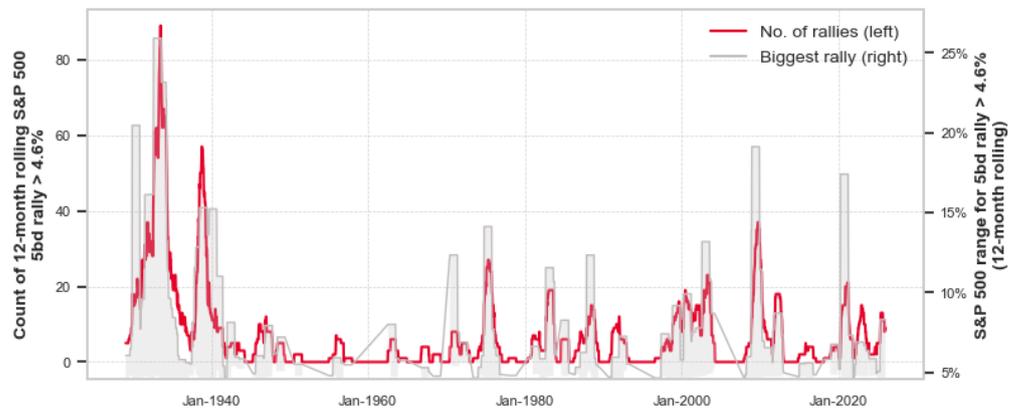
Source: Bloomberg, SG Cross Asset Research/Quant

Commodity carry – Keep your foot on the gas

Adjusting for the structural evolution of the US gas landscape

BCOM weighted carry struggled during 4Q25, being short BCOM vs BCOMF3, underperforming by 1.1% between 30 September and 30 November. The culprit: natural gas (the dominant driver of VaR in BCOM – see the chart below). While the visible trigger was an early winter polar vortex that made temperatures plunge across North America, the less visible backdrop is a US gas market that has structurally changed over the past decade: as a side effect of rapidly growing shale oil production, the US has turned itself into a major LNG exporter – in 2024, every fifth MMBtu of gas produced was export bound.

As we describe in our recent piece on commodity carry and summarise below, carry has benefitted from being short gas market beta, in conjunction with a downward drift in gas prices brought on by the US shale revolution. The arising structural risks to consider for BCOM weighted carry are: **Downside risk:** will a burgeoning export bid reverse the downtrend in US gas prices of the past two decades? **Upside risk:** with 68% of exports bound for other Northern hemisphere countries, the US may be exporting molecules, but at the same time, is it re-importing weather risk it is already short? Put differently, will a growing export market amplify seasonality and increase the winter weather risk premium, ultimately benefitting carry?

% of Value-at-Risk explained: while BCOM in 2026 will allocate only 7.2% of its weight to natural gas, natural gas contributes 35% to the total VaR generated in BCOM weighted F0/F3 carry
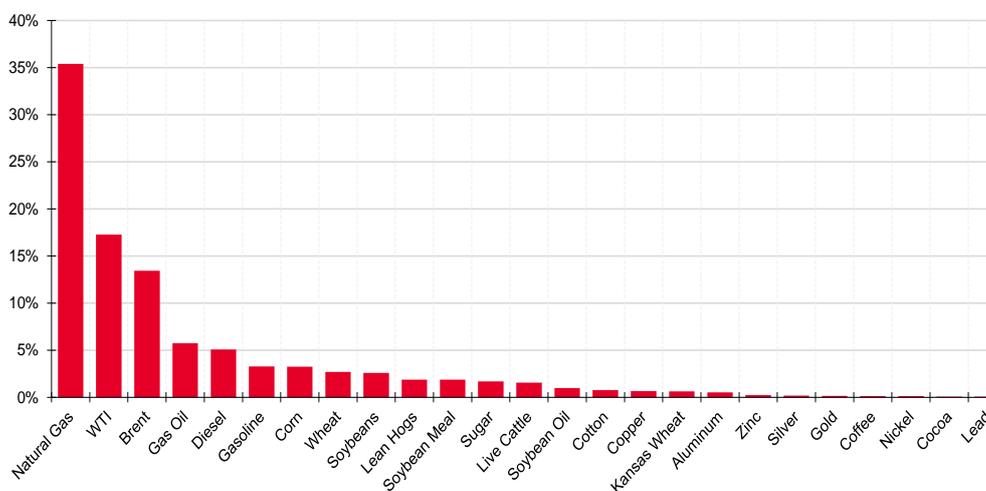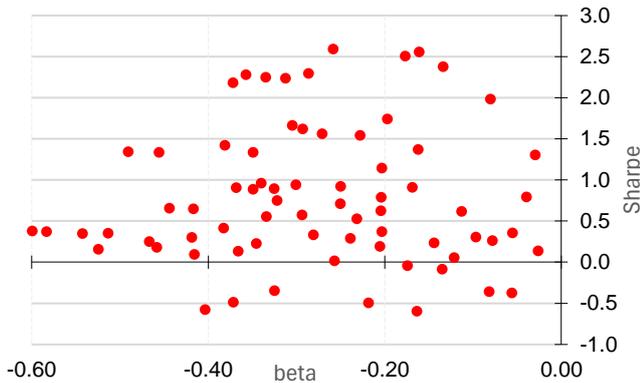

Source: SG Cross Asset Research/Commodities

"Two for the price of one" or "double trouble"?

BCOM weighted index carry is designed to be equally exposed in notional terms on both the (short) front leg and the (long) back leg. The result in a typical contango market is a short beta exposure. Why?

Firstly, in a contango market (where the front of the term structure is cheaper than the back), it forces a larger contract exposure in the front than in the back. Secondly, the Samuelson effect makes the front of the term structure more volatile than the back. As a result, natural gas carry –

which has been contango 78% of the time[5] – is not just short time spreads but also (mostly) short beta to the market. Will the short beta continue to contribute to a positive performance drift as it has over the past two decades? If the down trend in gas prices arrests or even reverses, the inherent doubling down on a bearish view – short beta and curve steepening – risks turning into double trouble.

Reducing beta does not necessarily reduce Sharpe...

... but it does reduce gas carry risk[6]
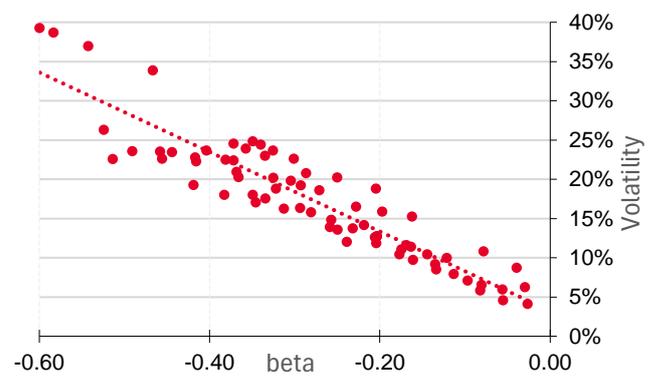
Source: SG Cross Asset Research/Commodities

From worse to bet(t)a: hedge downside and keep the upside

The upside – a potentially more pronounced winter weather risk premium expresses itself in carry through richer front-month time spreads that weaken if adverse weather does not materialise. The downside – a potential weakening of the downdrift in gas prices – is transmitted largely through the short beta inherent in gas carry. But this beta morphs through time and depends on the specific implementation of carry along the term structure. For investors concerned with a potential change in gas market structure, the obvious approach is to minimise beta – either by dynamically managing the tenor exposure of carry through the calendar year to keep both legs in the same season or alternatively by risk directionally hedging the trade's inherent beta. We illustrate the sensitivity in the table below.

Carry beta is dependent on incarnation and month of the year: beta increases with legs in different seasons, as we see along the diagonal from top left to bottom right

	F0/F2	F0/F3	F0/F4	F0/F5	F0/F6
January	-0.25	-0.30	-0.33	-0.34	-0.35
February	-0.23	-0.27	-0.29	-0.30	-0.38
March	-0.13	-0.16	-0.18	-0.26	-0.31
April	-0.10	-0.11	-0.20	-0.25	-0.33
May	-0.08	-0.21	-0.26	-0.37	-0.42
June	-0.16	-0.22	-0.32	-0.37	-0.40
July	-0.20	-0.32	-0.37	-0.42	-0.44
August	-0.24	-0.35	-0.38	-0.42	-0.51
September	-0.23	-0.28	-0.29	-0.46	-0.52
October	-0.17	-0.20	-0.35	-0.46	-0.49
November	-0.08	-0.47	-0.54	-0.58	-0.60
December	-0.20	-0.29	-0.33	-0.36	-0.37

Source: SG Cross Asset Research/Quant

[5] We compare the first to the sixth nearby since 2012
[6] F0/F2, F0/F3, F0/F4, F0/F5 and F0/F6 carry by month starting on December 29, 2006

VIX carry attractive due to steep and concave futures curve

We discussed three systematic strategies that look to benefit from the rolldown and the concave shape of the VIX futures curve in September in Low realised volatility and hedge demand have made VIX carry attractive:

1) Strategy #1: systematically sell constant tenor one-month VIX futures synthesised using the first and second futures contracts. This aims to monetise the rolldown from the one-month point to spot on the VIX curve.

2) Strategy #2: combine Strategy #1 with systematically buying constant tenor two-month VIX futures. This is attractive when the rolldown from the one-month point to spot exceeds that from the two-month to one-month point.

3) Strategy #3: systematically selling the first future and buying the second one; akin to strategy #2 above.

All three strategies have a positive beta to the S&P 500.

Three ways of earning carry from VIX curve rolldown (curve as of 9 January 2026)
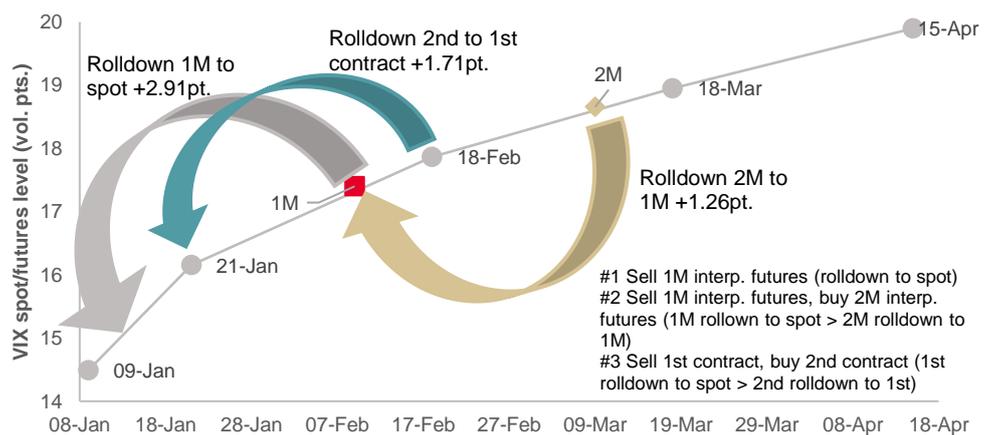
Source: Bloomberg, SG Cross Asset Research/Quant

The opportunity arises due to the steep and concave VIX futures curve (see chart above), which in turn is a result of the low volatility environment in which long VIX ETPs have accumulated substantial AUM. These ETPs, as discussed in the September paper, typically provide constant maturity exposure to VIX futures. The most common long VIX ETP is long constant tenor one-month futures. This requires buying both the first and second VIX futures, in differing weights. When the one-month maturity is close to the first futures expiry, the ETP buys more of the first than the second. As each day passes, the one-month maturity gets closer to the second contract's expiry. The ETP therefore increases its position in the second contract and reduces that in the first one. This activity causes the VIX curve to steepen, especially if there are substantial AUMs in long VIX ETPs.

The chart on the left below shows an estimate of the net AUM in long VIX ETPs. The number has come down from the recent peak after the turmoil in April last year. However, it is substantial enough to cause the VIX futures curve to remain steep and concave (right chart below).

Net AUMs in long VIX ETPs have come down since October but are on the high side relative to history

The VIX curve has remained steep and concave creating the conditions for positive rolldown when volatility is low

Source: Bloomberg, SG Cross Asset Research/Quant
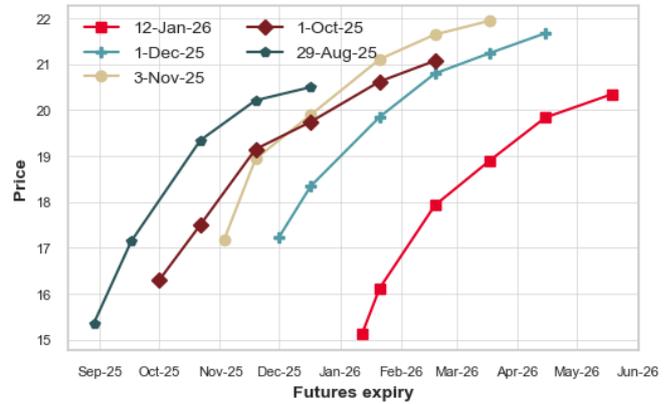
The chart below shows the historical performance of the three strategies. Strategies #1 and #2 gained in 4Q25. The quarter saw two S&P 500 mini sell-offs that were accompanied by the VIX spiking by approximately 10pt each time, and the VIX curve briefly inverting. Strategy #3 has been unable to recover from the mid-November VIX spike.

Two strategies: short one-month VIX futures, and short one-month vs long two-month VIX futures performed positively in 4Q25 despite S&P 500 sell-offs and accompanying VIX rising ~10pt in mid-October and mid-November

Source: Bloomberg, SG Cross Asset Research/Quant

We remain positive on the strategies. We expect them to continue to gain if the current confluence of (1) low realised volatility, (2) a low-conviction rally with continued demand for hedges, and (3) upwardly sloping and concave VIX futures term structure, remains in place. The latter two factors help to keep the slopes sold by the strategies at an attractive level. The first factor helps ensure that rolldown materialises as spot VIX remains contained.

The key risk is a sharp and volatile equity sell-off, which results in the VIX curve moving upwards and inverting significantly. One way to hedge this is through an overlay using a dynamic long VIX futures-based strategy that scales exposure to VIX futures with rising risk, as discussed in *ConVIXity*

Gap risk premium in equities

Equity gap put selling, which we first discussed in 2020,[7] has been an important carry strategy for us for most of the past five years. We last discussed it in mid-October last year in the middle of a 4.5% drawdown in the S&P 500. With volatility elevated, gap puts were pricing in material downside at that time – systematically selling gap puts was attractive on a risk-reward basis. Our previous analyses have shown that the strategy is not only more resilient to sudden equity declines when volatility is somewhat elevated, but also has a better return profile than when volatility is low.

The chart below shows the downside priced with 10% probability by S&P 500 weeklies versus the realised volatility of the index. Realised volatility is currently low, and the option market is pricing tail downside very much in line with this low value (note: the situation is similar for Nasdaq 100 puts as well.)

S&P 500 realised volatility is low, and weekly options are pricing tail downside in line
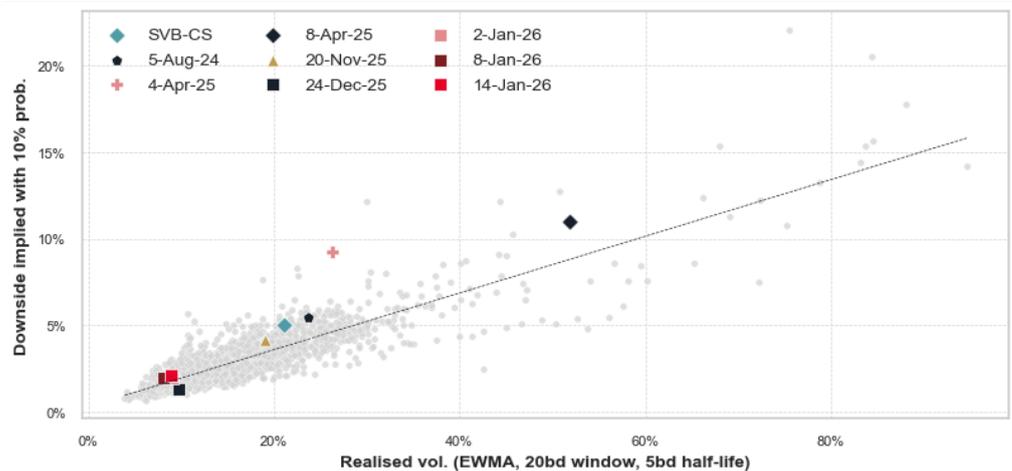
Source: Bloomberg, SG Cross Asset Research/Quant, OptionMetrics

Systematically selling tail puts is not attractive at the time of writing (14 January 2026). However, our view is that the current low volatility regime is unlikely to persist, just like our views at around this time last year. There are too many macro factors in the coming weeks and months that could rapidly push volatility higher. Our equity volatility strategists agree; their fundamental volatility model points to an elevated volatility regime for 2026.

We expect a change in volatility regime to lead to higher premiums for S&P 500 and Nasdaq 100 gap puts. And when that happens, selling these puts should become more attractive from a risk-reward standpoint.

Gap risk premium in JPY options

Monetising the gap risk premium by selling short-expiry, deep-OTM puts on USDJPY (or EURJPY) is interesting currently as the yen remains under sustained pressure. These puts have become more expensive recently, with both a pick-up in short-dated ATM implied volatility and an

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[7] See The penny and the steamroller (August 2020).

increase in the skewness of the volatility smile (left graph below) that has elevated the gap risk premium.

Additionally, the yen remains very undervalued despite the narrowing US-Japan rate differentials. The correlation between USDJPY spot rate and USDJPY rates differential has weakened significantly in recent months. Higher JGB yields have stoked debt sustainability concerns, and the ongoing political uncertainty has further weakened the yen. Selling one-month, 10-delta puts on both USDJPY and EURJPY has benefitted from the yen recovery failing to materialise in recent months (right graph below), and the macro dynamics stepping into 2026 remain supportive for now for these strategies to monetise the increased gap risk premium.

Deep-OTM put premia in USDJPY and EURJPY have risen with a pick-up in ATM volatility and a steeper volatility smile
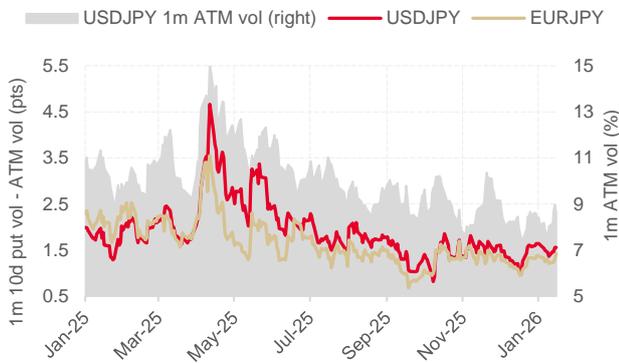
Selling one-month, 10-delta puts in USDJPY and EURJPY has benefitted from the sustained yen weakness

Source: SG Cross Asset Research/Quant
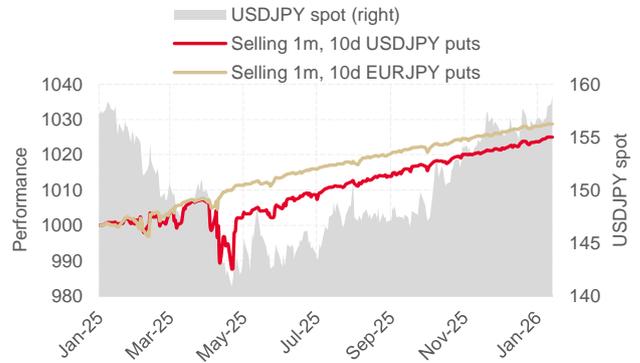
A quantitative approach to trading FX

In previous research on a factor-based approach in currencies, we identified six main factors that drive the cross-sectional performance of currencies: carry, value, momentum, reversals, volatility risk premium and quality. We found that long-short currency baskets constructed using these factors performed positively over the long term. Further, these factors have historically shown low correlation with each other on an average, highlighting diversification benefits.

We now update the recent performance of signals within these factors. Signals based on carry, value, momentum and mean reversion comprise some of the commonly traded strategies in FX. We evaluate the performance of 'long top five, short bottom five' currency baskets based on these signals in 2025. Further, we also update the relative value currency scorecards, which rank currencies based on each of these factors, with the top-ranked currencies the most attractive ones to buy, and the bottom-ranked currencies the least attractive.

Carry is dominating cross-sectional performance

Carry tends to be one of the strongest predictors of currency flows. The classic carry trade involves borrowing in the lowest-yielding currencies and lending in the highest-yielding ones. Here, we measure carry in absolute terms, based on 12-month FX forward points. The left graph below shows that there tends to be a positive relationship between the level of ex-ante carry of the carry basket and its forward returns, for an underlying universe of G10 and 16 liquid EM currencies. And the right graph below shows that the strategy has delivered a strong outperformance in the post-COVID inflationary years, with ex-ante carry at elevated levels. The strategy returned 10.1% in 2025, rebounding strongly post its April drawdown thanks to a sustained carry buffer, resurgent risk appetite and exceptional EMFX outperformance.

Ex-ante carry tends to be a good predictor of future returns for the carry strategy
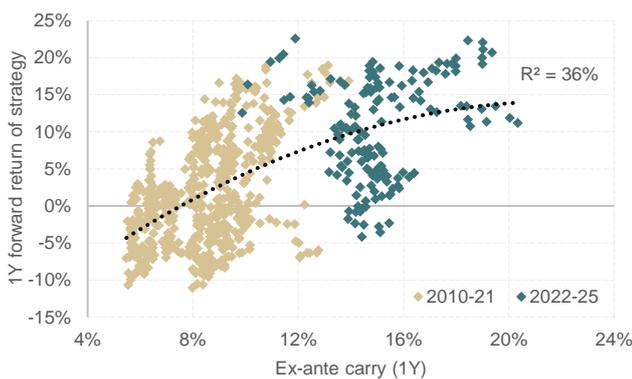
G10+EM carry strategy outperformed strongly in 2025 as the ex-ante carry remained high

Source: SG Cross Asset Research/Quant, Bloomberg

In previous research, we have also discussed other indicators that are closely related to the level of carry in currencies, and whose performance has historically been positively correlated with that of the classic carry implementation. These indicators include the carry-to-volatility ratio, nominal bond yields and risk reversals. The current ranking of currencies according to the indicators grouped within the carry factor is shown in the table below.

Ranking scorecard for G10 currencies based on carry indicators: NOK is the best currency to hold currently and CHF the worst

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD
Carry (aggregate)	**2**	**7**	**10**	**8**	**3**	**9**	**1**	**4**	**6**	**5**
Carry	3	6	10	8	2	9	1	5	7	4
Carry-to-volatility ratio	3	7	10	8	1	8	1	5	6	4
Nominal yields	1	6	10	8	2	9	2	4	7	5
Risk reversals	1	7	10	8	4	9	2	3	5	6

Source: SG Cross Asset Research/Quant, Bloomberg

Ranking scorecard for EM currencies based on carry indicators: TRY is the best currency to hold currently and SGD the worst

	BRL	CNH	CZK	HUF	IDR	ILS	INR	KRW	MXN	PHP	PLN	SGD	THB	TRY	TWD	ZAR
Carry (aggregate)	**2**	**15**	**12**	**5**	**10**	**6**	**7**	**13**	**3**	**8**	**9**	**16**	**14**	**1**	**11**	**4**
Carry	2	15	12	6	11	7	4	13	3	7	10	16	14	1	9	4
Carry-to-volatility ratio	2	16	12	6	11	6	3	13	4	8	10	15	14	1	9	5
Nominal yields	2	13	9	-	10	6	5	11	3	7	8	12	14	1	-	4
Risk reversals	2	14	11	5	6	8	12	13	3	9	7	15	10	1	16	4

Source: SG Cross Asset Research/Quant, Bloomberg

Value has suffered from a delayed yen recovery

There exist several fair value models in literature for currencies. However, we concluded in previous research on value investing in currencies that a simple model based on PPP yields the best results, and the inclusion of macro variables (such as those used in equilibrium exchange rate models) does not add much value in terms of performance, while adding a fair amount of model complexity and data uncertainty. The recent performance of a model based on PPP is shown in the left graph below. While its performance in 2025 was positive overall with a return of 0.33%, the strategy has suffered in recent months, particularly on its long JPY and short CHF positions.

The PPP-based signal here is implemented on a G10-only universe. While including EM currencies improves the performance of the PPP-based value strategy historically, the performance becomes highly correlated with that of the carry strategy. This is because EM currencies tend to be persistently undervalued relative to PPP (as discussed in our research paper on currency factors), resulting in similar EM positioning historically. We thus limit the universe for the PPP-signal to G10-only, where we observe significant deviations from PPP level currently for several currencies (right graph below).

PPP-based value strategy underperformed in 2025 due to further CHF strengthening and JPY weakening vs USD
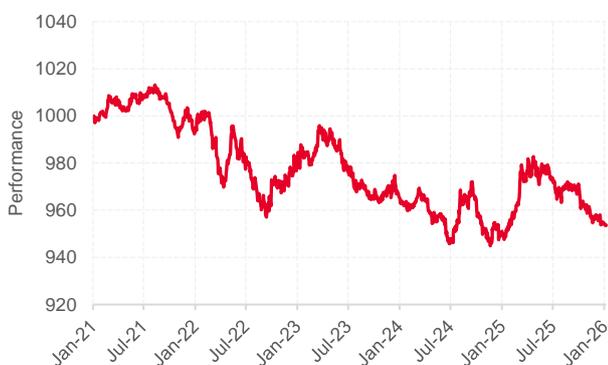
G10 currencies show significant deviation from PPP levels currently due to monetary policy and investment flows

Source: SG Cross Asset Research/Quant, Bloomberg, SGI
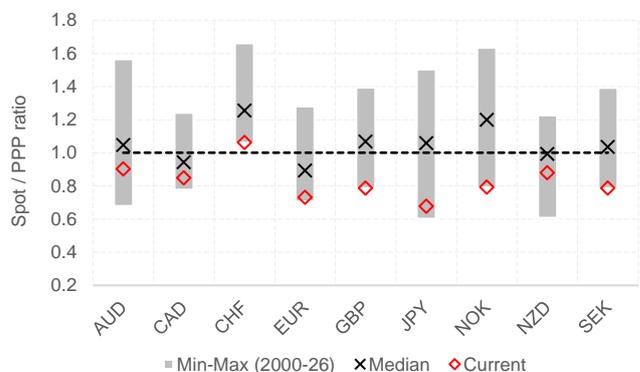
We have also discussed previously that the performance of long-term price reversion (such as over a five-year horizon) has historically been positively correlated with that of the value strategy based on PPP. The current ranking of currencies according to PPP and five-year price reversion is shown in the table below.

Ranking scorecard for G10 currencies based on value indicators: JPY is the best currency to hold currently and CHF the worst

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD
Value (aggregate)	**4**	**3**	**10**	**6**	**7**	**1**	**4**	**2**	**9**	**8**
PPP	7	3	10	2	5	1	6	4	8	9
Price reversion (5Y)	4	3	10	8	7	1	5	2	9	6

Source: SG Cross Asset Research/Quant, Bloomberg

Cross-sectional momentum has performed well

Momentum is a classic signal used in systematic trading, whose performance typically shows a low correlation with other signals based on carry and value. Here, we use a binary signal that looks at the cumulative return of the currency over a specified lookback window and is volatility-targeted. The basket is then long the top five outperformers, and short the bottom five underperformers. In previous research on trend-following, we noted that inclusion of EM currencies improves both performance and the level of diversification, and that diversification can also be improved via lookback window selection. The recent performance of the momentum signal on a G10+EM universe over lookback windows of 1m and 1y is shown in the graph below. The current ranking of currencies based on the momentum signal is shown in the table below.

Momentum signal (lookback windows 1m and 1y) performed positively in 2025

Source: SG Cross Asset Research/Quant, Bloomberg

Ranking scorecard for G10 currencies based on momentum: EUR is the best currency to hold currently and JPY the worst

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD
Momentum (aggregate)	**5**	**3**	**4**	**1**	**1**	**10**	**6**	**6**	**8**	**9**
1M momentum	5	3	4	1	2	10	7	8	6	9
1Y momentum	5	1	4	3	2	10	7	6	8	9

Source: SG Cross Asset Quant, Bloomberg

Ranking scorecard for EM currencies based on momentum: CNH is the best currency to hold currently and TRY the worst

	BRL	CNH	CZK	HUF	IDR	ILS	INR	KRW	MXN	PHP	PLN	SGD	THB	TRY	TWD	ZAR
Momentum (aggregate)	**11**	**1**	**3**	**10**	**9**	**13**	**14**	**12**	**5**	**14**	**4**	**2**	**6**	**16**	**7**	**7**
1M momentum	11	1	4	7	8	15	12	10	5	13	3	2	9	16	14	6
1Y momentum	11	1	5	10	8	12	15	13	6	14	7	2	4	16	3	9

Source: SG Cross Asset Research/Quant, Bloomberg

Subdued FX volatility has been a headwind for reversals

Mean reversion is another classic signal in systematic trading. Here, we focus on a shorter horizon, comparing the current spot of each currency to its one-month simple moving average. The basket is then long the five most undervalued currencies based on this metric, and short the five most overvalued ones. Unlike the momentum signal, we find that the addition of EM currencies makes the performance of the short-term mean reversion signal less stable. The recent performance of the signal for a G10-only universe is shown in the left graph below. The signal delivered a strong outperformance in the post-COVID inflationary years; however, the performance has been flat in recent months given the significantly reduced realised volatility in currencies.

In previous research on value investing in currencies, we have also discussed building an indicator based on the current slope of the interest rate curve of currencies. First, the rates slope differential is calculated as the difference between the 1y1y forward rate and the 1y spot rate in the currency, minus that of the USD. We then run a linear regression on the six-month forward return of the currency and the rates slope differential historically, to forecast the 'fair value' currency level in six months based on the current rates slope differential. Once again, the basket is long the five most undervalued currencies based on this metric, and short the five most overvalued ones. In previous research on currency factors, we found that this signal falls into the reversals group of signals upon clustering analysis. The recent performance of such a signal based on rates expectations for a G10-only universe is shown in the right graph below. Despite its outperformance during the post-COVID rate hike cycle in 2022, and again at the end of monetary tightening in 2024, the strategy failed to hold on to gains and has suffered in recent months, particularly on its short CHF, NOK and SEK positions.

Short-term mean reversion delivered a flat performance recently as FX volatility has reduced significantly

The signal based on the medium-term rates slope differential underperformed in 2025

Source: SG Cross Asset Research/Quant, Bloomberg, SGI

The current ranking of currencies according to the short-term price reversion and the signal based on rates expectations is shown in the table below.

Ranking scorecard for G10 currencies based on reversals indicators: JPY is the best currency to hold currently and SEK the worst

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD
Reversals (aggregate)	**7**	**2**	**6**	**5**	**8**	**1**	**9**	**3**	**10**	**4**
Price reversion (1m)	8	2	6	3	10	1	7	4	9	5
Rates expectations	6	2	7	8	5	1	9	3	10	4

Source: SG Cross Asset Research/Quant, Bloomberg

Aggregate G10 scorecard

At an aggregate level, the high carry currencies - CAD, NZD, AUD and GBP - appear to be the most attractive currencies to hold currently, while CHF and SEK appear to be the least attractive, if we assume that each factor ranking (carry, value, momentum and reversals) should be equally weighted. USD sits towards the bottom of the pack, still supported by momentum and carry, but quite overvalued according to the value and reversals signals.

Ranking scorecard by factor for G10 currencies (January 2026)

	AUD	CAD	CHF	EUR	GBP	JPY	NOK	NZD	SEK	USD
Aggregate (equally weighted)	**4**	**1**	**9**	**5**	**3**	**7**	**6**	**2**	**10**	**8**
Carry	3	7	10	8	1	9	2	4	6	5
Value	4	3	10	7	6	1	5	2	9	8
Momentum	4	2	3	7	1	9	4	10	7	4
Reversals	4	5	6	10	6	1	3	2	8	9

Source: SG Cross Asset Research/Quant, Bloomberg

However, it is worthwhile noting that these factors have different trading horizons and turnover: in previous research, we found that the Spearman rank correlation between currency rankings remains fairly stable for carry and value signals up to a year, but decays rapidly within the first month for momentum and reversals signals. This implies that the trade horizon (or rebalancing frequency) should also be considered for applying appropriate weights to the rankings based on the various factors, to obtain an optimal aggregate scorecard, for example to use for a systematic currency hedging strategy.

In summary, diversification across signals remains key for systematic strategies. Carry clearly dominated cross-sectional FX performance in 2025. Momentum also outperformed, while value and reversals signals lagged. The carry buffer remains attractive to enhance portfolio returns, and momentum can serve to diversify risk as a traditionally uncorrelated signal.

2025 was a great year for equity quant

Bottom-up, multi-factor strategies

Traditional equity quant strategies navigated a complicated 2025 smoothly, continuing to deliver strong performance. This marks the fifth consecutive year of positive performance. Their resurgence follows the challenging 'quant winter' of 2019-2020, when such strategies experienced significant and prolonged drawdowns. Since then, their recovery has been remarkably consistent, reviving attention in equity quant strategies.

Our bottom-up, long/short equity factor strategy delivered strong results in 2025. The global strategy, which we highlighted in Quant Spring: Systematic stock picking is working, and we think an equity factor overlay approach makes sense, gained 19%, with a volatility of 7% this year. We believe an equity factor overlay approach remains interesting, especially as the current market environment favours greater stock performance differentiation, an essential driver for stock-picking strategies. Building on this, we will be launching live investable indices based on this strategy later this month. In addition to this more traditional approach, we are also introducing a new strategy that incorporates our machine learning-based factors alongside traditional factors.

Global long/short bottom-up factor performance has bounced back (net of transaction costs)
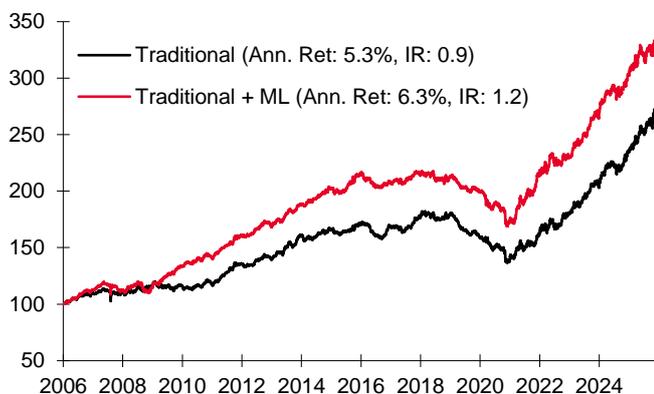
and performance in 2025 was exceptional

Source: SG Cross Asset Research/Quant, FactSet

Below is a summary of our methodology. We will also provide further updates and details about each strategy following their launch.

Global bottom-up, long/short equity methodology
We optimise exposure to our bottom-up equity factors while limiting exposures to other common risk factors. For **a) the Traditional strategy:** we maximise a 3-factor score, defined as the average of our Value, Momentum, and Fundamental Quality scores and for b) **the Traditional + ML strategy:** we maximise a 5-factor score, defined as the average of our Value, Momentum, Fundamental Quality, Monthly ML and Weekly ML scores.

Each month, we run the following long-short optimisation, and we implement the new weights with a two-day execution lag:

- **Universe:** Global Developed Markets large/mid-caps.
- **Weight:** less than +/-50bp.
- **Country weights:** constrain within +/-5%.
- **Sector weights:** constrain within +/-2.5%.
- **Avoid negative exposure to any of our 5 core equity factors shown below.**
- **Limit exposure to Size factor:** constrain within +/-0.4 standard deviations.
- **Long-short ex-ante volatility:** max 5%.
- **Monthly two-way turnover:** 50% of the optimal turnover for the traditional strategy and 75% of optimal turnover for traditional + ML.
- **Liquidity:** max 10% ADV trading and 50% ADV holding assuming $1,000m capacity at each rebalancing.
- **Minimum weight:** when a new stock is selected, it will be assigned at least a 25bp absolute weight (relaxed to 10bp for existing stocks).

SG Quant core equity factors

Value	Combined Momentum	Fundamental Quality	Low Risk	Growth
• Book to Price • Earnings to Price • 1-year forward Earnings to Price • EBITDA to EV* • Free Cash Flow Yield* *excludes financials* *all relative to Sector*	**Price Momentum** •12-month residual (beta-adjusted) momentum lagged by 1-month **Earnings Momentum** •Combined revisions ratio based on FY1 and FY2 EPS upgrades versus downgrades divided by total number of analysts providing estimates *Earnings Momentum is calculated relative to Sector*	**Ex-Financials** •Gross Profits/Assets (GPOA) •5-year GPOA Trend •FCF on Invested Capital (FCFROIC) •5-year FCFROIC Trend •Total Accruals •Net Operating Asset Accruals •Change in Asset Turnover •External Financing **Financials** •ROE •5-year ROE Trend •Asset Growth •External Financing *all relative to Sector*	**Ex-Financials** • Merton's distance-to-default **Financials** • 6-month price volatility	**Ex-Financials** • Long Term Growth • One Year Forward EPS Growth • Free Cash Flow Per Share Growth • 5-Year Risk-adjusted Trend in Sales Per Share • 5-Year Risk-adjusted Trend in Net Cash from Operating Activities Per Share • 5-Year Trend in Sales Per Share **Financials** • Long Term Growth • One Year Forward EPS Growth • 5-Year Trend in Earnings Per Share •Net Income Growth

Source: SG Cross Asset Research/Quant

Portable alpha

Despite the strong performance of equity quant models, implementation remains a key challenge. Highly concentrated equity markets are making it extremely difficult to extract meaningful and diversified factor exposure in a long-only context. This is evident when we deploy our traditional multi-factor strategy in two different settings: (a) constructing an optimised long-only portfolio against the MSCI World cap-weighted index, and (b) constructing an optimised long-only portfolio against the MSCI World equal-weighted index. In both cases, we measure the excess performance relative to the corresponding benchmark. In recent years, there has been significant performance divergence between the two implementations, with the cap-weighted benchmark approach failing to fully capitalise on the strong factor performance.

This divergence is a direct consequence of the reduced opportunity set caused by high market-cap concentration. The two strategies we are launching both short stocks directly, and they can also be utilised in a long-only setting as portable alpha overlays. Instead of optimising for a long-

only portfolio directly, we can implement the factor model in a 130/30 or 150/50 format, which allows us to achieve high factor exposure while maintaining 100% equity beta. Such implementations have attracted significant interest this year and have more effectively captured the year's good factor performance.

Performance of MSCI World long-only implementations
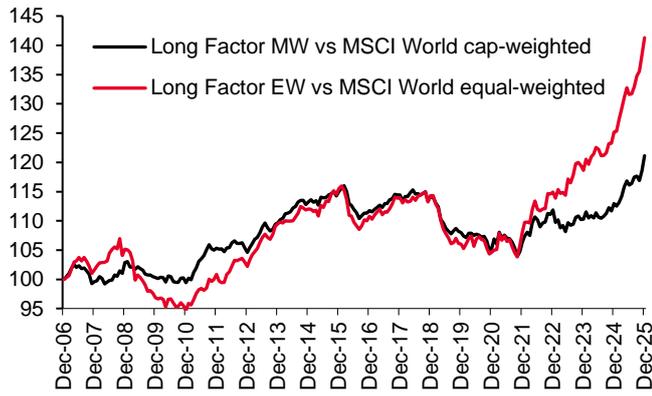
MSCI World + SG Equity Factor overlay performance (net of transaction costs, based on traditional + ML overlay)

Source: SG Cross Asset Research/Quant, FactSet
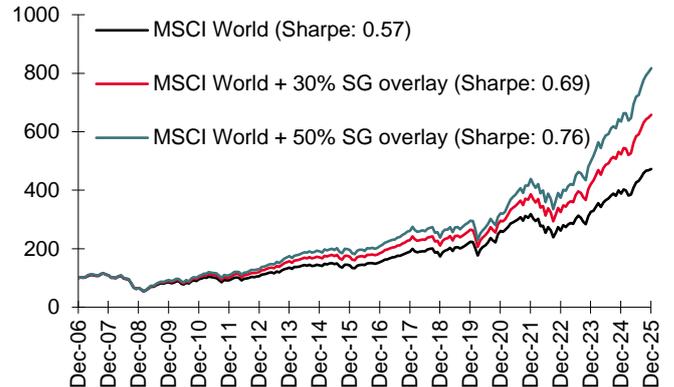
Machine learning factor-based models

Global DM monthly alpha model

We have been exploring ML-based factor stock selection models for nearly a decade. Our journey into machine learning began with the implementation of our monthly global long-short developed market model. This strategy has a live track record since March 2019, performing well during the Quant Winter and generally delivering out-of-sample results consistent with its in-sample performance. However, 2025 proved to be a challenging year, as the model was more exposed to defensive factors such as low volatility, which underperformed following the market rally that began in April. This being said, its performance improved towards the end of the year, recovering 2% from the October low.

Global machine learning monthly long/short model (SGEPMLWU Index – net of transaction costs)

Global monthly long/short factor exposures (Z-Scores)
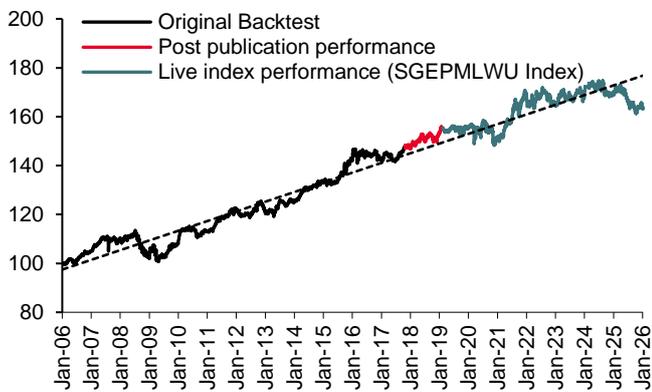
Source: SG Cross Asset Research/Quant, FactSet, Bloomberg
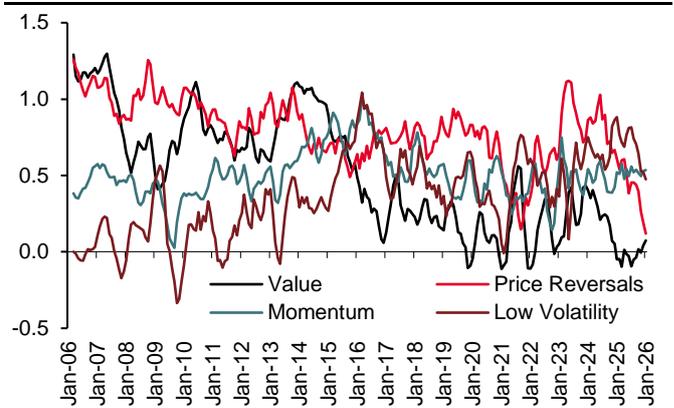
Global DM weekly reversal model

Since our original work with ML, we have explored a variety of additional applications, from deploying our framework across different universes to adapting it for predicting dividend cuts and hedging credit risk, see for example Chat GPT build me a Quant model. One of the most promising applications we highlighted earlier this year involves adapting our machine learning framework to predict stock returns over a one-week horizon - Can ML help us design a better stock mean reversion strategy? The resulting model demonstrated strong overall risk-adjusted performance in our backtests, coupled with a resilient return profile. We launched live strategies tracking this model last September. The Global strategy delivered solid performance in 2025, gaining 3%, with the US leg up strongly at +7.8%.

The model is not trained to be a mean reversion strategy. Instead, it is left unconstrained to find the best factor mix to predict 1-week returns and naturally identifies price-reversal, as well as earnings momentum, both commonly used factors in stock mean reversion models. It improves on traditional reversal strategies through utilising a wider range of factors and decreasing turnover and hence implementation costs.

Machine learning-based weekly long/short performance across regions (net of transaction costs)

Global weekly long/short factor exposures (Z-Scores)

Source: SG Cross Asset Research/Quant, FactSet, Bloomberg
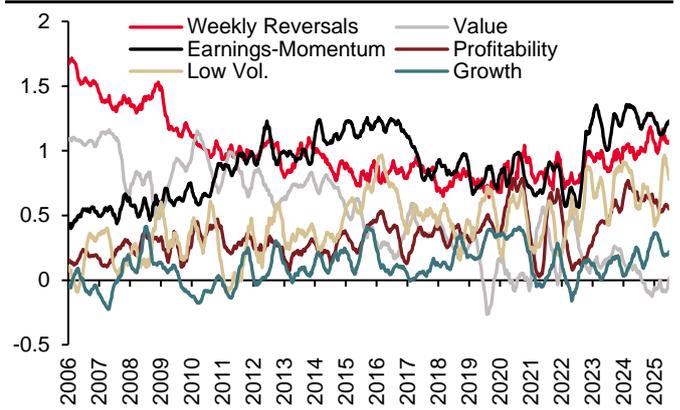
Due to its mean reversion nature, the model benefits from large irrational swings in markets, that subsequently revert. It therefore thrives in high volatility, low liquidity environments, more common during periods of crisis. Whilst it has a defensive profile similar to other strategies, it remains primarily an alpha strategy capable of generating positive returns in calmer markets.

ML equity mean-reversion thrives in high volatility (global long-short performance by VIX quintile, annualised)
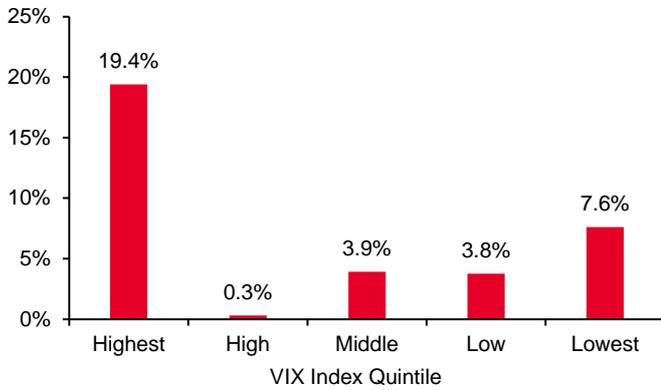
Returns in crisis vs normal periods for ML equity mean-reversion next to traditionally defensive strategies

Source: SG Cross Asset Research/Quant, Bloomberg
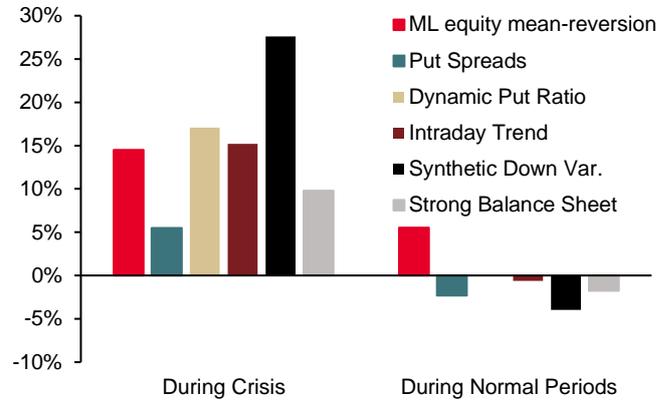
Top-down factors

Individual equity factors generally performed well in 2025, with the Value factor in particular delivering solid returns across markets. The notable exception was Low Risk/Low Volatility-type factors, which have experienced a significant drawdown since April. Following the initial sell-off in April, high-volatility stocks rebounded strongly, posting substantial gains. This trend was especially pronounced in the US small-cap segment, but it was also evident in other markets. Consequently, defensive strategies and multi-factor models that incorporate low volatility elements have faced challenges. As mentioned previously, our ML monthly model was among those negatively impacted. The charts below are based on our investable equity factor series, which are implemented on a long the factor portfolios, short the equal-weighted benchmark format.

Equity factor performance in 2025 (long the factor portfolio short the equal-weighted benchmark)
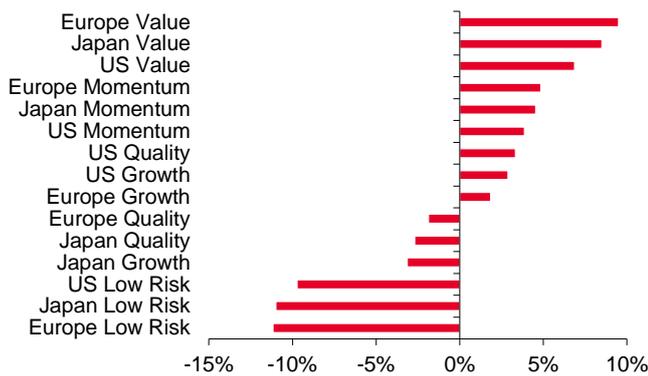
Source: SG Cross Asset Research/Quant, Bloomberg

Top-down factor combinations to the Value, Momentum and Quality factors
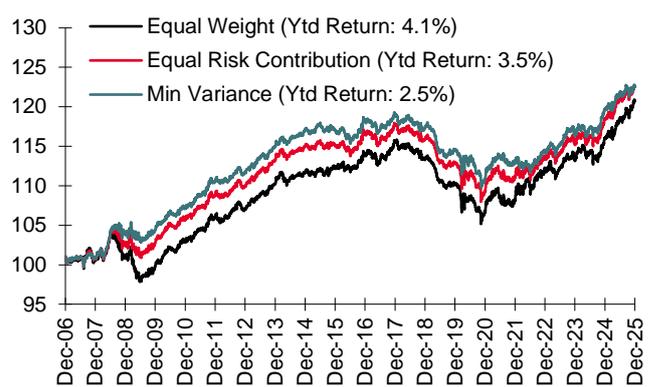
A bottom-up scorecard for equity factors

Below, we examine the current bottom-up fundamentals of our factor portfolios. We start by assessing how attractive they are relative to one another – for example, evaluating the Value exposure/score of the Quality basket today. We also provide historical context by calculating a percentile ranking of each current score versus its history since 2006. Finally, we calculate an aggregate score by simply averaging the individual factor scores.

Factor			Percentile Scores (current level versus history since 2006)					
Ticker	Region	Style	Value	Momentum	Low Risk	Fundamental Quality	Growth	Average Score
SGEPVLBE	Europe	Value	n/a	23.60%	46.70%	46.70%	92.20%	52.30%
SGEPCMBE	Europe	Momentum	82.40%	n/a	37.70%	91.80%	70.80%	70.68%
SGEPLRBE	Europe	Low Risk	57.50%	44.60%	n/a	66.90%	12.40%	45.35%
SGEPFQBE	Europe	Fundamental Quality	75.90%	37.30%	22.30%	n/a	86.20%	55.43%
SGEPGBE	Europe	Growth	77.20%	67.80%	6.40%	86.60%	n/a	59.50%
SGEPVLBJ	Japan	Value	n/a	77.20%	74.60%	18.00%	81.50%	62.83%
SGEPCMBJ	Japan	Momentum	52.30%	n/a	32.60%	24.00%	36.40%	36.33%
SGEPLRBJ	Japan	Low Risk	47.60%	32.60%	n/a	24.80%	15.00%	30.00%
SGEPFQBJ	Japan	Fundamental Quality	1.20%	59.60%	6.00%	n/a	70.80%	34.40%
SGEPGBJ	Japan	Growth	80.60%	24.40%	9.80%	86.60%	n/a	50.35%
SGEPVLBU	United States	Value	n/a	58.70%	66.00%	1.70%	32.10%	39.63%
SGEPCMBU	United States	Momentum	44.20%	n/a	31.70%	76.80%	44.20%	49.23%
SGEPLRBU	United States	Low Risk	62.20%	32.10%	n/a	26.10%	18.40%	34.70%
SGEPFQBU	United States	Fundamental Quality	20.10%	14.10%	36.00%	n/a	61.30%	32.88%
SGEPGBU	United States	Growth	25.30%	16.30%	8.10%	96.10%	n/a	36.45%

Source: SG Cross Asset Research/Quant, FactSet

The standout factor from this analysis is European Momentum, which is highly attractive from a valuation perspective (82nd percentile) and scores well on our Quality and Growth factors. This is interesting, as momentum stocks generally finished last year very strongly, which would typically suggest a decline in their valuation appeal. However, momentum portfolios are naturally high turnover, resulting in substantial changes at each monthly rebalancing and causing factor exposures to vary significantly over time. According to our scorecard, European Momentum remains very well positioned going forward. Additionally, the increased overlap between Value and Momentum stocks bodes well for European Equity Quant models, which tend to have high exposure to both factors.

Strong Momentum performance in 4Q and early 2026

Factor exposures (Z-Scores) of European Momentum Portfolio
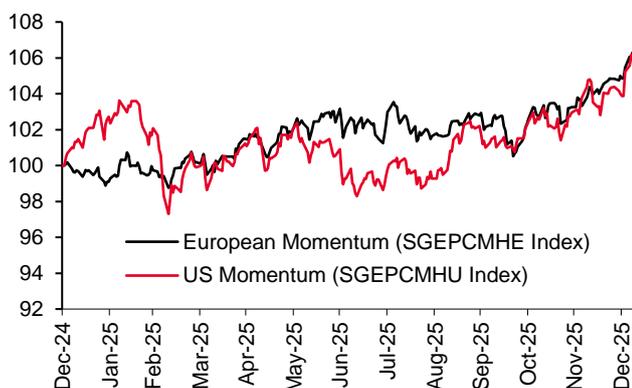
Source: SG Cross Asset Research/Quant, Bloomberg, FactSet

16 January 2026
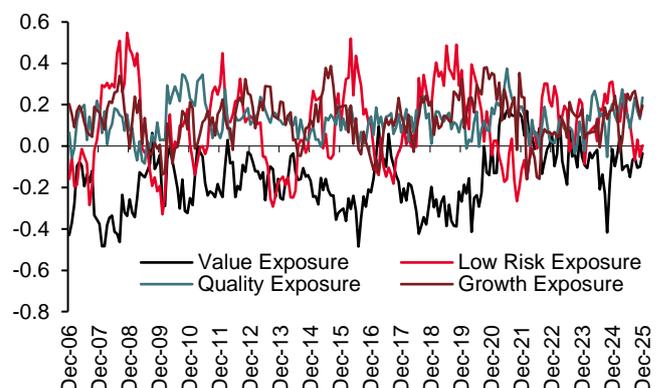
European Fundamental Quality is another factor worth highlighting, as it remains attractive on a valuation basis. As we noted in a recent publication, several individual European quality factors continue to be affected by the QE-induced valuation bubble. This has posed challenges for many European portfolio managers, who often have a quality bias. Our Fundamental Quality factor, which is based on Joseph Piotroski's F-Score, combines various fundamental quality metrics. This approach has helped outperform individual quality factors such as profitability.

QE-era valuation impact yet to fully unravel: Europe stock valuations based on a stock's correlation to 10y bond yields
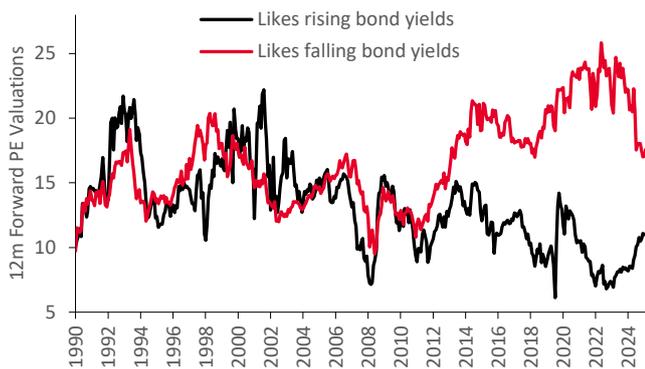
Performance of European Quality factors (long versus universe) in 2025

Source: SG Cross Asset Research/Quant, FactSet
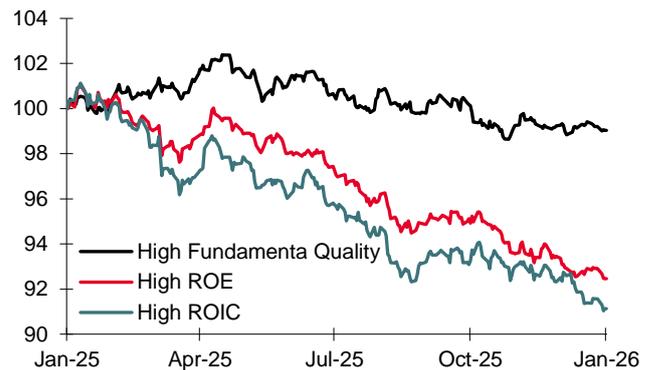
We can also run a similar analysis using specific metrics instead of the overall factor scores. This approach also highlights European Momentum and European Growth as two of the most attractive factors at present. The data used for both bottom-up scorecard tables is available through our Quant Data API across all our factor portfolios. Please let us know if you are interested in getting access.

Factor			Percentile Scores (current level versus history since 2006)							
Ticker	Region	Style	Earnings Yield	Book to Price	FCF Yield	Dividend Yield	3m EPS revisions	ROE	FCF ROIC	Average Score
SGEPVLBE	Europe	Value	53.20%	51.00%	69.50%	45.90%	3.80%	37.70%	69.90%	47.29%
SGEPCMBE	Europe	Momentum	95.20%	89.20%	59.20%	87.90%	63.00%	28.70%	11.50%	62.10%
SGEPLRBE	Europe	Low Risk	69.90%	65.20%	29.60%	68.20%	66.00%	63.00%	39.90%	57.40%
SGEPFQBE	Europe	Fundamental Quality	76.80%	78.10%	43.30%	48.90%	39.90%	26.60%	52.70%	52.33%
SGEPGBE	Europe	Growth	96.10%	62.60%	42.00%	59.20%	76.30%	84.10%	72.50%	70.40%
SGEPVLBJ	Japan	Value	40.70%	48.40%	29.60%	60.00%	74.60%	17.10%	8.50%	39.84%
SGEPCMBJ	Japan	Momentum	47.60%	33.00%	57.90%	51.90%	51.50%	62.60%	51.50%	50.86%
SGEPLRBJ	Japan	Low Risk	54.50%	69.00%	68.60%	60.00%	12.80%	48.90%	55.30%	52.73%
SGEPFQBJ	Japan	Fundamental Quality	28.30%	44.20%	29.10%	9.80%	90.90%	75.50%	97.80%	53.66%
SGEPGBJ	Japan	Growth	73.80%	94.80%	25.30%	51.00%	69.90%	15.40%	6.00%	48.03%
SGEPVLBU	United States	Value	77.20%	70.30%	41.60%	87.10%	18.40%	33.00%	18.40%	49.43%
SGEPCMBU	United States	Momentum	43.30%	39.00%	17.50%	39.40%	45.00%	75.90%	86.60%	49.53%
SGEPLRBU	United States	Low Risk	47.20%	96.50%	9.80%	36.90%	80.60%	40.30%	15.80%	46.73%
SGEPFQBU	United States	Fundamental Quality	21.80%	22.30%	7.70%	15.80%	37.70%	74.20%	58.70%	34.03%
SGEPGBU	United States	Growth	9.80%	18.40%	26.60%	10.70%	75.90%	77.60%	99.50%	45.50%

Source: SG Cross Asset Research/Quant, FactSet

Cross-asset and rates slope trend

A mixed year for cross-asset trend

2025 was a tale of two halves for trend following. It began with a sharp drawdown in April, followed by a remarkable recovery, driven primarily by an exuberant equity market and some commodities, particularly precious metals. On the other hand, FX performance was relatively flat, whilst fixed income was a significant detractor. This is reflected in the performance of our cross-asset trend strategy which was in line with the commonly used SG trend benchmark.[8]

SG trend benchmark and SG cross-asset trend in 2025

Legend: SG trend benchmark (NEIXCTAT Index); SG cross-asset trend (SGIXXATR Index)
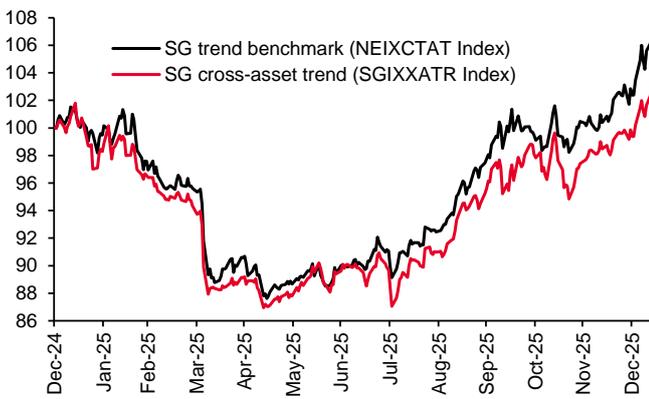
Trend following performance by asset class

Legend: Equity (SGIXEQTR Index); Commodities (SGIXCYTR Index); FX (SGIXFXTR Index); Fixed Income (SGIXIRTR Index)

Source: SG Cross Asset Research/Quant, Bloomberg
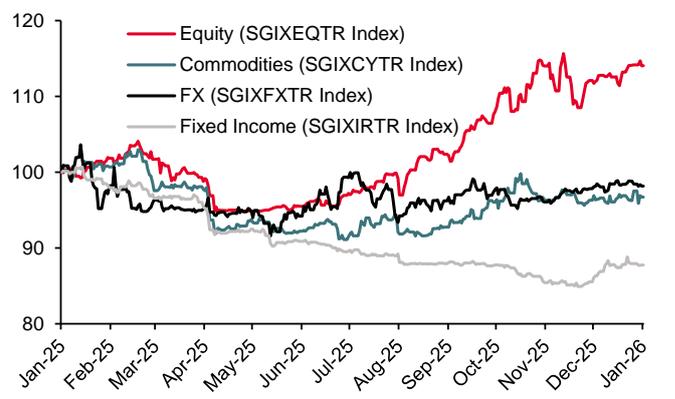
Most equity indices within the SG Trend Index delivered positive contributions in 2025, with only two exceptions. This is in clear contrast to bonds, which struggled significantly. Commodity trend performance was mixed: precious metals drove the bulk of gains, while oil and gas proved too volatile amid tariffs and ongoing global conflicts.

All but 2 equity indices trended
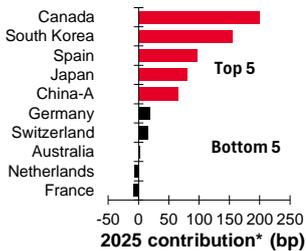
All 10y treasuries failed to improve trend returns
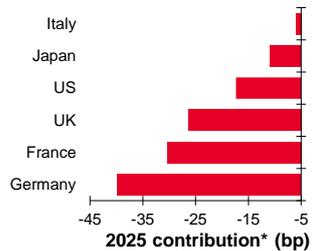
The Indian rupee has lead the way in 2025
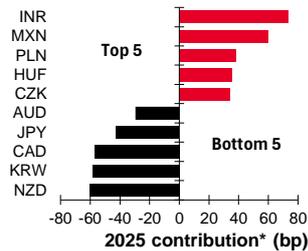
Precious metals trended whilst gas/oil did not
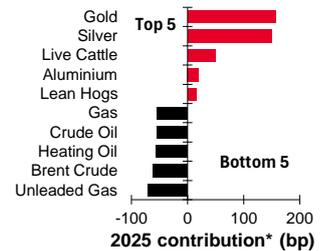
Source: SG Cross Asset Research/Quant, Bloomberg, *Estimated

Rates direction is difficult to forecast at this point. Our rates strategists' base case view for the US has rates rangebound at current levels with factors such as an expected demand shock, inflation trending higher, untethering of the longer end from the shorter end being scenarios in which material moves in 10-year rates can occur. One of these events could be a catalyst for trend in the fixed income space. The BOJ's monetary tightening was reflected in JGBs having the biggest

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[8] The SG Trend Index is a widely used benchmark for trend following, tracking the performance of a group of ten trend following managers.

short positions in 2025 and going into 2026. However, our rates strategists do not expect any further tightening.

The mixed environment has favoured gold and other precious metals which rallied strongly in 2025. This rally has now extended to industrial metals such as copper, zinc and aluminium, which now enter 2026 with long positioning.

All equity indices currently have positive weights
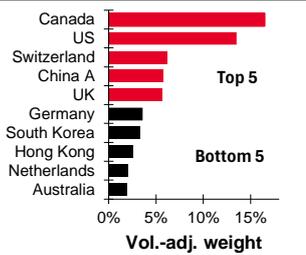
Source: SG Cross Asset Research/Quant

Japan has the most negative weight
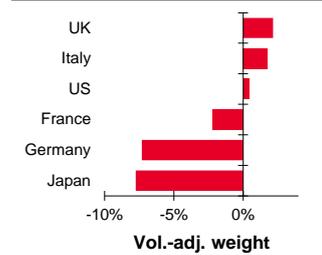
Current weights in FX
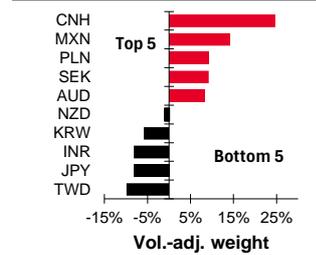
The precious metal rally broadened to industrials
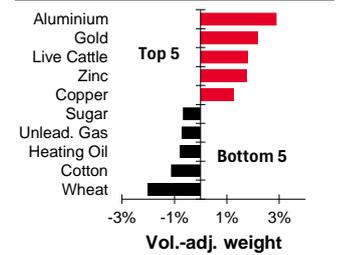
Every single equity index within SG cross-asset trend enters 2026 with long positioning. In early November, we highlighted the risks associated with trend-following portfolios becoming increasingly concentrated in equities. We were right to raise concern, with the moderate market sell-off (-4.4%) seen in November directly driving negative returns in cross-asset trend (-3.9%). This heavy equity concentration is a widespread concern for trend followers broadly. For instance, the SG trend benchmark has had a 63% correlation with MSCI World since June last year.

The picture remains positive for equity trend. The consensus price target[9] for MSCI World is a 13% increase by the end of the year, driven by double-digit growth expectations, a consensus with which our equity strategists concur. However, equity downside risk remains a thorny issue.

Total equity weight in the SG cross-asset trend index is near historical highs
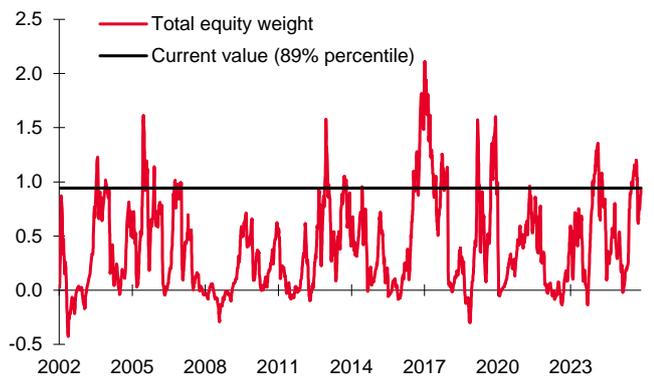
Source: SG Cross Asset Research/Quant, Bloomberg

SG cross-asset trend performance has been driven by equity returns
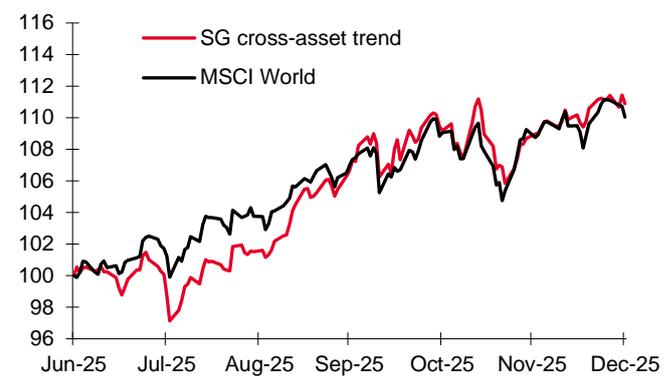
We therefore emphasise the importance of diversifying sources of returns across asset classes or time horizons, highlighting, for example, the complimentarity of cross-asset trend and an ML-based stock mean-reversion strategy back in November. The latter is beta neutral due to its cross-

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[9] Source: Bloomberg's best target price

sectional long/short construction, whilst the former can take long and short positions with varying market exposure. As a result, these strategies do not hedge each other but, with near-zero correlation, offer diversification benefits by reducing risk without sacrificing returns.

SG cross-asset trend combines well with cross-sectional equity mean-reversion (2006-2025 performance)

Legend:
- Cross-Asset Trend (SGIXXATR Index) - IR = 0.73
- ML Reversal (SGEPMRWU Index) - IR = 1.04
- 50/50 Combination - IR = 1.32
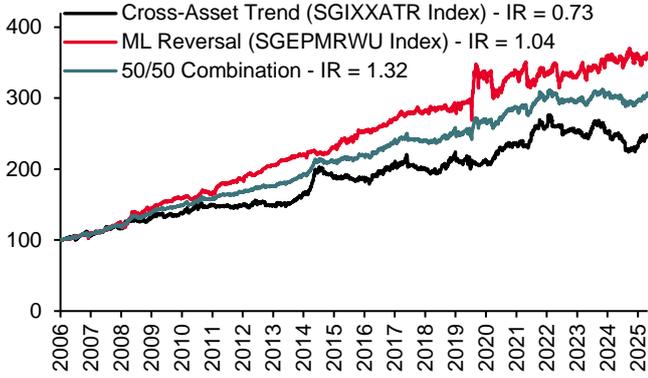
6-month rolling beta to MSCI World

Legend:
- ML equity mean-reversion
- SG cross-asset trend

Source: SG Cross Asset Research/Quant, Bloomberg
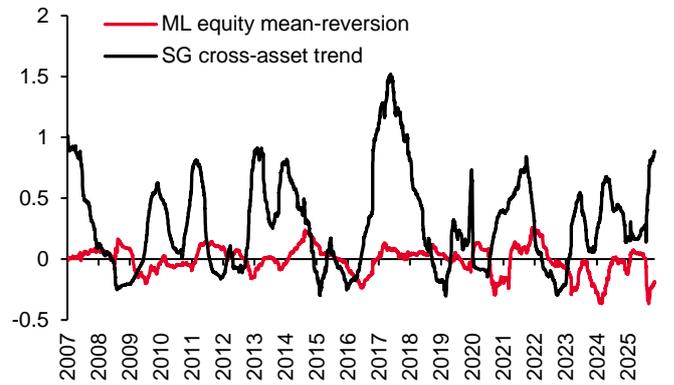
Rates slope trend benefitted from curve re-steepening

The rates slope trend following strategy enters duration-neutral steepener or flattener positions on the USD 2s20s swap curve. The strategy had positive returns in 2025, largely driven by the ~70bp curve steepening that occurred between mid-February and mid-April. Subsequently, its performance followed the 2s20s slope which broadly remained rangebound.

Our US rates strategists' base case for 2026[10] (50% probability) is for the status quo to persist with modest cuts, lower bond yields and the curve slope staying close to current levels. The rates slope trend strategy should, in this case, have small P&L moves like it did from about May 2025 until the end of the year.

However, they have two risk scenarios that diverge materially from the base case. In the more likely bearish case driven by reflation (35% probability), the Fed reacts to rising inflation by keeping policy on hold which would then mean that longer-end yields move up, and the curve steepens. Other bearish scenarios such as stagflation (higher front-end yields) or a deterioration of the fiscal outlook (higher term premiums) could also lead to higher yields where the bearish flattening/steepening could be more pronounced. However, if the Fed stays on hold, higher inflation and rising deficits could lead to a bearish steepening of the yield curve. These scenarios should lead to the slope trend strategy performing.

The bullish scenario (15% probability) sees modest steepening of the curve. Again, the scenario is slightly favourable for the slope trend following strategy.

The scenarios we have outlined here are neutral to bullish for the strategy. However, risks remain. A major one is continuous contradictory news flow that causes rates to remain rangebound, but volatile.

The steepener positioning of rates slope trend benefitted from yield curve steepening in 1H25
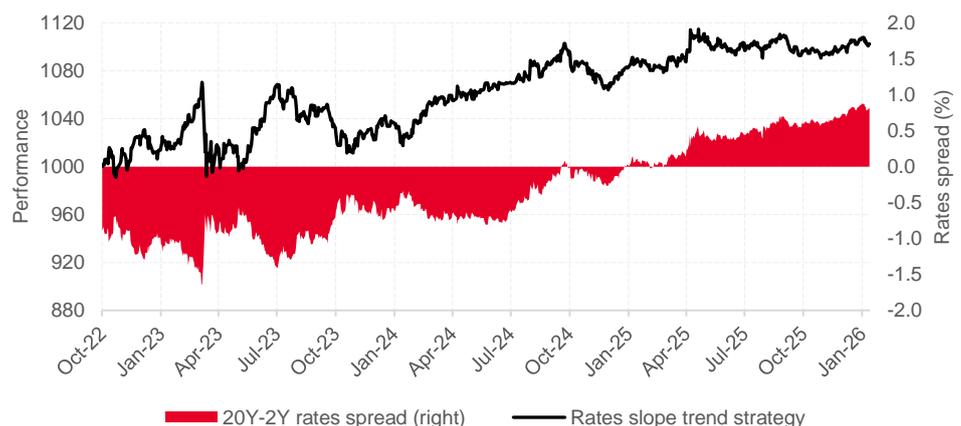
Source: SG Cross Asset Research/Quant

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[10] FI Outlook 2026 – Duration unleashed.

Hedging and rates volatility perspectives

Short-dated, fixed-leverage put spreads to hedge an underpriced, slow sell-off

A slow grinding sell-off, such as the one seen in 2022 or during the dotcom unwind, remains a material risk due to:

■ An unexpected economic slowdown leading to a downward revision of earnings expectations.

■ A valuation correction in segments sensitive to structural themes such as AI.

■ A private credit crunch – potentially driven by idiosyncratic defaults and unwinds – leading to an unforeseen freezing of financing pipelines, which has ripple effects in the economy.

These dynamics can produce a moderate but persistent equity drawdown – a scenario that markets currently deem less probable. The chart below compares the S&P 500 option-implied return distribution with the historical distribution, conditional on starting in the moderate-vol. regime. According to the chart, option markets currently assign a much lower probability to a 15-30% drawdown similar to 2022 than historical experience suggests.

S&P 500 options underprice the possibility of a 15-30% drawdown over the next year – a likely scenario in the moderate-vol. regime that will likely prevail in 2026
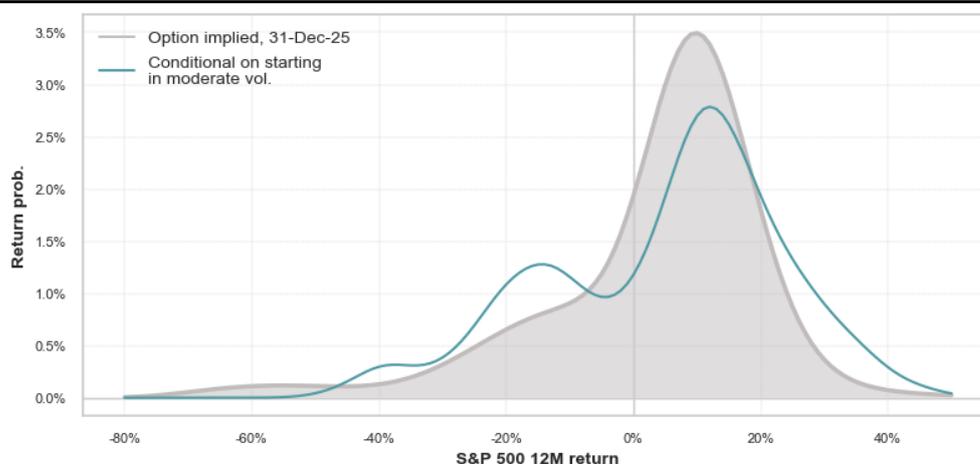
Source: SG Cross Asset Research/Quant, Bloomberg, SG Volhub

Put spreads are appropriate for hedging this scenario, as we discussed in *How to hedge a slow equity sell-off* parts 1 (April 2022) and 2 (September 2022). Our analysis, using long-term historical data, suggested that long-dated put spreads were optimal. However, with the S&P 500 more than 20% above its level at the *start* of April 2025, a systematic strategy buying long-dated put spreads currently carries deep out-of-the-money (OTM) options, and would respond only to large, rather than moderate, sell-offs. Put differently, a systematic strategy that buys long-dated put spreads has significant path dependence – it is most reliable when the underlying index remains rangebound or rallies slowly. A fast rally, similar to what the S&P 500 has experienced, makes the put spreads the strategy carries deep OTM thereby reducing its effectiveness as a hedge for a moderate sell-off on an *ex-ante* basis. Using short-dated options means that options are frequently re-struck and the strikes keep in touch with spot. This alleviates the path dependence of using long-dated options – especially relevant now given the strong equity rally of the past nine to 12 months.

A systematic put-spread portfolio using 12-month options now contains many puts that are far out-of-the-money

Short-dated put spreads allow for much better tracking of the underlying index

Source: Bloomberg, SG Cross Asset Research/Quant, SG Volhub
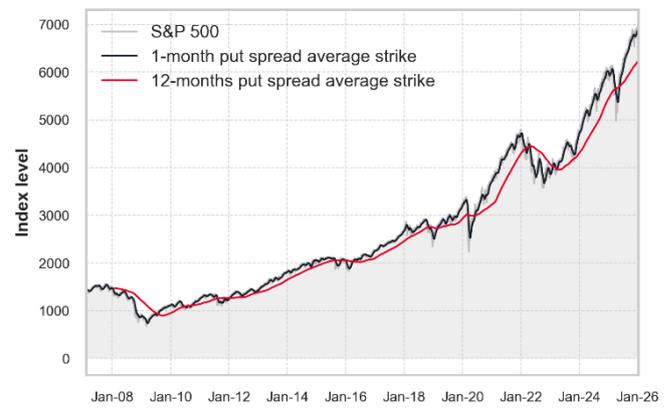
We outline a systematic strategy that buys **one-month at-the-money (ATM) put-spreads with fixed leverage**. The leverage of a put-spread is its maximum payout ratio, i.e. the difference between put strikes divided by the upfront cost of the put spread. Fixing leverage therefore sets a defined, predictable maximum upside, making it easier to construct a portfolio of hedges. In this section, we identify the environments in which these structures offer the most value. We also show that combining fixed leverage with budgeting yields a more favourable asymmetric performance profile, while providing a pre-defined maximum upside and downside for the investor.

Key takeaways

■ Short-dated ATM fixed leverage put spreads provide predictable, downside cover because the spread width adapts to volatility to keep the payout-to-cost ratio constant.

■ We investigate a strategy that systematically buys fixed-leverage, short-dated put spreads to hedge moderate sell-offs. The long put spread is struck ATM to keep the hedge responsive to small- to moderate-sized down moves.

■ Strikes in a short-dated put-spread strategy track spot closely. This reduces the path dependence associated with long-dated options – especially important following the strong 2025 rally.

■ Fixed leverage requires varying put-spread width as market conditions change. Width and reactivity differ significantly across volatility regimes: low-vol. environments mean tight put spreads with high reactivity, while high-vol regimes have wider put spreads that require deep drawdowns to pay off.

■ The strategy performs best in a moderate-vol. regime, which we expect the market to shift into in 2026. This regime has the highest likelihood of medium-sized sell-offs, leading to meaningful payouts for the strategy. For context, our models characterised most of 2022 and 2025 as being in a moderate-vol. regime.

■ Using short-dated (one-month) options means that any gains during sell-offs are typically monetised and largely retained as contracts expire relatively quickly, unless the market stages a fast and pronounced rebound before maturity.

■ Furthermore, setting the daily spend as a fixed fraction of the index level brings cost control and exposure that scale naturally with the market level.

Systematic fixed leverage (4x) one-month put-spread buying on S&P 500 without a budget and with a budget of 1% of S&P 500 index level
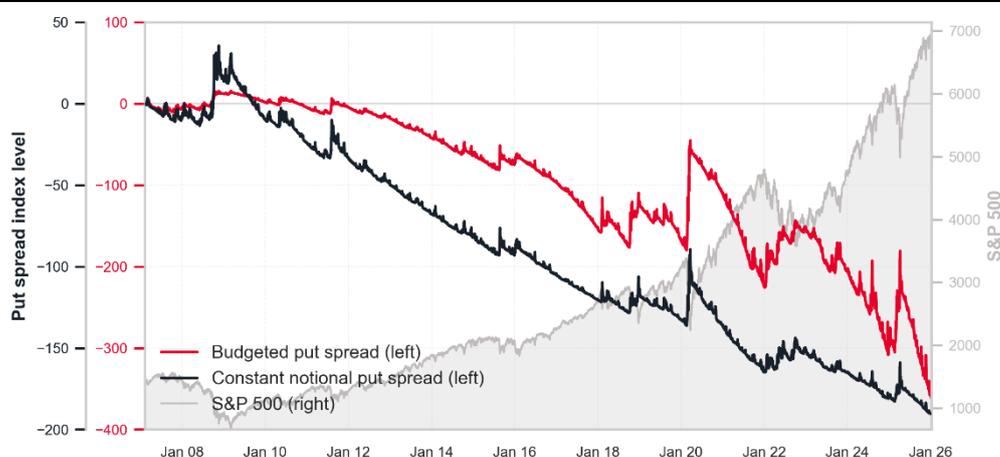
Source: SG Cross Asset Research/Quant

The rest of this section delves deeper into various aspects of the strategy, specifically how put-spread width and reactivity vary across market conditions, and the accompanying performance distributions. Furthermore, it also shows the added convexity that budgeting introduces.

We note before delving into our analysis that, unless otherwise stated, we use one-month put spreads with 4x leverage and the long put struck ATM.

Fixed leverage put spreads and market pricing

Fixed leverage requires varying put-spread width as market conditions change. We begin our analysis by understanding how the width of a one-month put spread changes across different market regimes. We consider three regimes defined in volatility terms: low-, moderate-, and high-vol.[11]

Fixed leverage put-spread width increases with volatility

The chart on the left below shows leverage as a function of put-spread width in various volatility regimes. We note the following:

▪ Higher target leverage means wider put spreads.

▪ Put-spread leverage or, equivalently, maximum payout ratio, increases much more quickly in a low-vol. regime than in a high-vol. one.

▪ A wider put spread is needed to achieve the same target leverage as we move from a low- to a high-vol. regime.[12]

The level of implied volatility is the primary determinant of put-spread width in our fixed leverage implementation (right chart below).

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[11] We identify regimes using a Hidden Markov Model trained on a parsimonious representation of the implied volatility surface and a fast-moving measure of realised volatility. Footnote **Error! Bookmark not defined.** mentions the publications detailing this approach.

[12] This arises from the fact that ATM options carry significantly more vega than OTM options. Under a parallel upward shift in the volatility curve, the ATM leg increases more in price than the short OTM leg. The price of the put spread thus increases, meaning that put-spread width must increase to maintain constant leverage. Formally, to first order:

Put-spread width change = Leverage x (Vega of long put – Vega of short put) x Parallel move in implied vol. level curve

Fixed leverage put-spread width increases with volatility
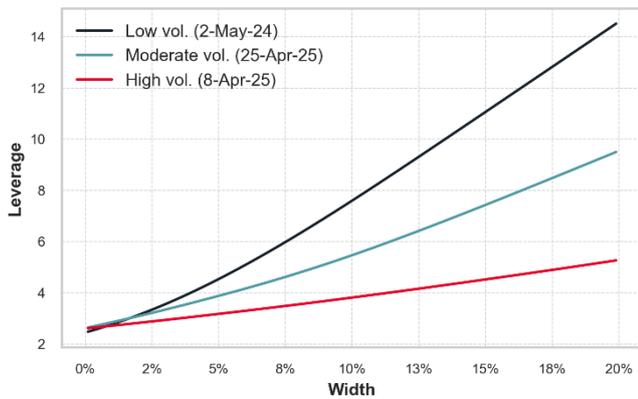
The level of implied volatility is the primary driver of fixed leverage put-spread width

Source: SG Cross Asset Research/Quant, Bloomberg, SG Volhub
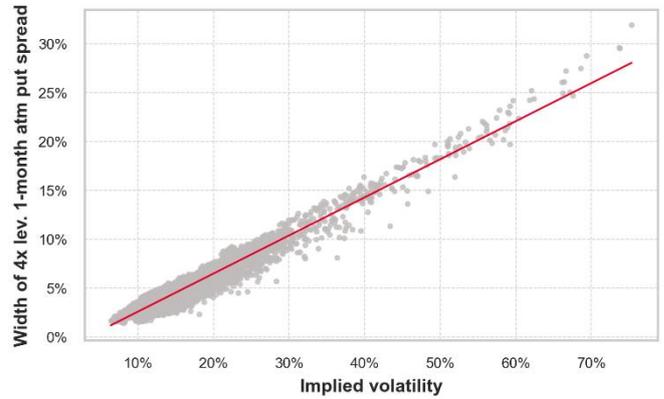
Higher skew leads to lower put-spread widths

In the fixed-leverage framework, implied-volatility skew is a secondary – but meaningful – driver of put-spread width. The relationship between width and skew is downward-sloping and approximately linear: higher skew corresponds to narrower spreads (left chart below). The rate of this decrease is greater in high-volatility environments, consistent with the wider vega profile of puts when volatility is elevated.[13]

We measure skew as the one-month implied volatility at 90% moneyness minus the one-month ATM implied volatility for the charts below.

Fixed leverage put-spread width decreases as the implied volatility skew steepens
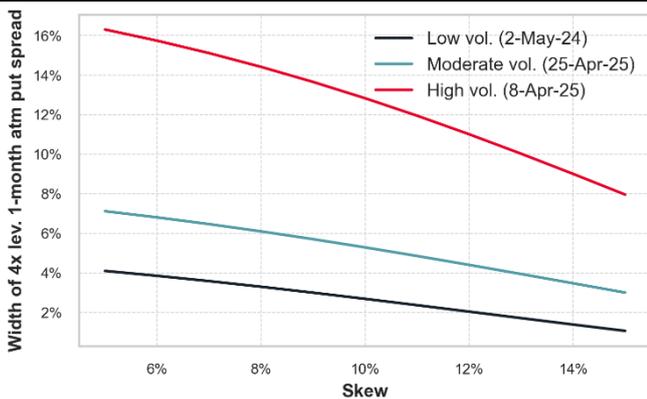
History shows that higher skew typically translates into lower width for a fixed leverage put spread

Source: SG Cross Asset Research/Quant, SG Volhub
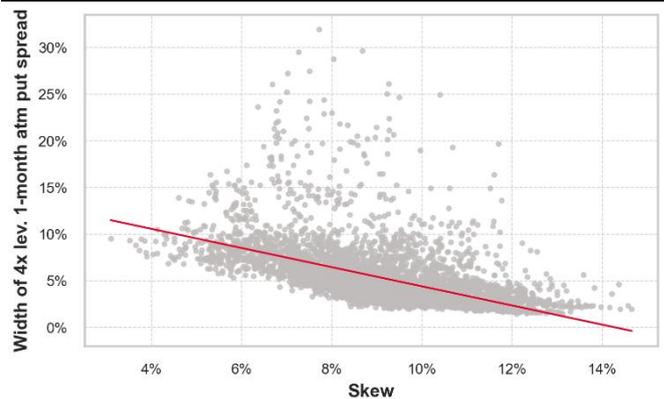
The right-hand chart (above) plots the skew and the width of a 4x leveraged, one-month S&P 500 put spread. We see width decline as skew rises. This relationship is materially weaker than the relationship between the level of implied volatility and put-spread width.

The chart below shows a longer history of the width of a one-month, 4x leveraged S&P 500 put spread, with the one-month ATM implied-volatility level on the right axis. The two expectedly

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[13] To first order, and under the usual assumption of positive skew (i.e., implied volatility decreasing with strike), we obtain: dWidth = - Leverage x Vega_short x dSkew

move together. Notably, the width is currently near the lower end of its historical range, which makes the put spread more reactive in a near-term sell-off.

Fixed leverage one-month put-spread width is currently low, making the put-spread portfolio more reactive in a near-term sell-off
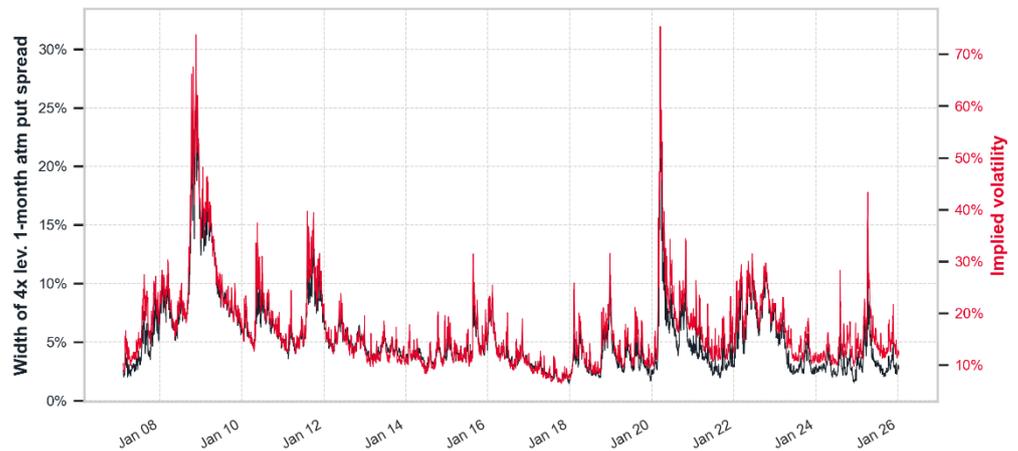
Source: SG Cross Asset Research/Quant, Bloomberg, SG Volhub

Strategy reactivity

The strategy performs best – reaching its defined maximum payoff quickly – when it holds thin put spreads. This implies that a low-vol. regime, in which the strategy typically buys thin put spreads, is the optimal time to execute. Performance should be strongest if the market regime then changes to a more adverse one due to an equity sell-off.

However, this is a very limited use case. Investors generally expect to hold protection through extended declines such as the one that occurred in 2022. Our regime model labelled 2021 and 2022 as moderate-vol. The equity decline took place in a well-established moderate-vol. regime, not in the trivial case of the regime changing from low to moderate. We need to understand how the fixed leverage strategy works in such an environment. For this, we need to understand equity return behaviour in various regimes, and how this behaviour translates into fixed leverage put-spread strategy performance.

The charts below show one-week and one-month S&P 500 return distributions conditional on starting these periods in low-, moderate-, and high-vol. regimes. The one-month distribution conditional on starting in the moderate-vol. regime (right chart below) visually stands out – its left tail fattens for sell-offs exceeding about 4%. The question is: has this tail been fat enough to allow the fixed leverage put-spread strategy to perform in spite of the wider put spreads it buys?

S&P 500 one-week return distribution *conditional* on starting the week in various regimes
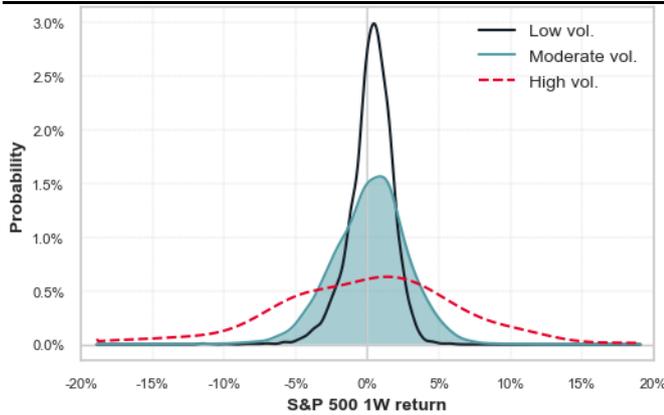
The S&P 500 one-month return distribution conditional on starting in a moderate-vol. regime has a fat left tail

Source: SG Cross Asset Research/Quant, Bloomberg
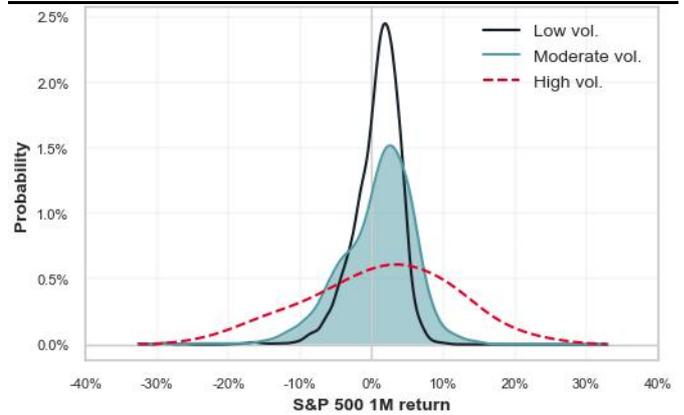
The charts below show the distribution of weekly (left) and monthly (right) performance of the 4x fixed leverage put-spread strategy, conditional on starting in the specified volatility regime. As expected for a put-spread strategy, the distributions have a negative mean representing the cost of carry. We see that the overall shapes of the one-week performance distributions are similarly centred and symmetrical for all regimes, in contrast to the distributions on the right.

One-week performance distributions of the 4x leverage one-month put-spread strategy conditional on starting in moderate- and high-vol. regimes are comparable…
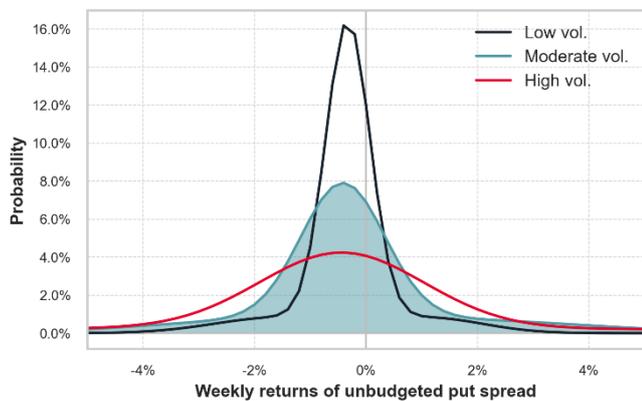
… while the right tail of the one-month return distribution conditional on starting in a moderate-vol. regime mirrors the left tail of the relevant S&P 500 return distribution

Source: SG Cross Asset Research/Quant, Bloomberg
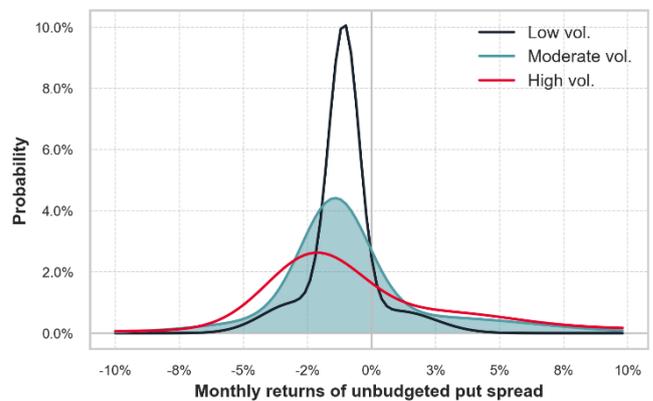
The chart on the right shows one-month *conditional* performance distributions for the strategy. The distributions conditional on starting in moderate and high-vol. regimes show a more significant and attractive positive skew, mirroring the fat left tail in the corresponding distribution for the S&P 500 above. The chart also demonstrates the utility of the strategy in the high-vol. regime, where the return distribution has the most probability above 1% returns, though we also see a higher probability of larger drawdowns.

Performance in the moderate-vol. regime is of most interest, as the drawdown the investor seeks to hedge is most likely to occur in this regime. The significant right tail of the performance distribution indicates that although the strategy buys relatively wide put-spreads in the moderate-vol. regime, they are still narrow enough to deliver positive performance in the (typically) limited sell-offs that occur.

The charts below show the historical one-month performance of the strategy, normalised by the cost, so that payouts range from -1x to +3x. The left chart shows the conditional performance regardless of whether the S&P 500 rallies or declines over the month. The right chart only considers instances in which the index sells off.

The fixed leverage implementation has typically performed best in the moderate-vol. regime, regardless of whether we consider all S&P 500 moves...
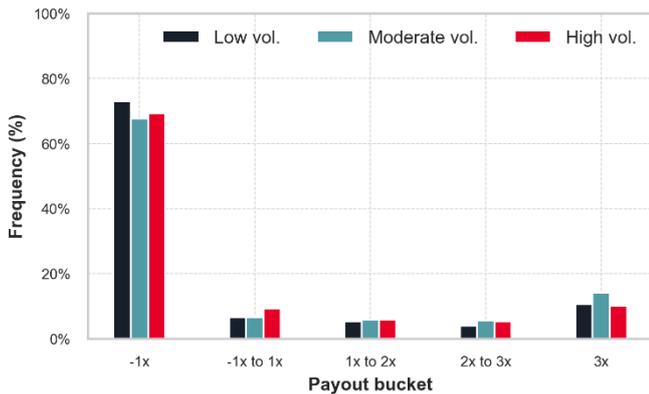
... or concentrate only on sell-offs
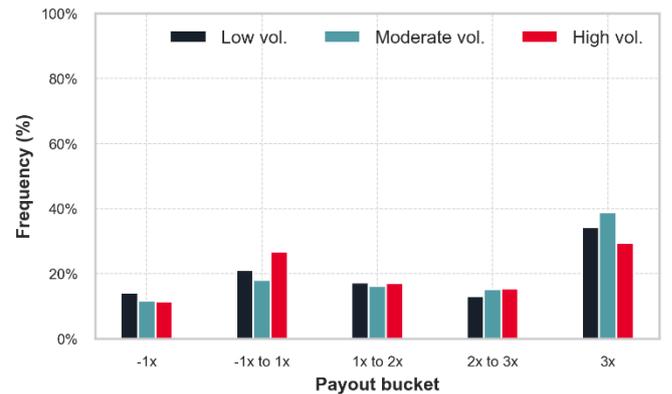
Source: SG Cross Asset Research/Quant, Bloomberg, SG Volhub

The left chart above shows that the moderate-vol. environment offers the strongest overall profile: the fraction of instances in which put spreads have material positive performance is the highest (and consequently, the fraction of instances for which the strategy has a -1x payout is the lowest). Although put-spread width is wider in this regime, larger index declines often offset this.

Focusing on the cases where the index ends below its initial level (right chart), the moderate-vol. environment has most frequently been associated with larger positive payouts, followed by the low-vol. environment (which benefits from narrow put spreads).These results are consistent with the S&P 500 return-distribution: the fatter tail for medium-sized sell-offs in moderate-vol. regimes translates into a higher probability of protection paying off meaningfully. This makes a strong case for owning the strategy during the moderate-vol. regime, not just in anticipation of a shift from low- to moderate-vol.

Benefitting from budgeting

We now introduce a daily cost budget for the strategy. This differs from the more common approach of fixing a size in notional terms, which comes with more unpredictable cost. The budget is set as a fraction of the index level on each day. Budgeting in this manner makes the worst-case costs predictable. Suppose we set the daily budget to be 1% ÷ 252 of the S&P 500 level on each day, and the S&P 500 goes from 7000 to 8000 over the next year without any drawdowns, the strategy will incur a cost of roughly 7500 x 1%.

We now back-test a systematic implementation of the one-month 4x fixed leverage put-spread strategy, financed by a daily premium spend budget of 1% ÷ 252 of the prevailing S&P 500 index level. The dollar amount spent on buying put spreads increases as the index rallies and drops as the index declines, introducing counter-cyclicality. As we see in the chart below, the cumulative P&L profile behaves as expected for a protection strategy: during prolonged equity rallies it loses money in a steady, controlled manner, reflecting the continuous cost of insurance. Conversely, equity drawdowns generate sharp positive jumps in P&L, as put spreads move deeply into the money.

Systematic fixed leverage (4x) one-month put-spread buying on S&P 500 without a budget and with a budget of 1% of S&P 500 index level
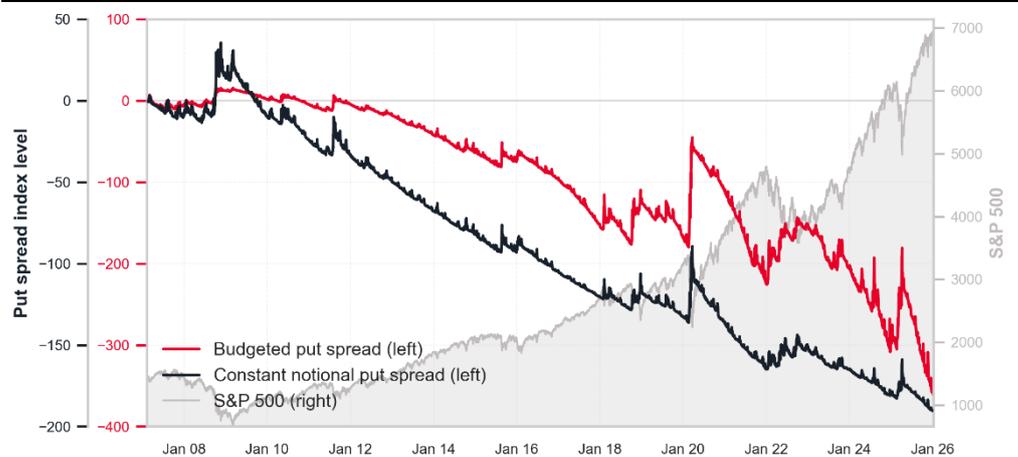
Source: SG Cross Asset Research/Quant, Bloomberg, SG Volhub

Thematic hedging with a portfolio of single stock options

The AI concentration story could come to a volatile end

As discussed, market leadership is unusually narrow: a handful of AI-linked mega-caps now account for a record share of market capitalisation and profits, creating clear concentration risk. Their valuations are elevated, skewing index-level metrics. While their profit delivery has been strong, their sheer size means that any earnings disappointment could weigh heavily on headline index returns and aggregate profit growth.

A material share of the AI value chain remains private—much as many of today's internet champions were not listed in 1999—so near-term AI cash flows may not accrue to the current stock of public equities. When (and if) these private players come to market, the investable universe will broaden, but investors will need to reallocate capital to fund new issuance, with greater choice arriving alongside the practical requirement to finance those IPOs.

In 1999–2000 the boom – and subsequent bust – was concentrated in the Nasdaq; the S&P 500 was cushioned by broader diversification. Today, by contrast, an AI-driven unwind would leave the Nasdaq, S&P 500, and MSCI World all over-exposed. And while equity markets can crash, bubbles typically deflate over time – in a disorderly, idiosyncratic fashion rather than in one clean break.

During the TMT-bubble, the S&P 500 was a bystander to the boom and bust (performance index to 100).
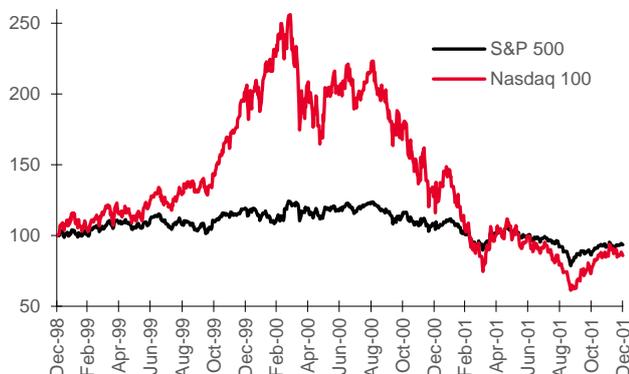
Deflating the Nasdaq bubble was prolonged yet disorderly (number of Nasdaq 100 stocks decline more than 10% a week)

Source: SG Cross Asset Research
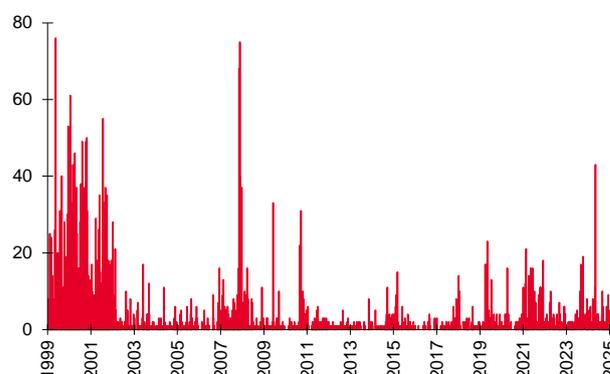
The right-hand chart above plots the number of stocks in the Nasdaq 100 dropping by 10% or more in a week. During a market crash all stocks fall together and the process of marking equity prices is sudden and short lived. During the underwinding of the Nasdaq bubble, yes there were days when the market fell dramatically and everything went with it, but there were numerous weeks when individual names disappointed as well, with the whole market being down. So, in a long-drawn-out bear market, there are still a significant number of big downside stock moves, and single stocks could become much more volatile than the index.

How to build a portfolio of single stock option trades

We aim to build a portfolio of single name options to hedge an unruly unwind of the AI theme. There are several points we need to consider which we summarise below:

■ We prefer a portfolio of single stock option trades to option trades on a portfolio (i.e. a stock index or ETF). Idiosyncrasies often cause single stocks to react much more violently to theme-driven shocks than priced in by option markets. This is less likely to be the case for indices or ETFs for two reasons: (a) idiosyncratic effects get averaged down, and (b) their implied volatilities are elevated due to a correlation risk premium which is absent in single stocks.

■ We aim to capture an unruly sell-off. This is typically accompanied by a material increase in volatility, both realised and implied. Consequently, we prefer an approach that benefits from volatility increasing sharply and not position directionally for single stock selloffs.

■ We use the following strategy for each single name:

■ Buy a 25-delta third monthly expiry put on each trading day.

■ Delta-hedge the portfolio of puts that builds up using a *skew-adjusted delta*.

■ Do not hold the puts until expiry – unwind them after holding them for between one and two months. This is simply to avoid a situation in which a significant portion (a third in our case) of the option portfolio expires on a single day leaving the strategy light on protection.

We have made several design choices here, and we discuss the pros and cons of these choices in the sections that follow.

While our aim is to create a basket to hedge AI risk, we approach our analysis in a more general way. We use observations from previous thematic sell-offs – the decline in energy stocks in 2014-

16 January 2026

15, and the 2022 inflation driven sell-off. The former was very different from what might happen in an AI bust but it still contains salutary lessons for us.[14]

A basket of single stock options > Options on a basket of stocks

The option-implied variance[15] for a basket of stocks such as an index or an ETF is typically higher than that given by the weighted sum of its constituents' option-implied variances. This is due to the option on the basket pricing in a significant premium for the likelihood of its single stock constituents moving in a correlated manner.[16] Consequently, implied volatilities of baskets are elevated.

Further, single stocks exhibit idiosyncratic behaviour which could amplify their responses to themes that may affect a material fraction of the basket's components. However, the basket averages out these idiosyncratic spikes making it less likely for the basket's returns to be more volatile than those already priced in by the option market.

The charts below highlight this. Each chart shows spot evolution (shaded grey) on the primary y-axis and compares implied and realised variance on the secondary y-axis. The implied variance (black line) is simply the square of the implied volatility of a 25-delta put divided by 252.[17] The red line shows the average of the squared daily return over the next 10 business days, i.e. the future 10-day realised variance. Essentially, we compare implied variance with what gets realised in the near future. A long vol. strategy would be set up to gain when the variance realised after entering a trade exceeds the implied variance "paid". Thus, having more instances where the future realised variance exceeds implied is favourable.

Realised variance did not often exceed implied for the Nasdaq 100 index even when it sold off in 2022…
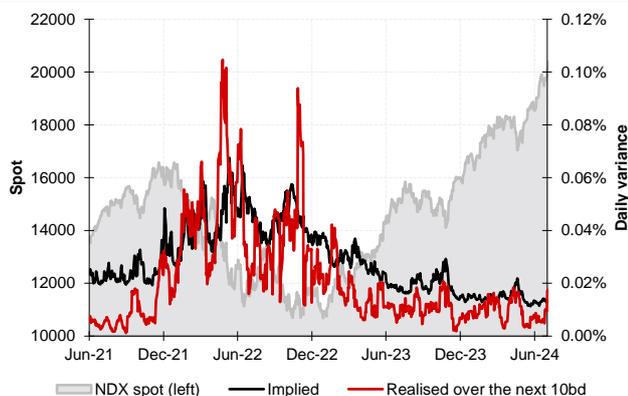
… but it did more often for META which experienced idiosyncratic volatility spikes
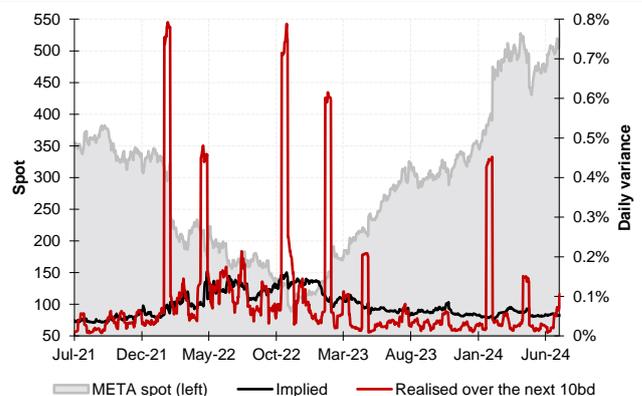
Source: Bloomberg, SG Cross Asset Research/Quant, SG Volhub

The charts above look at the Nasdaq 100 (left), and META (right), one of its constituents. The charts focus on the three-year period July '21 to June '24 which includes the inflation-driven sell-off of 2022. Future realised 10-day variance for Nasdaq 100 exceeded implied in a material way two times in 2022. For META, this happened several times even though implied variance for META

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[14] 2014-15 saw a sustained decline in commodity prices driven by a global disinflationary environment. This led to stocks of energy, metals and mining companies selling off, and their credit spreads widen materially. The broader S&P 500 index was mostly unaffected and only reacted in August 2015 after the unexpected Chinese currency devaluation.

[15] The variance is the square of the volatility.

[16] Driessen, Maenhout, Vilkov, *Option-Implied Correlations and the Price of Correlation Risk,* Journal of Finance (2009). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=673425

[17] Dividing by 252 converts an annual variance into that for a single day.

was significantly higher than that of the index. Essentially, the single name exhibited amplified idiosyncratic behaviour which the index did not pick up on.

The next two charts show the same metrics for Nvidia and Apple, two other large constituents of the Nasdaq 100. We see the same story as for META – many material idiosyncratic spikes in future realised variance that exceed what the market had priced in. The case of Apple is interesting – its implied volatility is comparable to that of the index.

The same happened for Nvidia…	… and for Apple
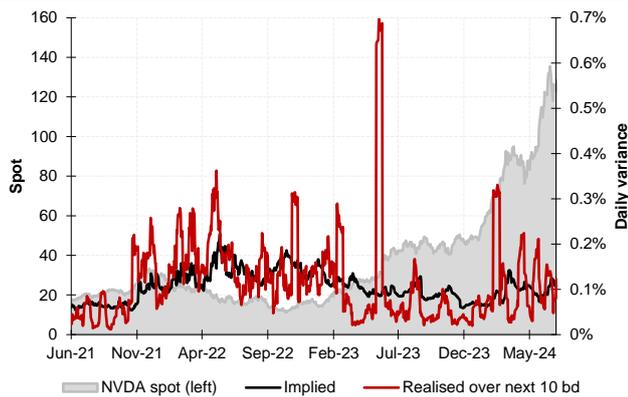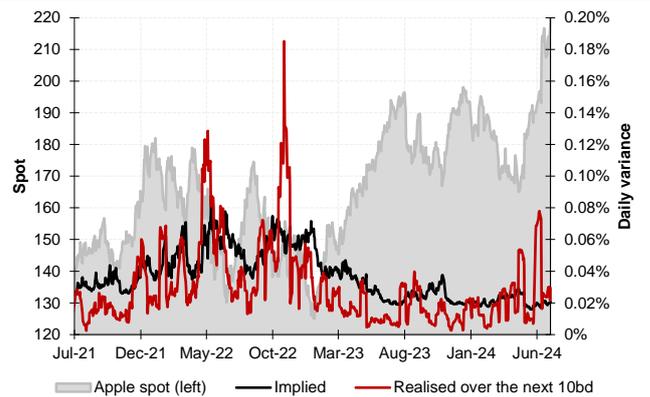
Source: Bloomberg, SG Cross Asset Research/Quant, SG Volhub

The examples here support our contention that single stocks are much more likely to react unpredictably and violently in a thematic unwind than the index. Consequently, a portfolio of long vol. trades on single stocks is a better thematic play than a long vol. position on an index or ETF containing these stocks.

Strategy design choices: pros and cons

Delta-hedging single puts preferable to replicating down variance

Synthetic Down Variance (SDV) is one of our preferred strategies for hedging index level tail sell-offs. We have not considered replicating it for single stocks. Rather, we prefer systematically buying a single OTM (25-delta) put every business day and delta-hedging the option portfolio.

There are two reasons for this. The first is that SDV buys significant amounts of deep OTM/tail puts. In fact, the further OTM a put is, the greater is the quantity purchased by SDV. This biases SDV to react more to very large sell-offs. For example, a three-month 5-delta put on Apple was struck at approximately 22% below spot at the time of writing. For Nvidia, the same delta put would have been struck 31% below spot. Having large quantities of puts that are so significantly OTM would mean that the strategy would react inadequately to 5-10% declines that can easily occur for single names in one or two days. Buying puts that are moderately OTM removes this problem.

The second issue is one of practicality. As explained above, implementing SDV requires buying large quantities of deep OTM puts. The single name option market is not deep enough to absorb the resulting flow. For example, the chart below shows a distribution of traded volumes of Nvidia puts by delta over the course of 2025. The highest liquidity is for moderately OTM puts. Note that this is the situation for Nvidia, the highest market capitalisation company in the world at the time of writing. SDV is not implementable in size for Nvidia. For other stocks, SDV would be even less feasible.

Nvidia traded put volume by delta bucket – moderately OTM puts had the highest volume
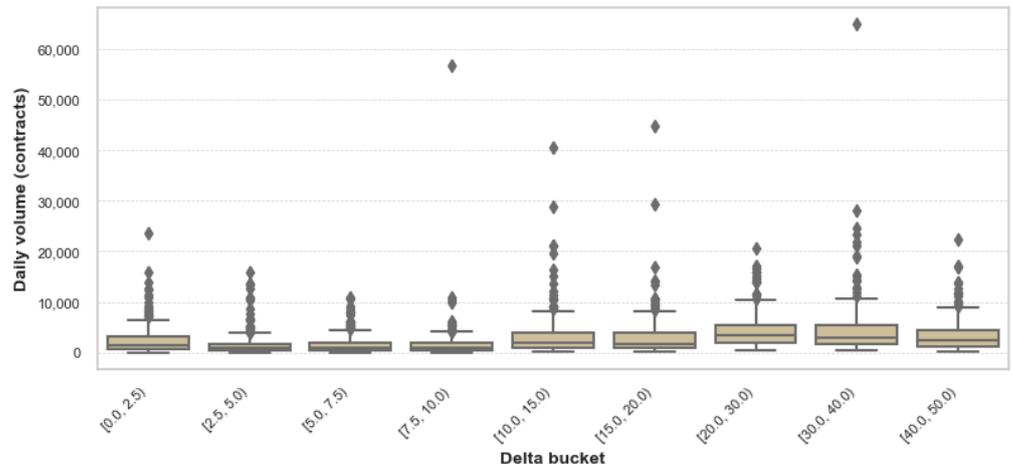
Source: SG Cross Asset Research/ Quant, OptionMetrics

Consequently, we stick to picking a moderately OTM strike for our strategy.

Where to strike the put? Prefer moderately OTM to ATM

We have stated at the outset that we aim to hedge unruly sell-offs. 10-20% declines are not uncommon for single stocks, especially in periods of theme driven declines. This is applicable even for the more stable stocks. The charts below show Apple and Microsoft stock prices since mid-2021 and highlight a few (but not all) material, sharp sell-offs. The sell-offs are fairly common.

10%+ sell-offs for Apple over a few trading days have been fairly frequent...

... as they have been for Microsoft as well

Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant

This influences our choice of put strike for the systematic strategy. 25-delta three-month puts for Apple and Nvidia were struck at approximately 7% and 11% below strike as of 14 January 2026. A material one-day sell-off would cause the puts to gain value rapidly; their deltas and gammas would also rise sharply.

We are designing a systematic strategy. So we need to care about not just puts being traded today, but also puts that are already in the portfolio held by the strategy. Suppose the sell-off occurs after a few days during which the stock has rallied. The 25-delta puts bought during the rally would all be lower delta puts by the time the sell-off starts. This is useful, as these options will gain more quickly during this sudden sell-off.

A very sharp rally however can present a risk to the strategy. It would reduce the deltas of previously bought puts to very low levels. This would likely cause the portfolio to be reactive to larger tail shocks and have only small reactivity to a "merely unruly" sell-off.

Buying ATM puts may be a way to combat this specific situation. However, ATM puts present their own issues in more normal sell-offs. Small declines cause their gammas to drop and they lose reactivity.

On balance, we prefer moderately OTM, for instance 25-delta, puts for our strategy.

Delta-hedging: skew-adjusted delta for slightly better carry

The delta-hedging methodology is an important consideration especially from a long-term carry perspective.

The obvious choice of delta is the Black-Scholes model delta. However, we prefer using the skew-adjusted delta which accounts for the increase in implied volatility in a sell-off predicted by the implied volatility skew.[18] The skew-adjusted delta is higher than the Black-Scholes one. It means the strategy is typically net long the single stock. This has several consequences:

- The strategy is more vulnerable to small sell-offs than it would be if the smaller Black-Scholes delta was used.
- The delta-hedge provides greater upside if the market rallies. This can make a material difference in a period of high volatility which sees sharp recoveries following sell-offs. And in benign periods when the underlying stock rallies slowly (but steadily), the higher gains provided by the skew-adjusted delta-hedge offset the cost of buying the put to a greater extent.

We now look at the skew-adjusted delta-hedge for two stocks with very different performance profiles – Nvidia since July 2021 and Exxon Mobil between January 2014 and December 2016. Nvidia (charts below) has rallied strongly, and the cumulative performance of its skew-adjusted delta hedge is materially higher than that of its Black-Scholes delta-hedge.

Skew-adjusted versus Black-Scholes delta-hedge for Nvidia: the strong rally in the stock has helped the skew-adjusted delta-hedge outperform
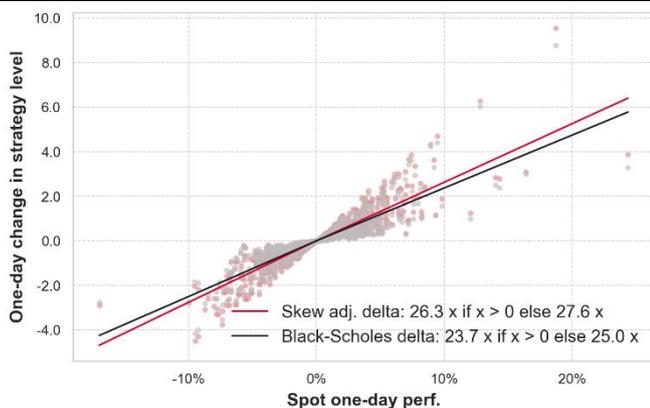
Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant, OptionMetrics

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[18] We introduced the idea of "skew-adjusted delta" in Hedges are not a luxury (October 2016).

Exxon Mobil sold off between mid-2014 and early-2016. The skew-adjusted delta expectedly performed worse than the Black-Scholes one in the sell-off, and outperformed in the rally that started in March 2016.

Skew-adjusted versus Black-Scholes delta-hedge for Exxon Mobil: the stock drifted down and there is no material difference between the two hedge types
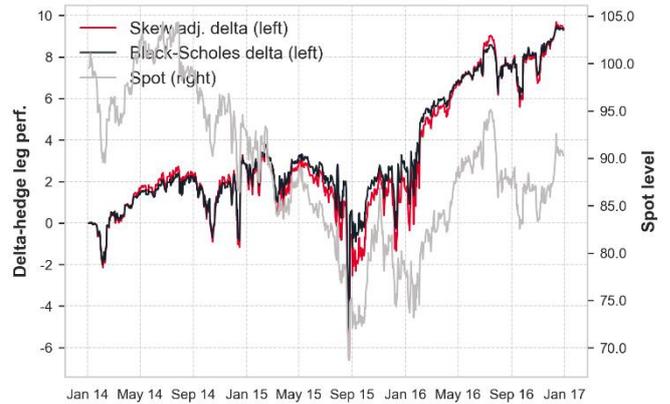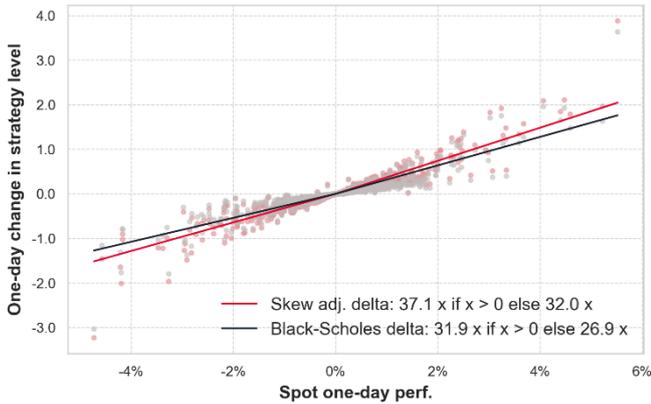
Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant, OptionMetrics

The single stock put strategies are convex

The attraction of a delta-hedged OTM long put is its convexity. The single stock strategies we have discussed are expectedly convex. The charts below show one-day changes in the strategies values versus one-day returns of spot. We show the results for Amazon (in the middle of the large cap tech name pack for volatility) and Exxon Mobil. For the latter, the chart covers the period early 2014 to end 2016 and so focuses on the energy sell-off of 2014-15.

The single stock delta-hedged strategy is convex (Amazon left, Exxon Mobil from 2014 to 2016 on the right)
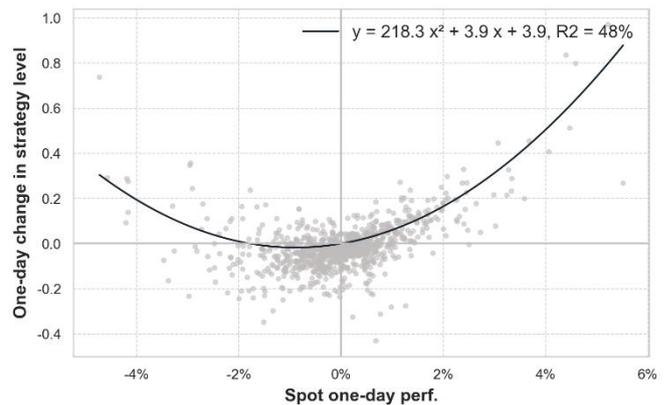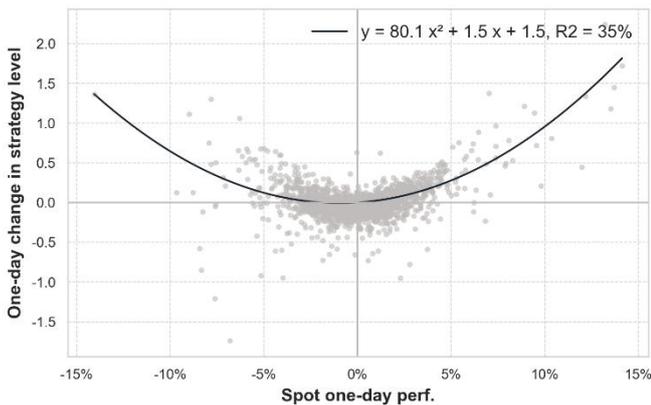
Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant, OptionMetrics

The strategies are broadly convex as the lines of best fit show. However, we also note that outcomes for small to moderate one-day moves are fairly dispersed for both. This is expected for a delta-hedged long put systematic strategy which has significant path dependence.

The delta-hedged OTM put strategy does not have simple performance like a put spread

The charts below compare the performance of the delta-hedged OTM put strategy (left chart) and systematic one-month put spread buying (right chart) for META. The put spread performance is straightforward to understand – it gains when the stock sells off, and bleeds carry when the stock is rangebound or rallies. The delta-hedged long put though has a more complicated performance profile: it typically gains in sharp sell-offs and rallies, but we need to look into its positioning and other market variables (like implied volatilities) to understand its performance at other times.

Performance of the delta-hedged OTM put strategy for META

Performance of systematic one-month 4x leveraged put spread buying for META
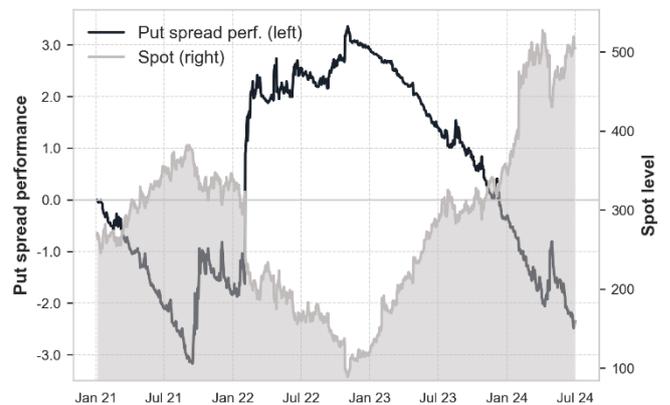
Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant, OptionMetrics

For instance, we see that the strategy has a sudden drawdown in late July 2022, even though the META stock moves little at this time. This was due to a significant drop in implied volatility. Three month 90% strike implied volatility fell by about 10 points. And the reason for a drop in value in October 2023 was similar.

Performance of the delta-hedged OTM put strategy for Exxon Mobil

Performance of systematic one-month 4x leveraged put spread buying for Exxon Mobil
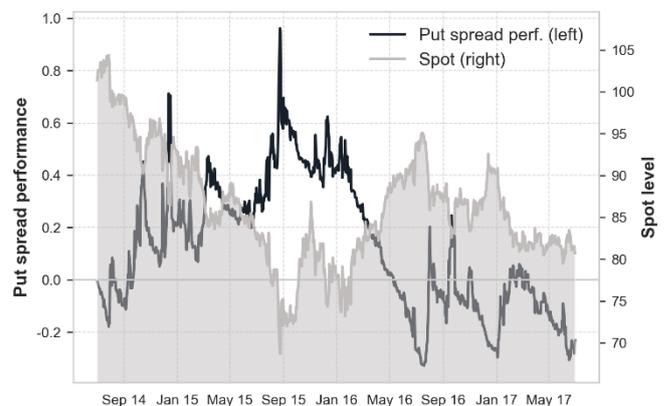
Source: Bloomberg, SG Cross Asset Research/Cross Asset Quant, OptionMetrics

The charts above show the same for Exxon Mobil. We see several draw-ups for the delta-hedged long OTM put strategy (left chart), but several draw-downs as well. For instance, the strategy lost between January and July 2015 even as Exxon Mobil stock declined by about 15%. This was a slow sell-off with low volatility – the put portfolio did not gain sufficiently and the delta-hedge

lost. Again, the strategy lost in 2017, this time due to theta decay of the puts and little gain in the delta-hedge as spot remained rangebound. The put spread strategy (right) performed as expected.

Our main takeaway from this analysis is that the delta-hedged OTM put strategy can be a useful overlay in volatile markets. It is also a low-cost strategy from a carry perspective for an underlying which rallies strongly in benign markets, something we have seen large cap tech names do. However, investors need to keep an eye on positioning and be aware of whether a strong rally has significantly reduced the delta of the puts held by the strategy.

Tactically Trading Dynamic Put Ratios and Synthetic Down Variance

Equities look orderly and volatility is contained currently. However, something feels amiss. The VIX sits in the lower part of last year's range but remains above its long-term average. The ongoing rise in equities is likely a continuation of last year's low-conviction rally with known and unknown flashpoints. It is prudent to add protection to risk portfolios. Not all hedges behave alike: some suit slow, grinding sell-offs; others target sharp shocks. Most are option portfolios that may accumulate positions between rebalances; if part of that build-up occurs when risk metrics are elevated, the added options are costly, and the later responsiveness—being partly anchored to purchase conditions—can disappoint. We set out this reasoning and formalised it into a framework in Trading systematic strategies tactically – Part 1: Dynamic Put Ratios and Synthetic Down Variance. Using the framework set out in that report, we assess the current positioning of both hedging strategies referenced here.

S&P 500 Synthetic Down Variance is still well positioned for a tail sell-off

Value metrics for Synthetic Down Variance (SDV) are (1) breakeven spot and implied vol. moves to counter theta drag, and (2) the breakeven implied vol. increase to offset a small sell-off in the underlying. The figures below show these break-evens for the stylised S&P 500 implementation. These break-evens have been ticking downwards towards the end of 2025. This is unsurprising as implied volatilities settled down towards the end of the year, and despite having picked up, are still trading around the lower part of their range from 2025.

Break-evens against theta decay for the S&P 500 have been trending down and are at an attractive level, despite the uptick over the last few days

The breakeven implied vol. moves to counter small S&P 500 sell-offs have been trending lower

Source: SG Cross Asset Research/Quant

The figure below shows the performance of the S&P 500 implementation of the strategy since July 2024. The strategy has been flat since the gains it made in April last year. Much of this has come from the long S&P 500 position due to the delta-hedge. Some of the gain has come from Vega as well, which is not ideal as it signals that implied volatility has been elevated and the strategy has been buying expensive options. However, as we have seen in the previous charts – while implied volatility has not gone back to its longer-term average, it slowly drifted lower across the second half of 2025.

The strategy's return has mainly been driven by gains on the delta-hedge over Q4 2025

Source: SG Cross Asset Research/Quant

The charts below show the performance of the strategy assuming instantaneous shocks to the underlying index but with the volatility surface held constant. We notice a steady decrease in the performance over time. This is not surprising and goes hand in hand with the gains made due to vega by the strategy.

S&P 500 SDV performance due to instantaneous spot moves assuming no change in implied volatilities
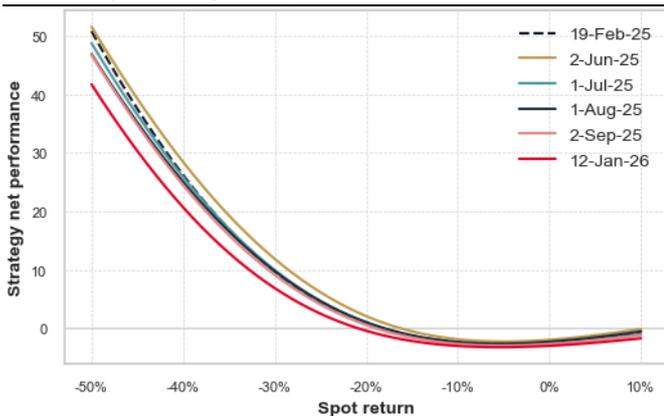
S&P 500 SDV vega due to instantaneous spot moves assuming no change in implied volatilities

Source: SG Cross Asset Research/Quant
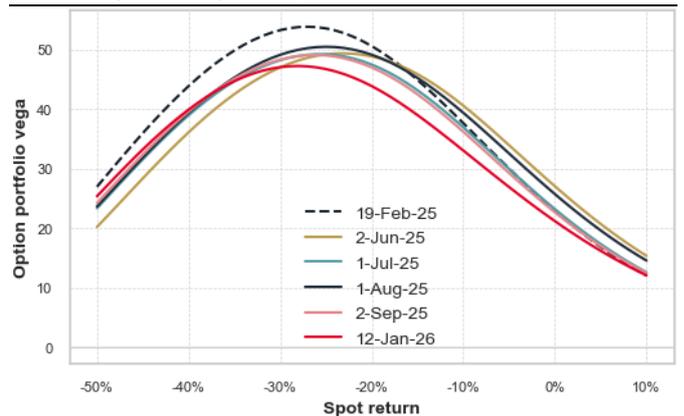
A proxy tail hedge with EURO STOXX 50 SDV – a diversification to the S&P 500 version

The figures below show the breakevens for the stylised EURO STOXX 50 implementation. In the left-hand chart, spot- and implied-move break-evens versus theta decay ticked up into year-end, then eased, and have since risen again; even so, both remain at attractive levels. The right-hand chart indicates that, despite this uptick in theta breakevens, the implied volatility move needed

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to offset small moves in the EURO STOXX 50 is materially lower than for the S&P 500. This suggests European equities are not yet fully pricing risks that US equities have begun to reflect. Should the S&P 500 experience a material drawdown and contagion emerge, implied volatility in the EURO STOXX 50 could adjust sharply higher.

Breakevens against theta decay for the EURO STOXX 50 have drifted up, but remain attractive
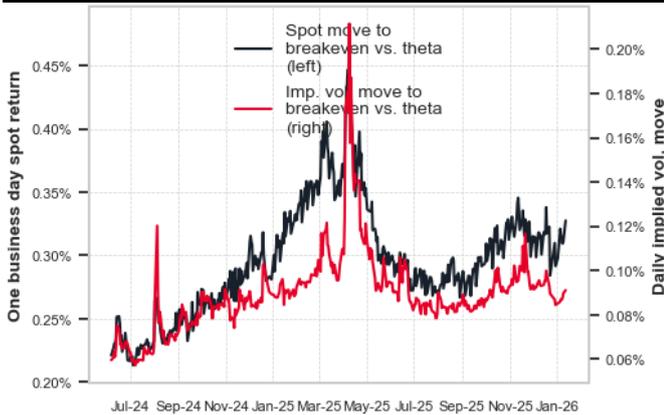
The breakeven implied vol moves to counter small EURO STOXX 50 selloffs remain low despite the recent move up
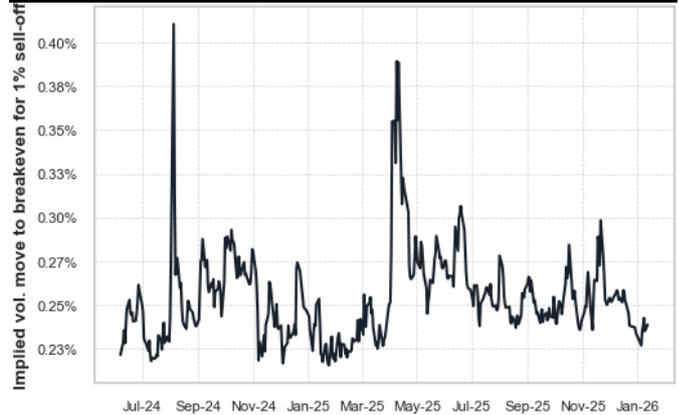
Source: SG Cross Asset Research/Quant

The charts below show the performance of the strategy assuming instantaneous shocks to the underlying index but with the volatility surface held constant. They are similar to those for the S&P 500.

EURO STOXX 50 SDV performance due to instantaneous spot moves assuming no change in implied volatilities
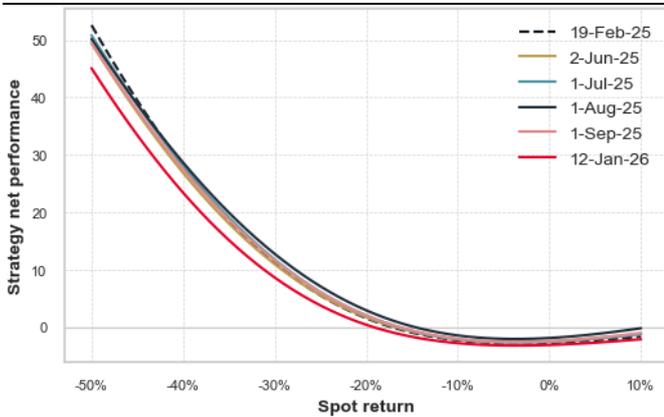
EURO STOXX 50 SDV vega due to instantaneous spot moves assuming no change in implied volatilities

Source: SG Cross Asset Research/Quant
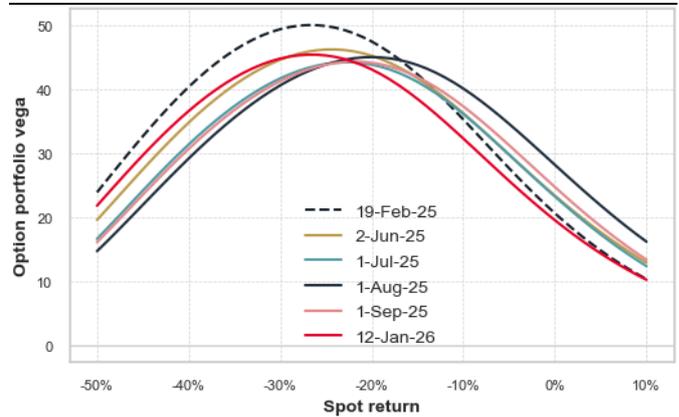
Both SDV implementations (US and Europe) look attractive, and the next shock's origin is unknowable. A portfolio of hedges across S&P 500 and EURO STOXX 50 is therefore the appropriate approach. While breakeven levels for synthetic variance swaps on S&P 500 and EURO STOXX 50 appear aligned, pricing parity can mask a structural fragility gap. European markets typically have shallower liquidity and an index composition more cyclicals-heavy, which tend to exhibit higher downside beta to global growth shocks. If a liquidation begins in the US, transmission to Europe may be non-linear: thinner EURO STOXX 50 futures depth can amplify gap risk as liquidity providers step back, causing European volatility to spike more sharply than US volatility.

In addition, US equity volatility seems to be pricing some "known" risks, whereas European equity volatility has been pricing in a more benign outlook. Diversifying the hedge buys convexity in Europe at a reasonable cost: if S&P 500 volatility is dampened by market depth while Europe reacts more acutely, the EURO STOXX 50 leg can capture a larger variance spike, improving portfolio level protection.

The hurdles for Dynamic Put Ratios to perform remain high

DPR targets high positive gamma in large sell-offs to monetise volatility spikes. The gamma profile depends on the options held, and the peak-to-trough ratio increases with the long put notional relative to the short. As shown below, the strategy hit a recent peak notional ratio in May 2025, and this has been steadily declining ever since. This is in line with the behaviour of implied volatility – VIX has been trending lower, but it has seen several material spikes.

The long/short put notional ratio has fallen over the past few months, and the long-put strike remains relatively far from the short-put strike for the stylised DPR implementation
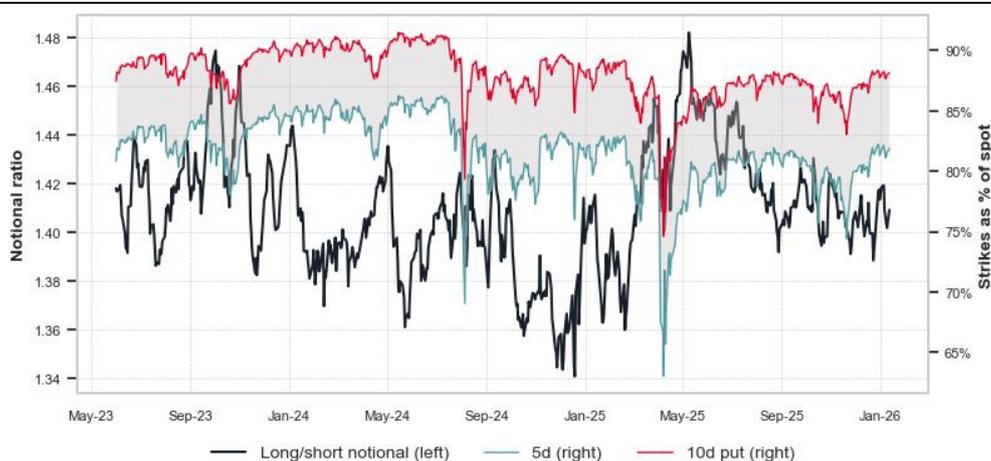
Source: SG Cross Asset Research/Cross Asset Quant

Points near the lower edge of the cloud in the left chart (below) indicate cheap put ratios; the upper edge indicates expensive ones. The options portfolio sat close to the upper edge just before the March 2025 sell-off, then improved as markets settled (see 30 June 2025). However, as realised and unrealised risks have drifted higher, the strategy's positioning has deteriorated. Relative pricing of puts employed by the strategy had begun to improve in December (see points for 1 December 2025 and 6 January 2026). However, with news flow about issues like Fed independence and the resulting increase in the VIX), deep OTM puts bought by the strategy have once again richened versus the puts it sells.

The right chart shows the gamma profile: the strategy remains in negative dollar gamma for roughly the first 20% market decline, with the peak only beyond a fall exceeding 25%. For reference, the tariff-related sell-off in March 2025 was about 19%; in this configuration we would scarcely have exited the negative-gamma zone and would likely not have been profitable.

The tail put skew has not flattened significantly, nor has the level of vol. fallen enough…

Legend: 13-Jan-26, 6-Jan-26, 15-Dec-25, 1-Dec-25, 30-Jun-25, 19-Feb-25

X-axis: 3M 10d put implied vol.
Y-axis: 3M 5d - 10d put skew
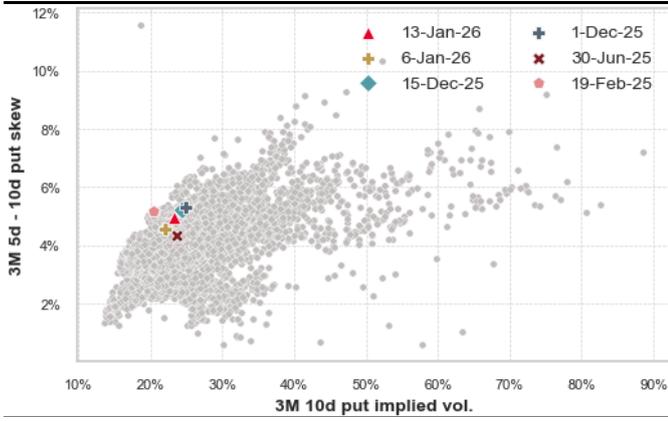
… and the strategy gamma profile shows significant downside potential for another limited but volatile sell-off

Legend: 19-Feb-25, 2-Jun-25, 1-Aug-25, 1-Oct-25, 1-Dec-25, 12-Jan-26

X-axis: Spot return
Y-axis: Option portfolio net dollar gamma

Source: SG Cross Asset Research/Quant
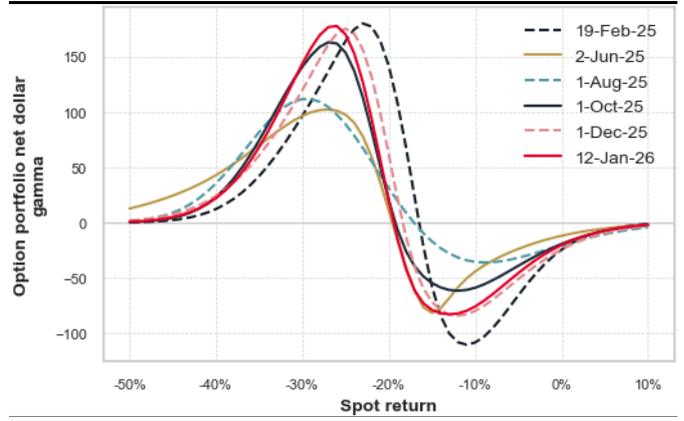
Rates volatility as a hedge for rates-driven risk-off

The USD rates volatility term structure is less inverted now than it was in the post-COVID inflationary years, implying a less positive roll-up than before (left graph below). However, long-term USD rates volatility has continued to fall and is an attractive entry point considering the uncertainty around the Fed's path in 2026. Risks relating to the labour supply, fiscal conditions and sticky inflation in the US are also supportive of holding long-dated rates volatility.

Long-dated rates volatility has tended to react significantly to news-driven flows that result in a re-pricing in the rates market (right graph below, which highlights several material increases in 10y20y volatility). In 2025, this was seen during the market turmoil in April and again in September when USD rates fell steeply. Holding long-dated rates volatility can thus serve as a useful hedge for long duration portfolios. Additionally, in scenarios where a risk-off environment is driven by higher rates, and which can result in traditional assets becoming correlated such as during the high-inflation period in 2022, the strategy can be a good diversifier for a multi-asset portfolio more broadly. Buying delta-hedged 10-year straddles on 20-year USD rates is thus a useful hedging strategy to keep in the toolkit.

USD rates volatility term structure has flattened significantly in recent months
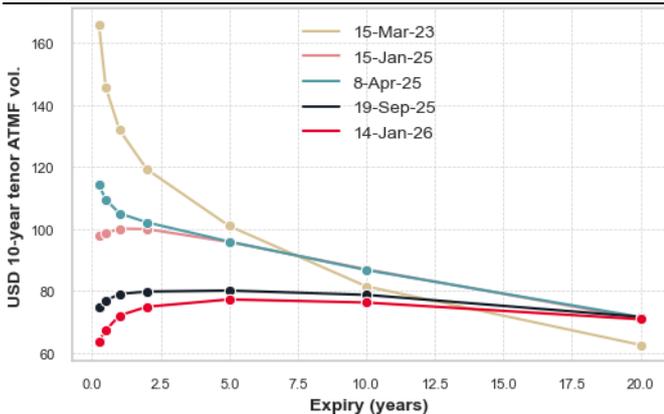
Long-dated rates volatility has tended to move up significantly due to news flow that leads to rates re-pricing

Source: SG Cross Asset Research/Quant

An alternative to the above rates spot volatility strategy is to go long the forward rates volatility (SG VRR suite of strategies). Such strategies seek to benefit from both a roll-up in the long-dated segment (long vega driven) and a roll-down in the short-dated segment (short gamma driven) of the rates volatility curve. However, the strategy can suffer losses in case of a sharp increase in realised volatility in the short-end, if long-end volatility remains unresponsive.

Thinking about portfolio construction

How to measure what we all talk about - diversification

In response to elevated valuations, concentration risk in benchmarks, and heightened geopolitical risk, a standard proposal has been to increase portfolio diversification globally. From a quantitative perspective it is fascinating to consider that there is no currently agreed method for measuring diversification. In 2025 we published our first piece addressing this. Dimensions of Diversification offered a way to put a value on the number of dominant drivers of risk in a portfolio in the form of the Effective Portfolio Dimensionality (EPD).

The EPD of a portfolio is simply the number of independent dimensions of risk that dominate and explain most of the risk in a portfolio. Independent is the key word here; to improve diversification we are looking for more uncorrelated sources of return. To this end, we showed that less directional systematic strategies can offer a useful complement to traditional long-only benchmarks and portfolios in being less correlated.

How to think about hedging

In addition to uncorrelated returns, investments that exhibit negative correlations to others are appealing when constructing portfolios. However, they can create ambiguity, as the volatility reduction benefit that they can help achieve does not necessarily improve portfolio diversification. This can be seen when taking the case of hedging, where completely negating a risk may reduce portfolio volatility, but it also removes the diversification benefit of having *some* of that risk in the portfolio. Diversification metrics that combine the idea of uncorrelated risk contributions and volatility reduction therefore produce ambiguous diversification assessments. EPD accounts for all correlations but is focussed on evaluating uncorrelated returns and risk.

From a practical perspective this means that we increasingly separate the search for (1) uncorrelated systematic "carry" strategies with positive expected returns, and (2) negatively correlated hedges with minimised cost-of-carry i.e. negative expected returns. This separation also begets more divergent discussions on strategic sources of uncorrelated returns versus more tactical views on the value and timing of hedging. In the latter case, this naturally includes equity hedging, while hedging of the USD is currently of particular interest to non-US based investors due to the outlook and cost. We expect investors to increasingly consider sourcing uncorrelated carry strategies to fund hedging, as discussed earlier in the case of selling upside equity volatility.

Thinking bigger than portfolios

The starting point for applying our EPD framework was the idea that investors typically produce volatility and tracking error numbers using a third-party risk model based on portfolio weights and a covariance matrix describing the investment universe. EPD can be calculated on the same basis and so is helpfully consistent with such a risk estimate.

However, risk models are built before portfolios are constructed and so a natural idea is to try to extend dimensionality to the investment universe. How might we put a value on the number of dominant drivers of risk? Could we use it to identify and evaluate uncorrelated sources of return? Can we assess changes to our investment universe? In the following section, we introduce a new measure to help us answer these questions, *Effective Universe Dimensionality*, then return briefly to an overview of our publication on portfolio dimensionality.

Dimensions of the investment *universe*

Why think about diversification potential?

As investors consider how to increase diversification away from concentrated benchmarks, explore new asset classes, and introduce systematic strategies to traditional portfolios, finding a way of quantitatively measuring the diversification benefit of such actions would be of great use. The increased adoption of a Total Portfolio Approach also brings more unconstrained investing and demand for new tools to support greater investment freedom. Analysing the diversification in a portfolio is the typical starting point for many investors; however, we believe that there is merit in initially understanding the opportunity within, or the diversification potential of, an investment universe before addressing the challenges of portfolio construction. Such an idea can also be applied, perhaps even more usefully, to a universe of indicators or signals. Indicators and signals are used to guide the investment process but, in and of themselves, will never be constituents of a portfolio. We propose Effective Universe Dimensionality (EUD) as a new way of measuring such diversification potential, assessing the number of independent drivers of risk in an investment universe. One useful application of such a measure is evaluating the improvement in diversification potential when expanding an existing universe with new investments, strategies, or signals.

Principal Component Analysis and its limitations

To understand the independent drivers of risk, the Principal Component Analysis (PCA) remains the dominant tool for constructing factors that explain the variance of investment returns. It is often used to show that the risk in a traditional 60/40 equity/bond portfolio is dominated by one equity-related component. Such a PCA is given in Fig. 1(b) for the universe in Fig. 1(a) where we see that over 80% of total variance can be explained by the first principal component (PC). It is worth keeping in mind however that while PCA uses correlations to account for the dependence between investments, the total variance it is trying to explain is the sum of the variances of the investments and not the variance of a portfolio, which would require the sum of the covariances too. Usefully this is not needed when examining the investment universe and so we adopt PCA as the basis of our approach.

While PCA is our tool of choice, we address two features to improve its relevance in defining an Effective Universe Dimensionality. Firstly, PCA produces a *distribution of variance explained* that one can then truncate to reduce the dimensionality of the original data; this is the primary motivation for its general use. However, where to truncate the distribution remains somewhat ad hoc. In practice, users might look for an "elbow" or structural break in the distribution of variance, but such a feature is not always present [1]. A simpler approach is to choose a cutoff in terms of variance explained. This is, however, subjective and does not use all the information available in the *shape* of the distribution.

Secondly, a further subjective feature in PCA is whether and how to normalise the input data. In Fig. 1(b), we showed input data that had been weighted by 60/40 portfolio weights across equities vs fixed income and commodities. However, this is less common in the general use of PCA, where one would typically use a covariance matrix if all data were in the same units, and a correlation matrix if they were not. The latter implies normalising input data to zero mean and unit variance to ensure data is comparable. This is equivalent to transforming data into z-scores. As we see in Fig. 1(b), the three different approaches can yield significantly different results.

Bloomberg index codes:

US Equities	SPXT
DM Equities ex US	M2WOU
EM Equities	M2EF
US Treasuries	LUATTRUU
US Credit	LUACTRUU
Commodities	SPGCESTR

60/40 weighting breakdown:

US Equities	40%
DM Equities ex US	10%
EM Equities	10%
US Treasuries	20%
US Credit	10%
Commodities	10%

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Fig. 1(a) Correlation matrix for traditional investment universe using weekly data from Sep. 2020 to Sep. 2025
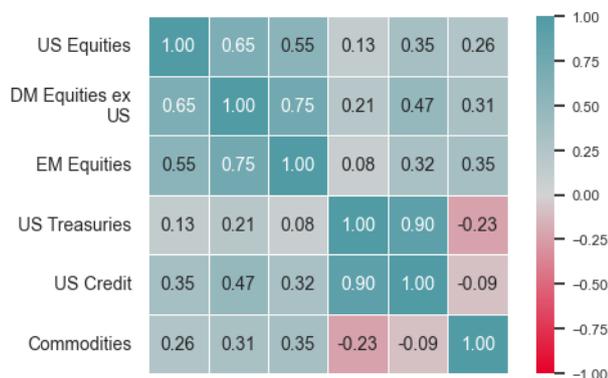
(b) Variance explained applying PCA to Fig. 1(a) using 60/40 weighted covariance, covariance alone, and correlation
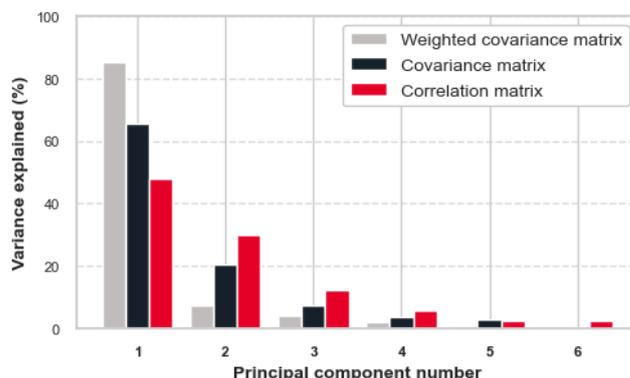
Source: SG Cross Asset Research/Quant, Bloomberg

We propose ways of addressing these two subjective features of PCA. First, we introduce the Effective Number to quantify the number of dominant components in the distribution of variance. This is grounded in information theory and provides an Effective Number of Principal Components as a natural suggestion for to where to truncate the distribution.

Second, we introduce a dynamic reweighting scheme for the input data that ensures the fair treatment of all investments. As we shall see, this addresses the counterintuitive behaviour that increasing the number of highly correlated investments continually dilutes the perceived importance of uncorrelated inputs; the latter of which is generally most important to investors. Applying the Effective Number to our fair PCA determines the Effective Universe dimensionality (EUD).

The Effective Number and its application to PCA

The fundamental purpose behind information theory and measuring entropy is assessing and focusing on what matters most in data, to be able to encode it as efficiently as possible, transmit it, and recover it without errors [2]. What matters most is determined by the probability of certain characters or numbers occurring. For example, if we look at the frequency of letters in the English language in Fig. 2(a), we can see that the most common is "e" and the least "z". If we were to encode this data without considering the frequency of each letter, we would need a theoretical $log_2(26) = 4.7$ bits per letter. However, we can code more efficiently over time by encoding the most common letters with fewer bits, and less common letters with more. Over time, the average number of bits used on this basis is given by the Shannon entropy $H(\boldsymbol{p}) = -\sum_i p_i log_2(p_i)$, which equals 4.2.

While bits are the correct units when thinking about computer hardware, they are not very familiar when trying to interpret information in terms of our original data set; here, letters of the alphabet. To that end, a useful transformation exists that returns us to the original data space; specifically, by taking $2^{H(\boldsymbol{p})}$, we return an Effective Number (EN) of letters of around 18. How to interpret this? In Fig. 2(b), we show a uniform distribution with 18 letters. This distribution has the same entropy as the original alphabet and so we can think of the EN as mapping any distribution to an equivalent flat and compact distribution that contains the same amount of information. We highlight that the Effective Number is a continuous number, and so any non-integer number, here 18.1, can be thought of as being equivalent to somewhere between two uniform distributions of the nearest integers, here 18 and 19.

Fig. 2(a) Probability distribution, by frequency, of letters in the alphabet, with entropy and the effective number
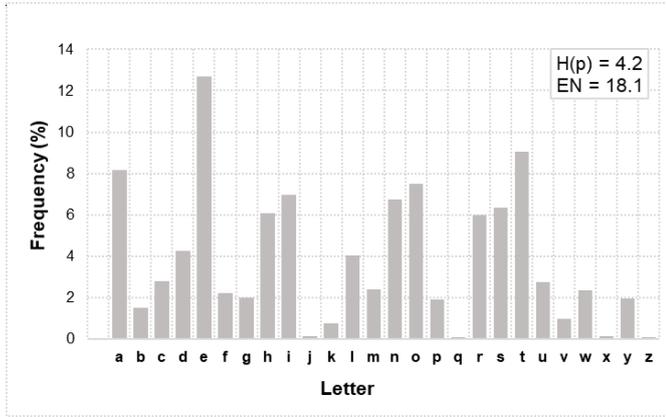
(b) Uniform and compact distribution equivalent of Fig. 2(a) with almost identical entropy and effective numbers

Source: SG Cross Asset Research/Quant, Bloomberg
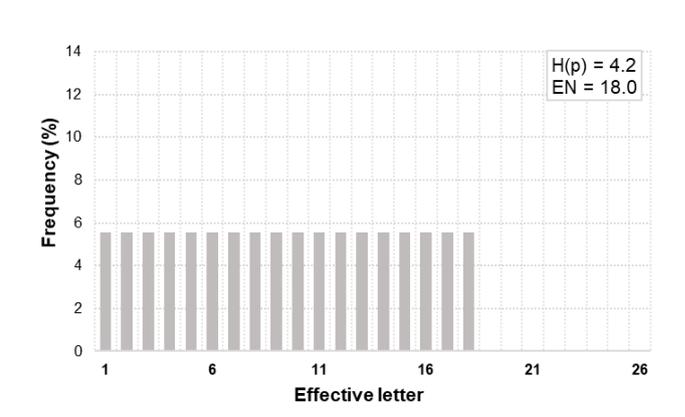
It is possible to work in different logarithm bases such as the natural logarithm, as we typically do in our work; in which case, the effective number is given by $e^{H(\boldsymbol{p})}$. While the choice does matter to the calculation of entropy, another benefit of working with the Effective Number is that it is independent of the logarithm. To see this, we can expand $2^{H(\boldsymbol{p})}$, or $e^{H(\boldsymbol{p})}$, to obtain the elegant expression: $EN(\boldsymbol{p}) = (p_1^{p_1} p_2^{p_2} \dots p_N^{p_N})^{-1}$, which is purely a function of the probabilities. By construction, EN always takes a value between 1, when all probabilities except one take a value of zero, and N when the distribution is uniform.

Rényi entropy of order q and EN:

$$H_q(\boldsymbol{p}) = \frac{1}{1-q} log \left(\sum_i p_i^q \right)$$

$$EN_q(\boldsymbol{p}) = \left(\sum_i p_i^q \right)^{\frac{1}{1-q}}$$

$$\frac{1}{HHI} = EN_2(\boldsymbol{p}) = \left(\sum_i p_i^2 \right)^{-1}$$

This idea has also been generalised to a family of Rényi entropies of "order" q, of which Shannon is order one [3]. We highlight this to observe that the second order Rényi entropy ($q = 2$) relates to the Herfindahl-Hirschman Index (HHI). This has a long history of use looking at market concentration and is still used by the DOJ in the United States to measure sector concentration risk for the purposes of competition assessment [3,4,5]. More specifically, the reciprocal of HHI gives an Effective Number of Companies in a sector and is identical to EN_2 in the adjacent sidenote.

Earlier in this Outlook, we used exactly this measure to put a value on the Effective Number of Constituents in equity markets based on market-cap weights, so the weights are treated as a pseudo-probability distribution. In particular, we used this to show how concentrated markets are. Again, the effective number EN_2 assigns a value that is equivalent to an equal-market-cap-weighted index with that number of stocks, similar to Fig. 2(b).

The order q adds a bias to increase or decrease the emphasis on larger probabilities relative to smaller ones. When $q = 1$, we have the Shannon entropy and the original expression for $EN(\boldsymbol{p})$ above, which is essentially independent of q. This lack of bias for $q = 1$ has been seen as attractive when applying the same $EN(\boldsymbol{p})$ to the abundance of species to produce an effective number of species [7] - a measure of diversity. Perhaps amusingly, we will consider diversity in the investment universe by applying this to the distribution of variance.

Finally, we note that the entropy and, by natural extension EN, are insensitive to the ordering of the probabilities. For example, in Fig. 2(a), one might choose to order the letters in decreasing order of probability, and this has no effect. We keep this in mind when applying EN to the distribution of variance we obtain by applying PCA, where such an ordering of principal components by decreasing variance explained is typical and preferred.

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Fig. 3(a) Illustrative example distributions of variance for three investments and their respective Effective Numbers
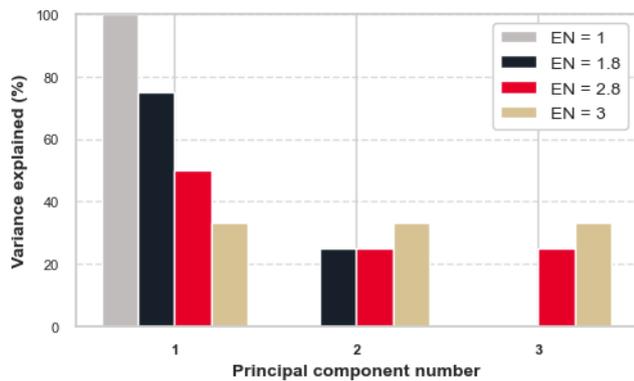
(b) Effective Number applied to the PCA analyses shown in Fig. 1(b), with rounded values close to two, three, and four
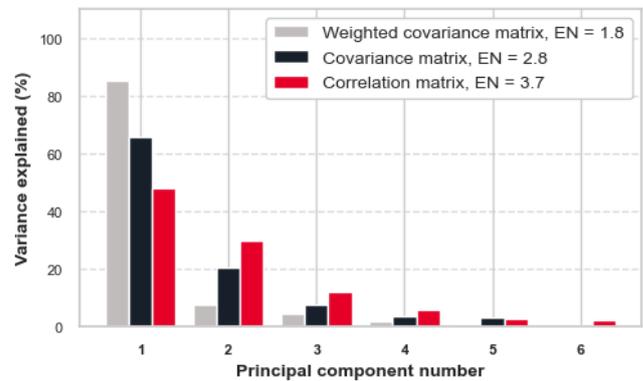
Source: SG Cross Asset Research/Quant, Bloomberg

The effective number of principal components

The effective number is easily applied to PCA to quantify an *Effective Number of Principal Components.* The ordered distribution of variance explained offers the pseudo-probability distribution that we need. We show how this works in Fig. 3(a) for numerous illustrative examples based on a universe of three investments.

The traditional rank of a covariance matrix equals the rank of the original time series of investment returns. This, in turn, equals N minus the number of linearly dependent time series. In practice, series are never *perfectly* linearly dependent and so the rank always takes maximum value N.

Although the application of EN to PCA may seem a little ad hoc, there is a satisfying link to the rank of the input matrix representing the data. Assessing the traditional integer-valued rank of a matrix is generally unhelpful with investment return data because such data rarely shows perfect linear dependence. This means the rank always takes a maximum possible value of N. Ideally, we would like a continuous version of the rank of a matrix that behaves intuitively as correlations vary, so that increasing correlations, though imperfect, would reduce the rank smoothly towards one, while decreasing correlations increase it towards N.

Such an *Effective Rank* has been proposed in the literature [8] and for our use is simply the Effective Number applied to the eigenvalues of a matrix, which are normalised to sum to one. Recognising that the output of PCA, like that shown in Fig. 3(a), is exactly this normalised eigenvalue spectrum of the input matrix, we see that the Effective Number of Principal Components is exactly the Effective Rank of input matrix. Using these terms interchangeably, we would consider this number the most natural suggestion for the number of components to keep when reducing the dimension of input data using PCA.

Although we have proposed this previously [9], our goal here is not dimension reduction but to simply put a value on the number of dominant drivers of risk in our investment universe. The Effective Number of principal components or, equivalently, the Effective Rank serves that purpose and offers the basis for talking about *dimensionality of the investment universe*.

In Fig. 3(b), we reproduce Fig. 1(b) and add the Effective Number of principal components. Interestingly, we see how the Effective Number varies depending on the weighting of the input data. Rounding numbers to the nearest integer, we would measure effective numbers of two, three, and four, respectively. This second subjective feature, the dependence on weighting, we address in the following section.

A dynamic weighting scheme for fair PCA

As described earlier, the inputs to PCA are generally a *covariance* matrix when the data is in the same units and a *correlation* matrix when they are in different units. In an investment risk setting, we normally see the covariance matrix of investment returns; however, some adjustment may be necessary if individual investments are significantly more volatile than other assets, as they may dominate the analysis. We assume that input data are always de-meaned, but as we saw in Figs. 1(b) and 3(b), different weightings lead to different results.

Even in the case of normalising all data to unit variance, i.e. starting with a correlation matrix, we can see quite unintuitive behaviour from PCA in an investment context when thinking about diversification. In Fig. 4(a), we show PCA for a starting universe with two uncorrelated assets with unit variance. The distribution of variance is flat, and the effective number of principal components (PCs) is naturally two. However, if we add more investments that are perfectly correlated to one in the starting universe, then the distribution becomes increasingly concentrated, and the Effective Number naturally decreases.

With three perfectly correlated assets and one uncorrelated, 75% of the variance is explained by PC1 and 25% by PC2. This is easily understood as the sum of the variances is 4, and 3 of that is explained by PC1, which covers the 3 perfectly correlated assets. This idea is easily extended, so if we have 95 perfectly correlated assets and 5 uncorrelated to everything else, then 95% of the variance would be explained by PC1.

If we were then building a risk model, perhaps truncating the distribution at 95% variance explained, then we would be ignoring all 5 uncorrelated investments, even though they are the most valuable from a diversification perspective. Part of the disconnect we believe is at play here is that explaining the sum of the variances relates more to approximating the input data, where we wish to capture and conserve the *energy* of all the inputs on a mean-squared-error basis.

From an investment universe perspective, this seems less relevant as all investments will be rescaled by portfolio weights when constructing portfolios anyway. In the case of signals, it also seems more relevant to retain more uncorrelated information. To that end we wish to remove the bias that comes from assets being increasingly correlated and introduce a dynamic reweighting scheme that down-weights assets as their correlation increases, be it positive or negative. The result of applying this to Fig. 4(a) is shown in Fig. 4(b).

Fig. 4(a) Three examples show the dilutive impact of adding perfectly correlated investments to an investment universe
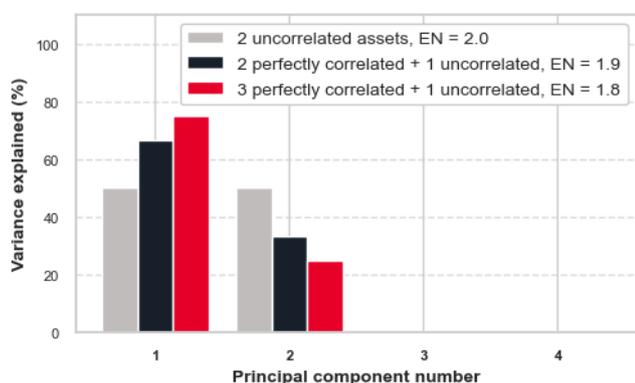
(b) Reweighting applied to the universes in Fig. 4(a) corrects dilution by adjusting for bias in the sum of variances
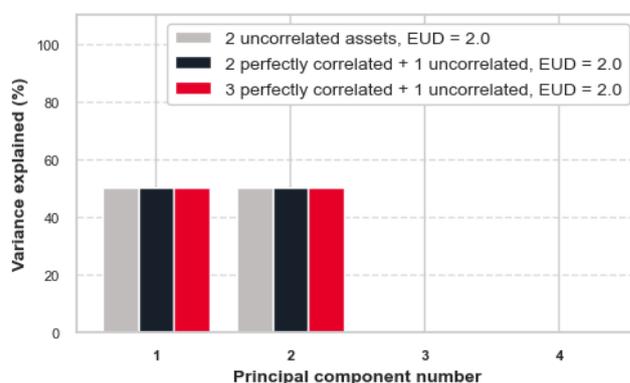
Source: SG Cross Asset Research/Quant, Bloomberg

We observe there that the distribution is perfectly flat in every case, as we would wish it to be. The Effective Number of PCs is exactly 2 and this in fact defines the Effective Universe Dimensionality (EUD): the Effective Number of PCs after PCA is applied to our reweighted inputs, for any input matrix. EUD has several useful properties:

(1) EUD = 1 if, and only if, all investments (or signals) are perfectly correlated (+ or -)

(2) EUD = N if, and only if, all investments are perfectly uncorrelated

(3) EUD is scale-invariant, i.e. it is insensitive to any *a priori* scaling of the inputs

To clarify property (3), we know PCA results are affected by the variances of the inputs, and we have shown that the correlation structure introduces a bias that we do not want. Regardless of whether we input a correlation matrix, a covariance matrix, or matrices based on weighted inputs, EUD will always rescale the data to achieve the same output.

Fig. 5 shows the addition of EUD analysis to our earlier examples with different input matrices. In this case, the EUD results are similar to the results for the correlation matrix but show a slightly broader distribution of variance and an associated higher dimensionality. In addition to properties (1) to (3), we also have the following:

(4) The addition of an investment always changes the EUD by some value between 0 and 1

For investors expanding their investment universe and looking for diversifying strategies, when adding an investment that is covered or "explained" by the current universe, there is no change in EUD. This is the case we observe in Fig. 4(b) when adding perfectly correlated strategies. In contrast, a strategy that is uncorrelated to all investments in the universe improves EUD by exactly one. Note that when changing a universe, all input data is rescaled again to ensure the fair assessment of the new universe; hence the scheme being dynamic.

By applying EUD analysis, we can assess the diversification potential for a given investment over a given period by simply specifying an associated input matrix. Although it does not matter in general, it will often be easiest to start with a covariance matrix, which may be pre-processed in advance to improve numerical stability. As we see in the next section, it is also useful to see how this diversification potential holds up through time.

Fig. 5: EUD added to the analysis in Fig. 3(b) for the traditional investment universe
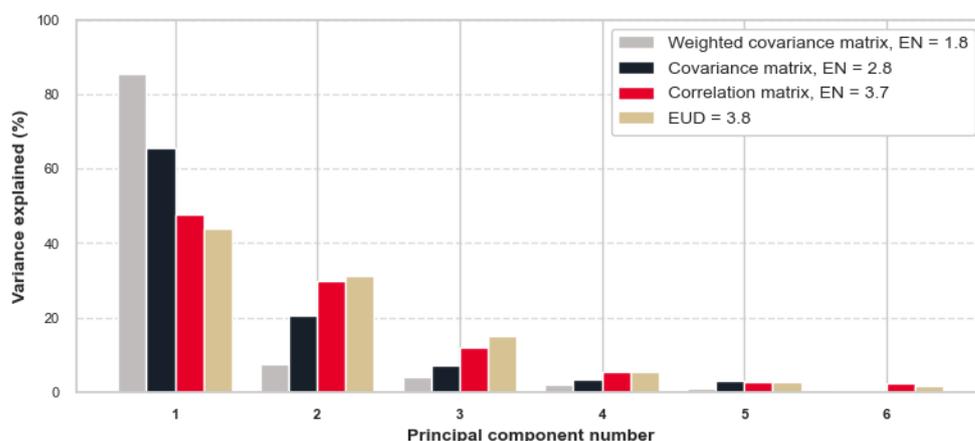
Source: SG Cross Asset Research/Quant, Bloomberg

Fig. 6(a) EUD for a base investment universe using equities and bonds from Fig. 1, with/without commodities included

(b) EUD difference yields the incremental diversification benefit over time from including commodities per Fig 6(a)

Source: SG Cross Asset Research/Quant, Bloomberg

Expanding the investment universe

Adding commodities to equities and bonds

We apply an exponential weighted moving average with a half-life of one year.

For managers of portfolios containing only equities and bonds, a first step to expand the investment universe is often to consider commodities. To explore this, we return to our initial universe from Fig. 1(a), separating out commodities, and defining equities and bonds as the *base universe*. In Fig. 6(a), we show how the EUD changes over time for the base universe and the expanded universe, while in Fig. 6(b) we show the difference. Fig. 6(a) shows that the base universe typically sits in the 2.5 to 3.25 range, which seems helpful for five return indices across two asset classes, as some correlations are expected to be high. The addition of commodities shows a significant diversification benefit in Fig. 6(a), the EUD at times coming in at over 4, albeit dropping markedly following the financial and COVID crises. Fig. 6(b) shows a high dimensionality benefit of around 0.8 to 1.0 up to 2008, being highly uncorrelated to base, and a more typical range of 0.6 to 0.8 after 2012, which remains material enough to consider a commodity index a strong diversifier to traditional portfolios.

Adding gold and bitcoin to equities and bonds

Digging further into the varied commodity universe, one of the standout performers of 2025 was gold, with further gains expected in 2026 by our [strategists](#). Also, in the current context of US fiscal policy, a weaker US dollar and geopolitical uncertainty, the merits of Bitcoin as an alternative safe-haven asset have continued to be debated. We examine the diversification potential of both assets by looking at the incremental benefit of adding them at the same time to the base universe of equities and bonds, which we show in Fig. 7(a). A benefit of the EUD framework is the possibility of having more than one investment in both the base universe and universe of additions.

Fig. 7(a) shows again that the expanded universe offers significant diversification benefit to the base universe, touching a substantial peak dimensionality of 5 from a universe of 7 assets. Fig. 7(b) shows a consistently high value for incremental dimensionality, and during the COVID crisis an additional dimensionality of around 0.75 was retained from the two additional assets, as both individual values fell sharply. From this attribution we can see the large structural change with bitcoin before and after the COVID crisis, shifting from a relatively constant level around a maximum possible value of 1 to having more cyclicality.

Fig. 7(a) EUD for the base investment universe of equities and bonds, with and without gold and bitcoin
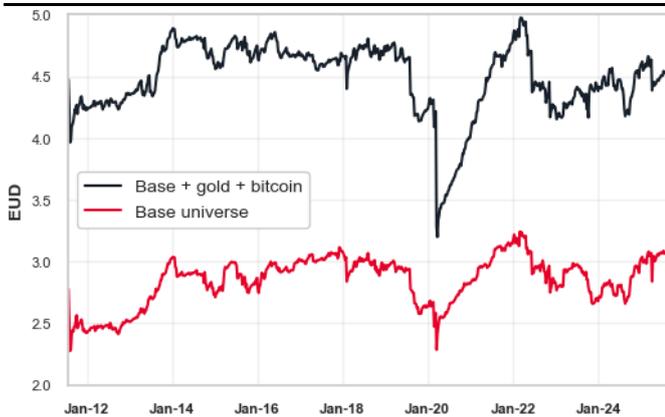
(b) EUD difference yields the incremental diversification benefit from including gold and bitcoin per Fig 7(a)
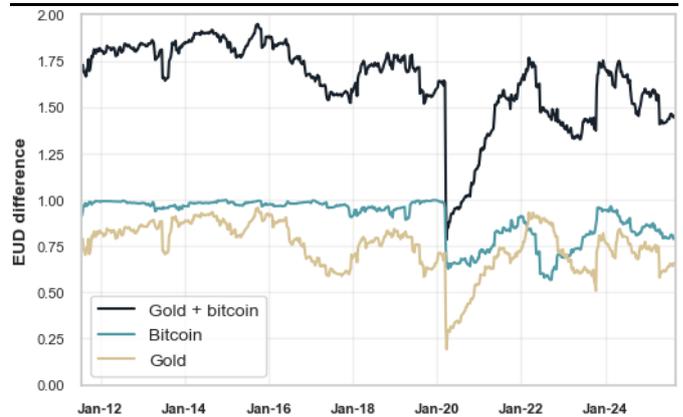
Source: SG Cross Asset Research/Quant, Bloomberg

Generally, both gold and bitcoin have offered a material diversification benefit both individually and jointly, indicating low correlation to traditional assets and each other.

Adding QIS to equities and bonds

Bloomberg index codes for example systematic strategies:

Eq. Mean Reversion	SGEPMRWU
Eq. Pure Factor	Forthcoming
Rates Slope Trend	SGIXRSTE
Rates Volatility	SGIXEVR4
Commodity Carry	SGIXV57E
Commodity Value	SGICCOVA
FX Carry	SGIXTFC3
FX Value	SGIX3FVE
Multi-Asset Trend	SGMDXATL

Note that we are using a time series of a trend strategy rather than a look-through of exposures through time, which is less accurate but partially mitigated by a rolling window analysis.

We next expand our equity and bond universe with a selection of nine QIS covered in our recent publications on how to measure portfolio diversification, and listed in the adjacent sidenote. In Figs. 8(a) and 8(b), we show our now familiar plots for the base and expanded universes through time. The dimensionality of the expanded universe of 14 investments is significantly larger, typically between 9 and 11, and finding a minimum of around 7.5 in early 2020. From looking at the difference in Fig. 8(b) we can see the QIS universe boosts the base universe by around 7, with a minimum of 5 in 2020. In Fig. 8(b), we also show the incremental benefit of adding only Multi-Asset Trend to the base universe. Although it does offer a useful dimensionality benefit, variability is expected by design as it is directional in its exposures, and includes equities and bonds, overlapping the base universe. Combined exposures within trend, including those of FX, do support decorrelated behaviour; however, this highlights that the role of trend as a diversifier is perhaps more about hedging when being short asset classes, rather than its low average correlation over time, which would be a natural consequence of a strategy alternating the sign of its beta exposures through time.

Fig. 8(a) EUD for the base investment universe and an expanded universe that includes 9 systematic strategies
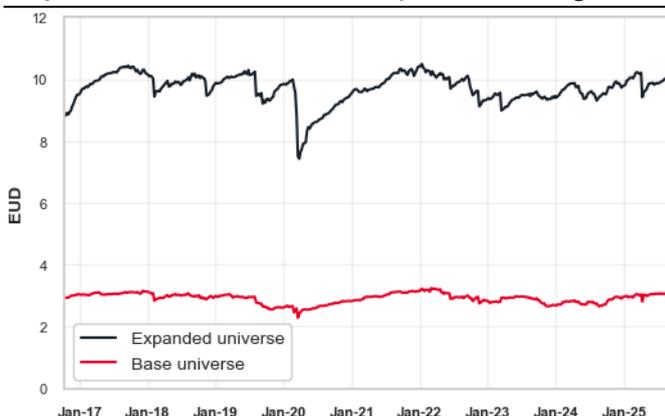
(b) Dimensionality benefit from adding 9 systematic strategies and trend in isolation vs the base universe
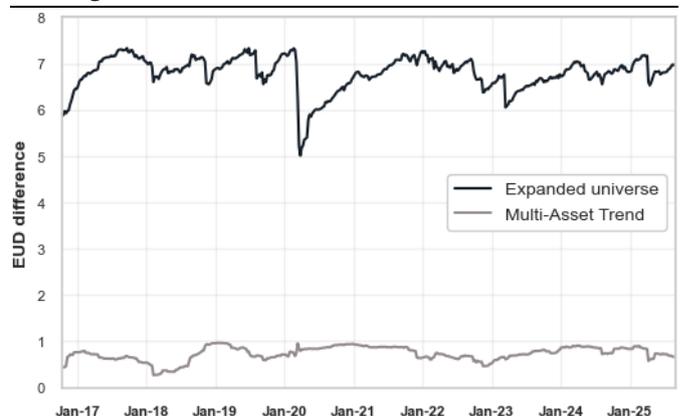
Source: SG Cross Asset Research/Quant, Bloomberg

Fig. 9(a) Dimensionality benefit from adding FX strategies: FX Carry and FX Value
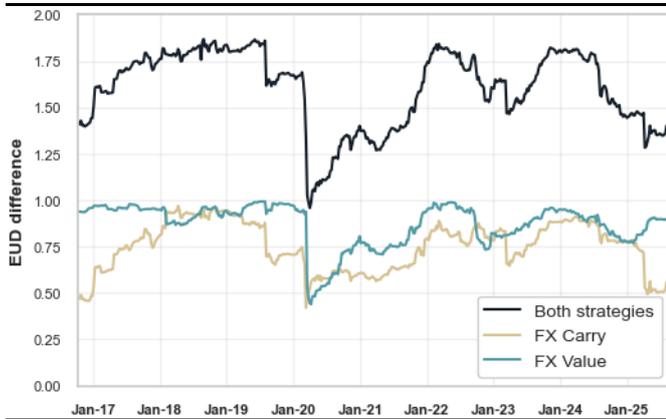
(b) Dimensionality benefit from adding Interest Rates (IR) strategies: Rates Slope Trend and Rates Volatility

Source: SG Cross Asset Research/Quant, Bloomberg
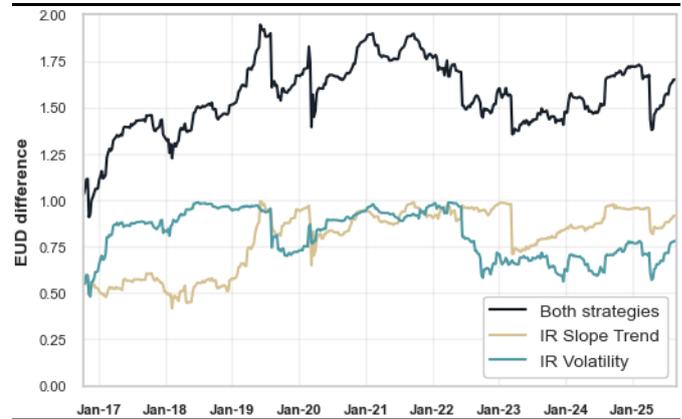
QIS dimensionality by asset class

Finally, having split out trend, we examine the dimensionality of each pair of systematic strategies within Equities, Rates, Commodities, and FX and show results in Figs. 9(a), 9(b), 10(a), and 10(b). The results are ordered from FX, to Rates, Equities, and Commodities. This order broadly reflects the increasing persistence of diversification benefit within asset class pairs and, as it did for Multi-Asset Trend, intuitively reflects the design of the strategies as being *less directional* or *more market neutral*. For example, in Fig. 9(a), FX cannot be market-neutral and cross correlation with the equity-bond base universe is expected on an ongoing basis. The exposures are also dynamic. In Fig. 9(b), IR Slope Trend is duration neutral but can exhibit correlation to bond returns, depending on how they are generated, as can being long IR Volatility. The equity and commodity strategies in Figs. 10(a) and 10(b) show a generally higher level of sustained diversification at the individual strategy level. All strategies therein are long/short in construction. In terms of market shocks, all strategies except Rates drop markedly in early 2020, though all pairs maintain at least one dimension of diversification benefit. What is notable in Fig. 10(b) is Q4 2018 where the individual commodity strategies maintain a good level of dimensionality benefit but together exhibit a sharp fall in dimensionality. Beyond headline growth concerns and the oil price falling at the time, cold US weather caused significant idiosyncratic gas repricing that, unusually, hit both strategies.

Fig. 10(a) Dimensionality benefit from Equity strategies: Equity ML Mean Reversion and Equity Pure Factor
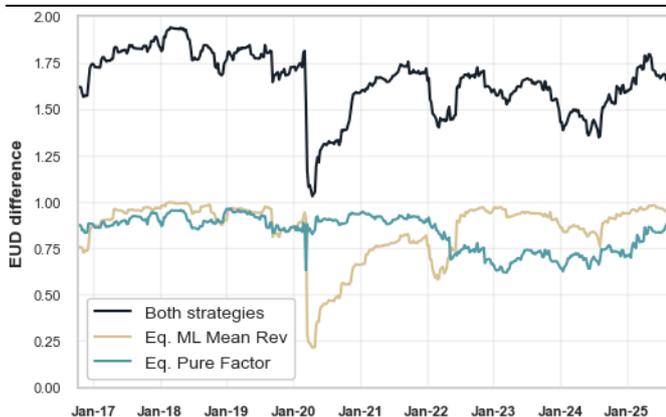
(b) Dimensionality benefit from Commodity strategies: Commodity Carry and Commodity Value

Source: SG Cross Asset Research/Quant
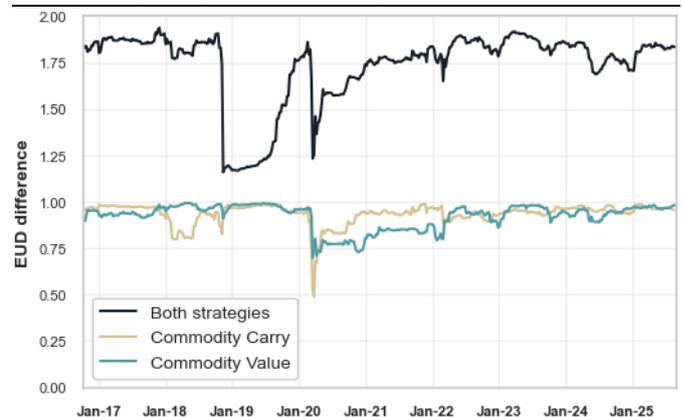
Ranked strategies by diversification benefit relative to our bond and equity base universe (calculated over 10 years)

Strategy	Diversification benefit	Carry/Hedge/Comparator	Ticker
IR Slope Trend	0.99	Hedge	SGIXRSTE
Commodity Carry	0.97	Carry	SGIXV57E
Commodity Value	0.96	Carry	SGICCOVA
Multi-Asset Trend	0.96	Hedge	SGMDXATL
Equity ML Mean Reversion	0.95	Carry	SGEPMRWU
FX Value	0.93	Hedge	SGIX3FVE
Synthetic Down Var EUR	0.92	Hedge	SGIXTRSE
Downside S&P Gap Risk	0.92	Carry	SGIXSTEP
Bitcoin	0.91	Comparator	XBTUSD
IR Volatility (Forward)	0.88	Hedge	SGIXEVR4
FX Gap Risk (USDJPY)	0.88	Carry	SGIHOPUJ
Upside S&P Volatility Carry	0.85	Carry	SGIXUFLY
Eq. Pure Factor	0.85	Carry	Forthcoming
FX Gap Risk (EURJPY)	0.84	Carry	SGIHOPEJ
FX Carry + Value	0.83	Carry	Combination
Synthetic Down Var US	0.80	Hedge	SGIXTTRU
Dynamic VIX Futures Hedge	0.78	Hedge	SGIXVIPR
FX Carry	0.77	Carry	SGIXFC3E
IR Volatility (Spot)	0.77	Hedge	SGBVV1ER
Gold	0.72	Comparator	SPGCGCTR
VIX Spread	0.67	Carry	SGMDVIS
Commodities (GSCI)	0.67	Comparator	SPGCESTR
VIX Spread Constant Maturity	0.35	Carry	SGIXVSPR
Short VIX	0.29	Carry	SGIXV1MS

Applying EUD to the Outlook universe

In the table above, we show an ordered diversification analysis of investments and strategies in this section along with a selection of strategies from this Outlook. The *EUD difference,* which we have also termed the *Dimensionality benefit*, we now present as the *Diversification benefit* of adding an individual investment or strategy to the same base universe we have used above containing equities and bonds. The analysis is done using a flat-weighted 10-year history of data.

The table is naturally dominated by less directional strategies that are less correlated to equities and bonds, such as IR Slope Trend, Multi-Asset Trend, Commodity Carry and Value, and Equity ML Mean Reversion. Some interpretation is, however, needed. For example, we have seen in Fig. 9(b) that IR Slope Trend, which is duration-neutral, is not always so uncorrelated over time. The same is true for Multi-Asset Trend in Fig. 8(b), since it can take both long and short direction positions. The diversification benefits remain significant, but 10-year averages can smooth over important variations that need to be kept in mind when constructing portfolios.

It is also worth noting that option-based strategies, with and without delta-hedging such as Synthetic Down Var in EUR/US, Downside S&P Gap Risk, and Upside S&P Volatility Carry behave in quite an uncorrelated way most of the time, showing strong diversification benefit, but can then be more correlated when markets move significantly. This may be positive or negative depending on their carry vs hedging characteristics, which is why we often discuss in our research the importance of scenario analysis and understanding nonlinearity.

Most strategies we present in the table offer a significant diversification benefit to the base universe. The less additive ones, VIX Spread Constant Maturity, and Short VIX, we already recognise as being generally long market risk and thus having a positive beta to the S&P. Depending on other characteristics, like expected risk-adjusted returns and particular scenarios, such strategies can of course offer diversification benefits, perhaps even as an equity alternative.

A framework for growing a diversified universe

We've introduced Effective Universe Dimensionality mainly to understand the benefits of expanding an investment universe, or perhaps a universe of signals. This focuses on how uncorrelated, i.e. orthogonal, the universe additions are. To do so, we introduced two ideas. Firstly, we applied the Effective Number to PCA analysis, which allows us to intuitively count the number of important drivers in the investment universe. Secondly, we introduced a dynamic weighting scheme to ensure that the uncorrelated components, which are most valuable to us as investors, are treated fairly within the scheme. We then demonstrated the usefulness of such an approach when expanding a traditional investment universe of equities and bonds, showing that systematic strategies across asset classes can be valuable additions. Although the framework explores only the correlation structure of the universe, the particular advantages, beyond enumerating additional dimensions, are that it works for any size of base or expanded universe and does not require any input weightings. Overall, it seems to be a promising tool for exploring universes and finding complementary strategies before building portfolios.

Building actual portfolios does of course require weights, and more careful accounting for the sum of strategies than PCA.

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Dimensions of the investment *portfolio*

An overview of Effective Portfolio Dimensionality

As mentioned above, we previously published Dimensions of Diversification with the simple motivation that investors talk about diversification continually but there is no agreed way to measure it. Mean-variance optimisation (MVO) tends to produce more concentrated portfolios than investors would like, and so different asset allocation methods exist to *spread risk* more than the MVO approach would suggest. However, without an agreed diversification measure it is unclear how such methods and allocations compare. Diversification measures have been proposed, but they can produce potentially unintuitive results in simple cases. This is also true for some allocation methods. Akin to EUD, we introduced the Effective Portfolio Dimensionality (EPD) framework to measure the number of independent risk dimensions *in a portfolio*.

For EUD we used PCA to assess uncorrelated risks in the investment universe; however, this doesn't work as straightforwardly for evaluating portfolios. For example, at the universe level, two sets of investment returns with the same variance that are perfectly positively or negatively correlated will be seen as a single risk in PCA. However, when added together in a portfolio the result is either, respectively, two additive risks, or two risks that fully negate each other. To resolve this, EPD takes a regression approach to properly account for the sum. With EPD in hand, we are able to evaluate portfolios on an absolute basis, compare portfolios of different assets, understand the impact of constraints, and evaluate the addition and removal of strategies.

Bloomberg index codes for example systematic strategies:

Eq. Mean Reversion:	SGEPMRWU
Eq. Pure Factor	Forthcoming
Rates Slope Trend	SGIXRSTE
Rates Volatility	SGIXEVR4
Commodity Carry	SGIXV57E
Commodity Value	SGICCOVA
FX Carry	SGIXTFC3
FX Value	SGIX3FVE
Multi-Asset Trend	SGMDXATL

The goal of using alternatives, such as systematic strategies, is ultimately to improve total portfolio return and diversification by finding less correlated investments, which we wrote about as far back as 2013. We also continue to highlight the related problem of generating alpha in more concentrated markets, as we have returned to in this Outlook. Maximum dimensionality is determined by the correlation structure of the investment universe. Reproduced from our paper, Fig. 11(a) shows correlations for a traditional multi-asset universe, many of which are positive, and its maximum EPD of 3.2. A more unconstrained approach using systematic strategies can increase dimensionality significantly. In Fig. 11(b), we see a more attractive correlation structure using nine systematic strategies in Equities, Rates, Commodities, and FX. Using this universe it is possible to build a portfolio with more than double the dimensionality with a value of 7.7.

Fig. 11(a) Correlations in a traditional portfolio offer a portfolio of dimension 3.2 (using data from 2020 to 2025)

(b) A more unconstrained approach can be used to construct a portfolio with over double the dimension at 7.7

Source: SG Cross Asset Research/Quant, Bloomberg

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APPENDIX

ANALYST CERTIFICATION

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