

Decoding Market Regimes

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Machine-learning insights into US asset performance over the last 30 years

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- Understanding market regimes is fundamental to investment strategy and historically has relied on a variety of quantitative and qualitative approaches.
- Our machine-learning approach, using 23 performance and uncertainty datasets, identified four distinct market regimes over the past 30 years.
- Our research identified the outperforming assets in each regime.

Market-regime analysis is a cornerstone of financial research, offering insights into the dynamic behavioural patterns of markets during distinct economic phases and shedding light on asset performance across cycles. Understanding regimes and regime change is vital for investors, traders, and portfolio managers because it helps them adapt strategies to prevailing market conditions, improve risk management decision-making, and maximise returns. In this paper, we outline our methodology, the four specific regimes identified, and the asset classes that performed in each regime.

This kind of analysis encompasses a wide range of influences, including economic, financial, social, and sentiment-driven factors, often in combination. For example, regimes may be shaped by macroeconomic conditions such as growth or recession, shifts in volatility, liquidity dynamics, or risk-on/risk-off sentiment. Structural trends, such as bull and bear markets and policy changes, also play a critical role in regime identification. One example of market regime analysis is State Street Investment Management's [Market Regime Indicator \(MRI\)](#), a proprietary macro indicator designed to identify the level of risk aversion/appetite in the market using forward-looking market information.

To capture the complexities of market dynamics, market regime analysis often combines qualitative and quantitative frameworks. Qualitative methods, such as expert judgment and narrative analysis, enable the interpretation of economic cycles, policy shifts, and sentiment trends, thereby uncovering nuances beyond numerical models. Quantitative approaches, by contrast, apply statistical techniques, machine learning, and data-driven insights to detect shifts in volatility, liquidity, and market behaviour. While both methods are valuable, this analysis focuses solely on a quantitative, machine-learning-based approach, using a targeted set of return and uncertainty indicators for the US market. To ensure the robustness of our findings, we conducted rigorous checks as described in our methodology below.

Regime analysis using machine learning: our methodology

To identify contemporaneous market regimes, we employed a dataset comprising 23 features: 17 derived from returns and 6 centred on measures of uncertainty. Drawing inspiration from a methodology proposed by Two Sigma,¹ this approach uses monthly return data as proxies for a range of macroeconomic and style factors. These include core macro factors (e.g., equities, interest rates, credit, and commodities), secondary macro factors (e.g., emerging markets, foreign currency, and local inflation), and macro styles (e.g., equity short volatility, fixed income carry, and trend following). Equity styles such as low risk, momentum, quality, value, and small caps were also incorporated. Complementing these features are uncertainty measures, including credit default swap (CDS) spreads, corporate bond liquidity, equity and fixed income option skews, and indices for economic and commodity uncertainty. Statistical techniques such as residualisation were applied to isolate common factors, and robust scaling ensured that no single feature disproportionately influenced the results. Following this data preprocessing, a t-distributed mixture model with Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) was employed to identify market regimes.

Mixture models are well-suited for regime identification as they provide a probabilistic framework for classifying data into distinct regimes based on shared characteristics. Each component of the mixture represents a potential regime, defined by parameters such as its mean and variance. This flexibility accommodates the inherent overlap and ambiguity in financial data, thereby capturing the uncertainty and complexity of regime transitions.

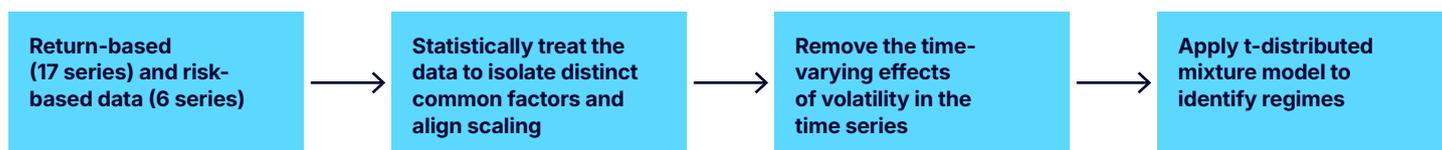
The t-distributed mixture model, rather than the more common Gaussian variant, is particularly advantageous for financial applications due to its ability to handle heavy tails and outliers. Financial return data often deviate from normality, with extreme values serving as key markers of regime shifts. The heavier tails of the t-distribution enable the model to effectively capture these extreme events, providing a more accurate representation of market dynamics, particularly during periods of stress or transition.

Integrating GARCH enhances this framework by accounting for the time-varying characteristics of volatility. Financial markets exhibit a phenomenon known as volatility clustering, where periods of heightened volatility frequently occur in succession. GARCH models this phenomenon, dynamically adjusting to shifts in uncertainty over time. This integration ensures the analysis captures both structural differences between regimes and the continuously evolving risk environment.

Together, the t-distributed mixture model and GARCH form an adaptive framework for regime identification. By relying on the statistical properties of the data, this approach avoids rigid assumptions and delivers insights into market behaviour. It effectively connects return dynamics with the temporal evolution of volatility, offering a comprehensive method for understanding and classifying market regimes (see Figure 1). The optimal number of regimes is determined using standard criteria such as the Akaike Information Criterion and Bayesian Information Criterion, striking a balance between model complexity and goodness-of-fit.

To verify the robustness of the results, we compared the dates associated with crisis-like regimes to those coinciding with NBER-defined recessions and the most significant drawdowns of the S&P 500, thereby demonstrating alignment with known periods of financial stress.²

Figure 1: Steps to identify market regimes using t-distributed mixture models



Source : State Street Investment Management. For illustrative purposes only.

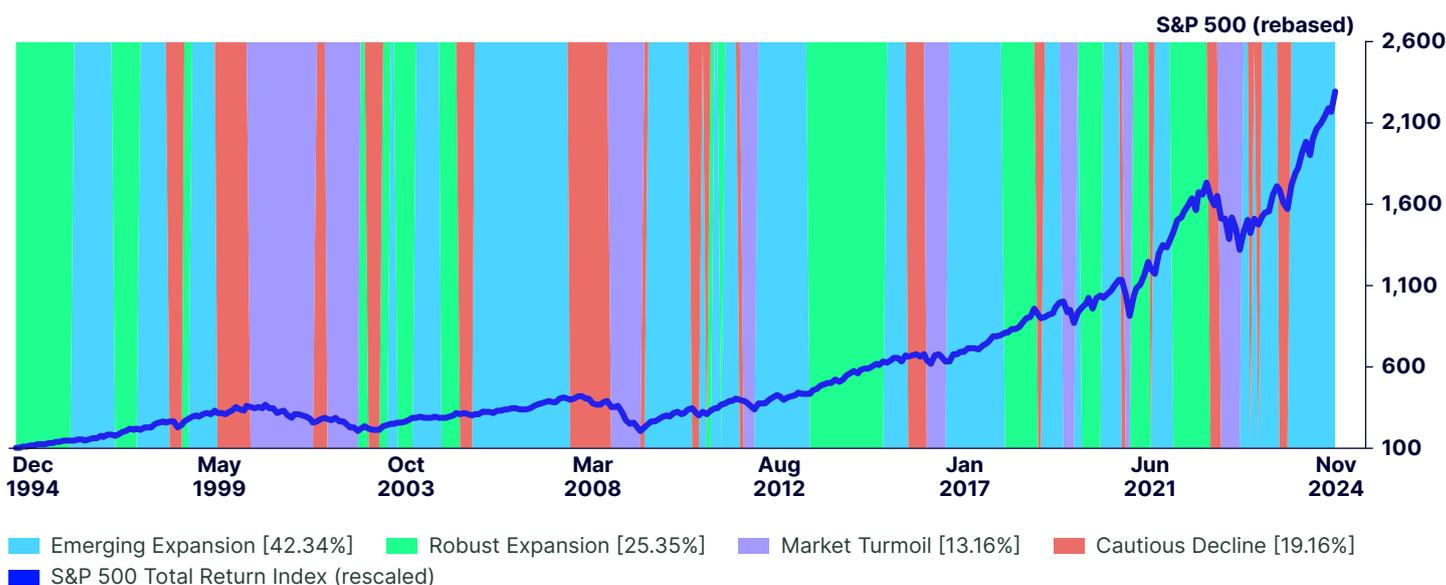
Our machine learning: findings

Market regimes in the US market

Examining data from 1995 to 2024, **four distinct regimes were identified** in the dataset, broadly categorised as **Emerging Expansion, Robust Expansion, Cautious Decline**, and **Market Turmoil**. The Emerging Expansion regime is the most prevalent (Figure 2), and the market is currently in this phase.

To assess the robustness of the analysis, the Market Turmoil regime was compared to the dates of NBER-defined recessions and the most significant drawdowns of the S&P 500. A high degree of overlap, as measured by the F1 score—which balances the precision and recall of predictions—indicates an accuracy of approximately 73% for the worst drawdowns, with an even higher accuracy of 78% when focusing on the five most severe drawdowns. This suggests that the regime-fitting procedure demonstrates strong potential for accurately identifying key market conditions (see Figure 3).

Figure 2: 4-state t-distributed mixture model based on macro and style factors



Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from January 1995 through November 2024.

Figure 3: Accuracy measures between the market turmoil regime and the worst drawdowns of the S&P 500

Accuracy of Market Turmoil regime (top 10 drawdowns)	4 State t-distributed mixture model (%)
Precision	73.61
Recall	71.94
F1 Score	72.77
Accuracy of Market Turmoil regime (top 5 drawdowns)	4 State t-distributed mixture model (%)
Precision	75.38
Recall	79.84
F1 score	77.55

Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from January 1995 through November 2024. Precision measures how accurate the positive predictions of a model are by calculating the proportion of true positives out of all the instances predicted as positive. Recall, also known as sensitivity, assesses the model's ability to identify all actual positive cases by calculating the proportion of true positives out of all the actual positives in the dataset. The F1 score combines precision and recall into a single metric by taking their harmonic mean, providing a balanced evaluation of the model's performance, especially when precision and recall are equally important.

Assessment of broad asset classes

To assess the performance of an asset class under different regimes, we propose examining both the magnitude of returns and their “reliability” across major asset classes, including broad US equities, broad US fixed income, broad commodities, and gold, over the period 1994 to 2024, as well as the subperiods 1994–2009 and 2009–2024. Performance reliability is evaluated using Quantile-Conditional Density (QCD), which analyses the conditional distribution of an asset's returns within market regimes. By assessing whether the distribution remains consistent and tightly clustered across quantiles, QCD provides insights into stability and predictability. The higher the QCD the more dispersed the return level and the lower the QCD the more certain the return level could be achieved.

Over the entire analysis period, equities achieved the best average performance on an absolute basis in both the Stable Expansion and Robust Expansion regimes (+2.1% and 2.9% per month), with the latter slightly outperforming. In addition, equities generated a positive return in 80% of the observations in the Stable Expansion regime and 88% of the observations in the Robust Expansion regime. This finding is also confirmed by their respective QCD and we also observe a similar outcome in the subperiods across these regimes.

Indeed, as the market regime deteriorated into Cautious Decline and then into Market Turmoil, not only did the average return for equities drop substantially to -0.7% in the Cautious Decline phase and -3.4% into the Market Turmoil phase, but the associated uncertainty was also much higher. For instance, the QCD of equities in the Market Turmoil phase was 0.6 versus 0.4 in the Robust Expansion phase.

The performance for fixed income was somewhat surprising. As expected, broad-based US Treasuries performed best in the Market Turmoil regime achieving a return of 0.7% on average, with a relatively high level of certainty as defined by its QCD across all the identified regimes. Interestingly, Treasuries fared worst during the Stable Expansion regime when the average return was the lowest among all the regimes and the uncertainty was highest.

As for commodities, the average performance was strongest in the Robust Expansion regime (0.9%) and weakest in the Market Turmoil regime (-1.8%), with relatively less variability in the returns in these regimes compared to the other two regimes.

Emerging Expansion regime

The Emerging Expansion regime represents 42% of the observations and is the most prevalent regime. In this phase, risk assets—namely equities and commodities—begin to exhibit stronger returns and often represent a transitory stage between moderate growth and robust growth. Notably, volatility in the Emerging Expansion phase is higher compared to the Robust Expansion phase.

As anticipated, the best-performing assets in the Emerging Expansion regime included financials, technology, small caps, metals and mining, aerospace and defence, and oil and gas equipment, with average returns ranging from 2.8% to 3.5%.

Among these, the stellar performance of small caps and technology was accompanied by the least degree of uncertainty, as determined by the QCD computation, whereas oil and gas equipment demonstrated the lowest inconsistency. Interestingly, metals and mining achieved the highest average return, yet was among the least certain assets in terms of performance stability (see Figure 4).

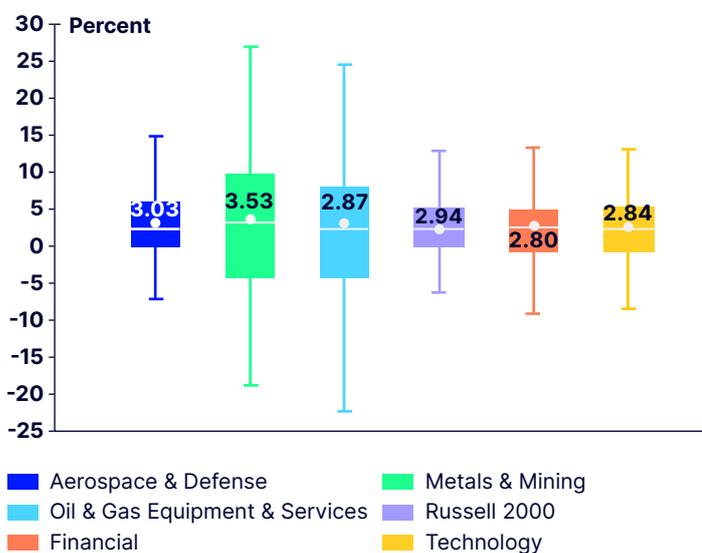
The strong performance of technology and small-cap stocks during the Emerging Expansion regime can be attributed to their heightened sensitivity to economic growth. Technology companies often lead innovation and capitalise on new growth opportunities, making them prime beneficiaries in the early stages of economic expansion. Similarly, small-cap stocks tend to outperform during economic recoveries due to their agility and domestic market focus, allowing them to respond swiftly to improving economic conditions.

Unsurprisingly, the worst-performing assets were fixed income, with returns ranging from 0.19% to

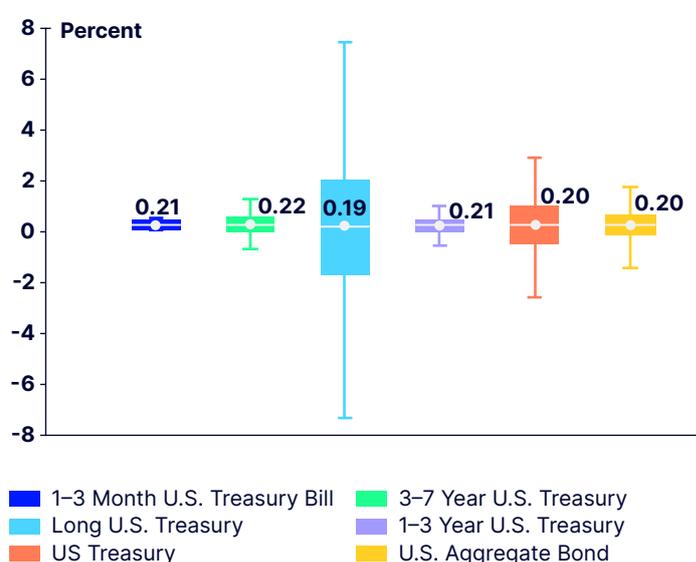
0.22%, and long-duration US Treasuries displayed the highest level of uncertainty. This was attributed to their extended duration, as longer-duration bonds are more sensitive to interest rate changes. In the Emerging Expansion regime, stable economic growth often raises expectations of increasing interest rates, which adversely impact long-duration bonds and heighten uncertainty in their returns. Interestingly, during this regime, gold exhibited the highest dispersion, with contrasting average monthly returns of +0.63% and median monthly returns of -0.15% when compared across all regimes.

Figure 4: Best- and worst-performing assets during the Emerging Expansion regime

Best performing (average monthly return)



Worst performing (average monthly return)



QCD	0.56	0.68	0.73	0.54	0.58	0.56
	Aerospace & Defense	Metals & Mining	Oil & Gas Equipment & Services	Russell 2000	Financial	Technology

QCD	0.53	0.79	0.92	0.53	0.8	0.63
	1-3 Month U.S. Treasury Bill	3-7 Year U.S. Treasury	Long U.S. Treasury	1-3 Year U.S. Treasury	US Treasury	U.S. Aggregate Bond

Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from 1 January 1995 through 30 November 2024. QCD is defined as Quantile-Conditional Density (QCD), is used to evaluate the reliability of the performance. QCD analyses the conditional distribution of an asset's returns within market regimes. By assessing whether the distribution remains consistent and tightly clustered across quantiles, QCD provides insights into stability and predictability. Aerospace & Defense is represented by the S&P Aerospace & Defense Select Industry Index, Oil & Gas Equipment & Services is represented by the S&P Oil & Gas Equipment & Services Select Industry Index, Technology is represented by the S&P Technology Select Sector Index, Financial is represented by the S&P Financial Select Sector Index, Metals & Mining is represented by the S&P Metals & Mining Select Industry Index, Russell 2000 is represented by the Russell 2000 Index, 1-3 Month U.S. Treasury Bill is represented by the Bloomberg 1-3 Month U.S. Treasury Bill Index, Long U.S. Treasury is represented by the Bloomberg Long U.S. Treasury Index Bloomberg, U.S. Aggregate Bond is represented by the Bloomberg U.S. Aggregate Bond Index, 1-3 Year U.S. Treasury is represented by the Bloomberg 1-3 Year U.S. Treasury, US Treasury is represented by the Bloomberg US Treasury Index, 3-7 Year U.S. Treasury is represented by the Bloomberg 3-7 Year U.S. Treasury Index. **The performance data quoted represents past performance. Past performance does not guarantee future results.** It is not possible to invest directly into an index. Index returns are unmanaged and do not reflect the deduction of any fees or expenses.

Robust Expansion Regime

The Robust Expansion regime accounts for 25% of the observations and is the second most prevalent regime. This phase can be characterised as a strong risk-on period, where most risk assets exhibit clear and sustained returns on both an absolute and risk-adjusted basis. The uncertainty of these returns, as measured

by Quantile-Conditional Density (QCD), is the lowest among all regimes.

In this bullish environment, risk-on assets such as Technology, Consumer Discretionary, Communication Services, Semiconductors, and Homebuilders outperform, with absolute average returns ranging from 3% to 5% (see Figure 5).

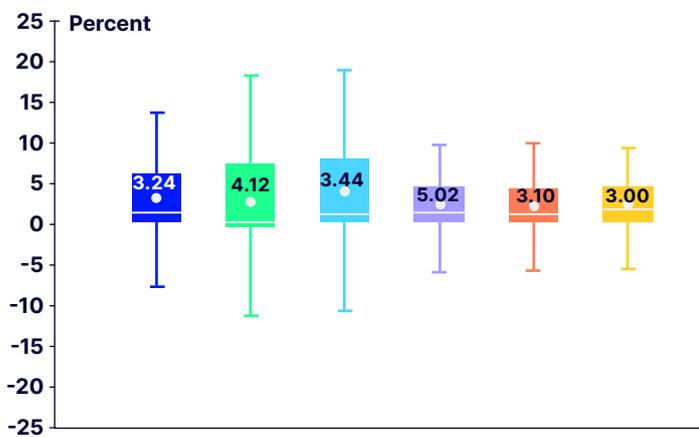
This outperformance is largely due to these sectors' sensitivity to economic growth and their capacity to capitalise on increased consumer spending and technological advancements during periods of robust expansion. As expected, defensive sectors like Consumer Staples and Utilities lag, as investors shift focus to higher-growth opportunities. Similarly, growth stocks outperform value stocks, with an average monthly spread of 0.5%, reflecting investors' preference for companies with higher expected earnings growth during economic upswings.

Conversely, fixed income assets underperform in this regime, with Treasuries and inflation-linked bonds yielding modest returns ranging from 0.05% to 0.3%. This underperformance can be attributed to rising interest rates, which negatively impact bond prices, and a decreased demand for safer assets as investor confidence in the economy strengthens.

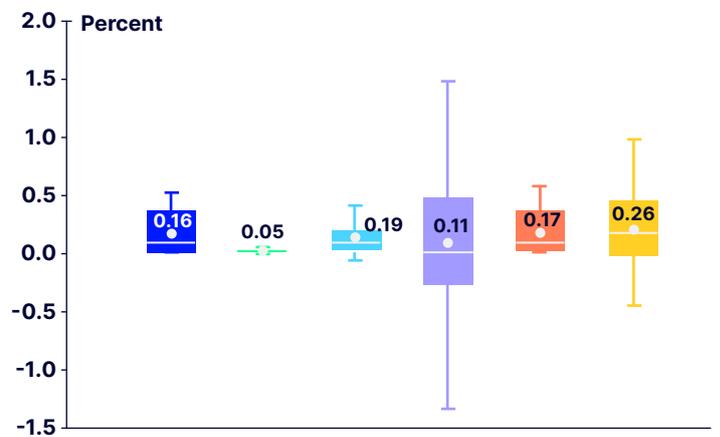
During this phase, gold generates a positive average return of 0.6%, albeit with high levels of inconsistency. The variability in gold's performance may be due to fluctuating inflation expectations and changes in investor sentiment regarding safe-haven assets during periods of economic strength.

Figure 5: Best- and worst-performing assets during the Robust Expansion regime

Best performing (average monthly return)



Worst performing (average monthly return)



■ Homebuilders ■ Metals & Mining
■ Semiconductors ■ Communication Services
■ Consumer Discretionary ■ Technology

■ 1-3 Month U.S. Treasury Bill ■ 3-12 Month U.S. Treasury Bill
■ U.S. Government Inflation-Linked Bond
■ 3-7 Year U.S. Treasury ■ 1-3 Year U.S. Treasury
■ U.S. Intermediate Corporate Bond

QCD	0.37	0.49	0.68	0.47	0.48	0.41

QCD	0.53	0.79	0.92	0.53	0.8	0.63

Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from 1 January 1995 through 30 November 2024. QCD is defined as Quantile-Conditional Density (QCD), is used to evaluate the reliability of the performance. QCD analyses the conditional distribution of an asset's returns within market regimes. By assessing whether the distribution remains consistent and tightly clustered across quantiles, QCD provides insights into stability and predictability. Homebuilders is represented by the S&P Homebuilders Select Industry Index, Metals & Mining is represented by the S&P Metals & Mining Select Industry Index, Semiconductor is represented by the S&P Semiconductor Select Industry Index, Communication Services is represented by the S&P Communication Services Select Sector Index, Consumer Discretionary is the S&P Consumer Discretionary Select Sector Index, Technology is represented by the S&P Technology Select Sector Index, 1-3 US Month US Treasury Bill is represented by the Bloomberg 1-3 Month US Treasury Bill Index, 3-12 Month US Treasury is represented by the Bloomberg 3-12 Month US Treasury Bill Index, US Government Inflation-Linked Bond is represented by the Bloomberg US Government Inflation-Linked Bond Index, 3-7 Year US Treasury is represented by the Bloomberg 3-7 Year US Treasury Index, 1-3 Year US Treasury is represented by the Bloomberg 1-3 Year US Treasury Index, US Intermediate Corporate Bond Index is represented by Bloomberg US Intermediate Corporate Bond Index. **The performance data quoted represents past performance. Past performance does not guarantee future results.** It is not possible to invest directly into an index. Index returns are unmanaged and do not reflect the deduction of any fees or expenses.

Cautious Decline regime

The Cautious Decline regime accounts for 19% of the observations and is the third most prevalent regime. This phase represents a transitory stage between the Robust Expansion regime and the Market Turmoil regime. During this period, risk assets generally experience negative returns accompanied by high levels of uncertainty, while defensive assets—particularly those in the lowest-risk spectrum—tend to outperform.

In this regime, the best-performing assets include Oil & Gas Exploration, Oil & Gas Equipment & Services, gold, Treasuries and inflation-linked bonds, with absolute returns ranging from 0.5% to 1% (see Figure 6).

However, the uncertainty in returns for fixed income assets, as measured by Quantile-Conditional Density

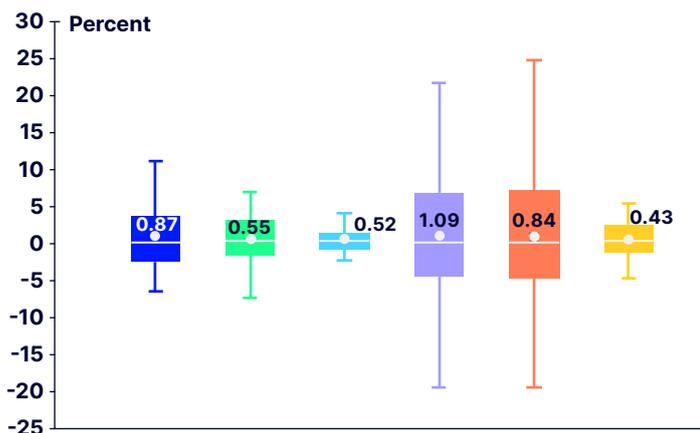
(QCD), is higher in this regime compared to the Market Turmoil regime. Additionally, Utilities and Biotechnology companies outperform the S&P 500 index. Among these assets, gold achieves the highest average monthly return (0.87%), though it records positive returns only 52% of the time during this regime. Notably, when gold does yield positive returns, its performance is exceptionally strong.

This pattern in gold's returns suggests a leptokurtic distribution, characterised by fat tails, indicating a higher probability of extreme positive returns compared to a normal distribution.

Conversely, equity exposures to financial institutions, real estate, communication services, and consumer discretionary sectors perform poorly, generating negative returns.

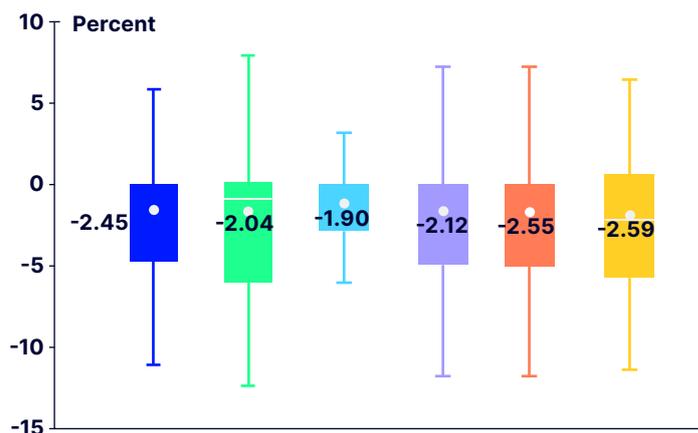
Figure 6: Best- and worst-performing assets during the Cautious Decline regime

Best performing (average monthly return)



■ Gold Spot ■ Long U.S. Treasury
■ U.S. Government Inflation-Linked Bond
■ Oil & Gas Equipment & Services
■ Oil & Gas Exploration & Production
■ 3-7 Year U.S. Treasury

Worst performing (average monthly return)



■ Regional Banks ■ Consumer Discretionary
■ Financial ■ Real Estate
■ Banks ■ Communication Services

QCD	0.96	0.85	0.79	0.93	0.91	0.76

QCD	0.63	0.64	0.48	0.5	0.61	0.63

Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from 1 January 1995 through 30 November 2024. QCD is defined as Quantile-Conditional Density (QCD), is used to evaluate the reliability of the performance. QCD analyses the conditional distribution of an asset's returns within market regimes. By assessing whether the distribution remains consistent and tightly clustered across quantiles, QCD provides insights into stability and predictability. Gold is represented by LBA Gold Price PM, Long US Treasury is represented by Bloomberg Long U.S. Treasury Index, US Government Inflation-Linked Bond is represented by US Government Inflation Linked Bond Index, Oil & Gas Equipment & Services is represented by S&P Oil & Gas Equipment & Services Select Industry Index, Oil & Gas Exploration & Production is represented by S&P Oil & Gas Exploration & Production Select Industry Index, 3-7 Year US Treasury is represented by Bloomberg 3-7 Year US Treasury Index, Regional Banks is represented by S&P Regional Banks Select Industry Index, Consumer Discretionary is represented by S&P Consumer Discretionary Select Sector Index, Financial is represented by S&P Financial Select Sector Index, Real Estate is represented by S&P Real Estate Select Sector Index, Banks is represented by the S&P Banks Select Industry Index, Communications Services is represented by S&P Communications Services Select Sector Index. **The performance data quoted represents past performance. Past performance does not guarantee future results.** It is not possible to invest directly into an index. Index returns are unmanaged and do not reflect the deduction of any fees or expenses.

Market Turmoil regime

The Market Turmoil regime accounts for 13% of the observations and, as previously highlighted, exhibits a high degree of overlap with the S&P 500's worst drawdowns. In this regime, risk assets delivered very poor performance with significant inconsistency, while risk-off assets achieved positive average returns with much lower variability.

The best-performing assets in this regime were found in fixed income, particularly US Treasurys across maturities, with long-dated Treasurys performing especially well (see Figure 7).

In a risk-off market environment, long-dated Treasurys typically outperform short-dated ones due to several factors. First, during periods of market stress, investors seek safe-haven assets; and long-term Treasurys, being backed by the US government, attract strong demand. Additionally, long-term bonds have higher duration, making them more sensitive to falling interest rates, which often occur during risk-off periods as central banks implement rate cuts to stimulate the economy. This sensitivity results in a more significant price increase for long-term Treasurys compared to

short-term ones. Furthermore, in such scenarios, the yield curve may flatten or invert, with long-term yields declining more than short-term yields, further boosting the performance of long-term Treasurys.

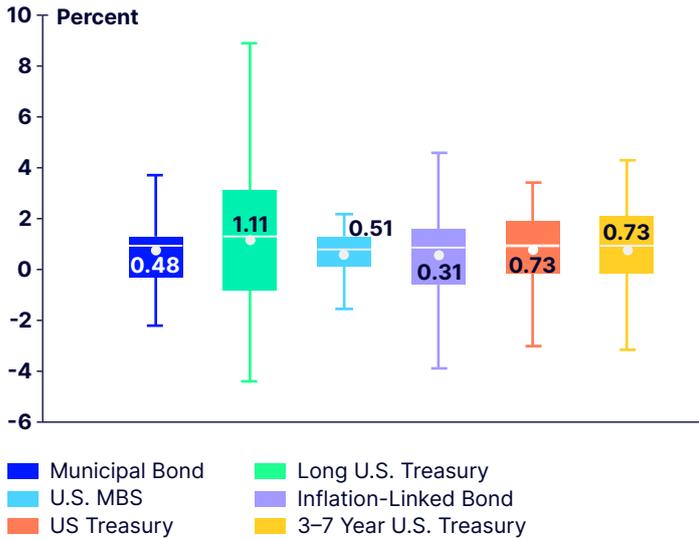
In contrast, equities experienced significant underperformance. The broad-based benchmark generated negative returns, recording an average monthly return of -2.74%. However, there were some relative bright spots within equities, most notably the Dividend Aristocrats, which outperformed broad US equities by approximately 2%. From a sector perspective, defensive sectors like Utilities and Consumer Staples were the only ones to outperform broad-based US equities, albeit with high levels of dispersion.

On the other hand, Financials, Industrials, and Materials ranked among the worst-performing sectors, with average monthly returns ranging from -5.4% to -6.82%, accompanied by relatively low levels of dispersion.

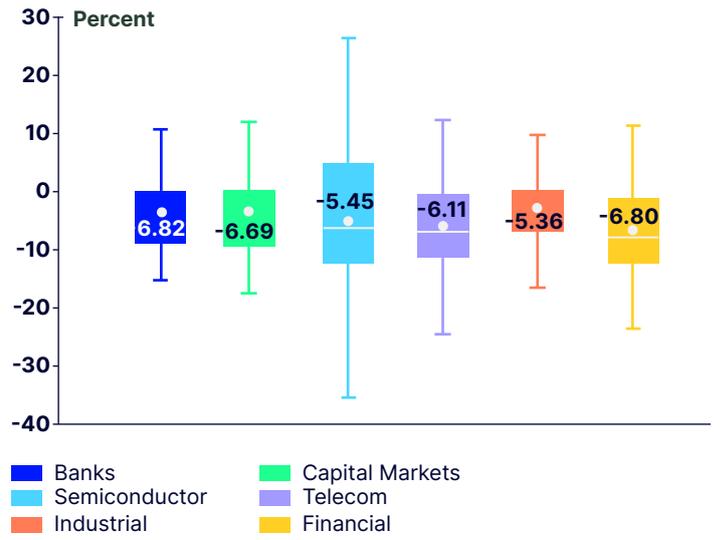
Interestingly, gold achieved an average monthly return of 0.54%, but this was accompanied by heightened volatility, with monthly returns ranging from -16.9% to 13% during this phase.

Figure 7: Best- and worst-performing assets during the Market Turmoil regime

Best performing (average monthly return)



Worst performing (average monthly return)



QCD	0.49	0.61	0.45	0.58	0.54	0.56
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QCD	0.52	0.48	0.56	0.48	0.47	0.51
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Source: State Street Investment Management, Bloomberg, <https://fred.stlouisfed.org>, from 1 January 1995 through 30 November 2024. QCD is defined as Quantile-Conditional Density (QCD), is used to evaluate the reliability of the performance. QCD analyses the conditional distribution of an asset's returns within market regimes. By assessing whether the distribution remains consistent and tightly clustered across quantiles, QCD provides insights into stability and predictability. Municipal Bond is represented by the Bloomberg 3-15 Year Blend (2-17) Municipal Bond Index, Long US Treasury is represented by Bloomberg Long US Treasury Index, US MBS is represented by the Bloomberg US MBS Index, US Government Inflation-Linked Bond is represented by the US Government Inflation-Linked Bond Index, US Treasury is represented by the Bloomberg US Treasury Index, 3-8 Year US Treasury is represented by the Bloomberg 3-7 Year US Treasury Index, Banks is represented by the S&P Banks Select Industry Index, Capital Markets is represented by the S&P Capital Banks Select Industry Index, Semi conductor is represented by the S&P Semiconductor Select Industry Index, Industrial is represented by the S&P Industrial Select Sector Index, Financial is represented by the Financial Select Sector Index. **The performance data quoted represents past performance. Past performance does not guarantee future results.** It is not possible to invest directly into an index. Index returns are unmanaged and do not reflect the deduction of any fees or expenses.

Summary of our findings

Here is the summary of our asset performance findings:

Regimes	Asset performance (in descending order)
Emerging Expansion	<ul style="list-style-type: none"> ★ ★ ★ Aerospace & Defence ★ ★ ★ Small caps ★ ★ ☆ Metals and Mining ⊗ Long-dated Treasuries
Robust Expansion	<ul style="list-style-type: none"> ★ ★ ★ Communication Services ★ ★ ☆ Metals and Mining ★ ★ ☆ Technology ⊗ Short term Treasuries and TIPS
Cautious Decline	<ul style="list-style-type: none"> ★ ★ ☆ Intermediate-dated US Treasuries ★ ★ ☆ Oil & Gas Equipment ★ ★ ☆ Gold ⊗ Financials
Market Turmoil	<ul style="list-style-type: none"> ★ ★ ★ Long-dated US Treasuries ★ ★ ☆ Other US Treasuries ★ ★ ★ Intermediate-dated Municipal Bonds ⊗ Telecoms

Source: State Street Investment Management. For Illustration only. The number of stars represent the average performance of the assets and how much dispersion there is historically and the circled cross represents assets to avoid.

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Endnotes

- <https://venn.twosigma.com/resources/factor-lens-update>.
- We examined the top 5 and top 10 worst drawdowns of the S&P 500.

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* This figure is presented as of December 31, 2025 and includes ETF AUM of \$1,950.80 billion USD of which approximately \$173.02 billion USD in gold assets with respect to SPDR products for which State Street Global Advisors Funds Distributors, LLC (SSGA FD) acts solely as the marketing agent. SSGA FD and State Street Investment Management are affiliated. Please note all AUM is unaudited.

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