

# Portfolio Testing 2.0: A Practical Guide to Scientific Portfolio's Conditional Simulations

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**AdvisorPlus**  
EXECUTIVE WRITING

# Contents

1	Defining Macro Regimes as Meaningful Scenarios for Equity Portfolios	3
2	Measuring the Impact of Macro Regimes on Equity Portfolios	5
3	Empirical Results and Summary	6

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## Introducing a More Reliable Rehearsal

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Simulating equity portfolio returns enables investment committees to rigorously evaluate strategies under diverse macroeconomic conditions. Given the sensitivity of portfolios to significant economic shifts, simulations provide critical insights into risks and opportunities that go beyond those revealed in historical data—a particular advantage when strategies lack extensive performance histories.

Unlike traditional backtesting, which focuses narrowly on past performance, simulations allow committees to anticipate potential future outcomes and construct strategies better prepared for evolving macroeconomic stresses.

*"Simulating equity portfolio returns enables investment committees to rigorously evaluate strategies under diverse macroeconomic conditions."*

However, many portfolio managers still rely on a simplified "what-if" approach to macroeconomic scenario analysis. In this approach, a portfolio's sensitivity to a risk factor is calculated using historical data, followed by the application of subjective stress levels to estimate potential gains or losses. This method faces several limitations:

- **Arbitrary Scenario Selection:**

Defining stress levels for macro risk factors involves subjective decisions that lack consistency or predictive accuracy.

- **Failure to Capture Multi-Dimensional Effects:**

Macroeconomic events often exhibit rare, extreme characteristics that challenge statistical reliability. Risk factors interact in complex ways, meaning simple single-factor stress tests fail to account for real-world dynamics and joint factor behavior.

- **Over-Reliance on Limited Data Samples:**

Many portfolios lack sufficiently long historical track records to include significant macroeconomic shifts. Sole reliance on historical data often leaves gaps in understanding portfolio behavior during extreme events.

This whitepaper introduces a simulation-based framework for macroeconomic scenario analysis, overcoming the traditional "what-if" method's limitations. Developed by the Scientific Portfolio (SP) research team, the framework builds on findings presented in *Simulation of Equity Portfolios Returns in Macroeconomic Regimes* (Vaucher, Bagnara, Herzog, 2024).

Rather than applying fixed stress levels, this framework uses regime-based simulations to model a range of plausible outcomes for portfolio performance under varying economic conditions. By spanning multiple economic cycles, this approach provides more robust performance and risk assessments, offering insights that extend beyond historical returns.

Through in-sample and out-of-sample validation, the SP team demonstrates how these simulations deliver reliable expectations and enable better-informed decision-making under extreme macroeconomic conditions.

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## Defining Macro Regimes as Meaningful Scenarios for Equity Portfolios

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Institutional asset managers, particularly those launching new strategies or making significant changes to existing ones, often struggle to predict portfolio performance across

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diverse economic conditions. Short track records or limited exposure to a range of macroeconomic regimes make it challenging to draw reliable conclusions from historical data alone. Defining and utilizing macro regimes provides a practical framework for testing strategies in these scenarios.

A macro regime represents a specific economic phase characterized by movements or levels of key macroeconomic indicators such as inflation, interest rates, or market volatility. By constructing scenarios based on these regimes, asset managers can evaluate how portfolios might behave under both benign and stressed conditions.

These regimes focus on large-to-extreme market moves, capturing the top and bottom quartiles of changes in macroeconomic variables. This approach offers rigorous, plausible stress-testing scenarios, replacing more subjective “what-if” methods often used in portfolio analysis. For example, managers without exposure to high-volatility environments can simulate how portfolios might react under such conditions, moving beyond the limitations of historical records.

## Criteria for Macro Regime Selection

To ensure robust and relevant regime definitions, macroeconomic variables are selected based on the following criteria (Amenc et al., 2019):

- **Reactiveness:**

Variables must quickly reflect changes in investor preferences, ideally through market-based measures.

- **Economic Relevance:**

Selected variables should significantly impact aggregate wealth.

- **Empirical Link:**

The relationship between macroeconomic variables and equity factor returns must be well-supported in academic literature.

Short-term rates, inflation, and market volatility are examples of such variables, chosen for their empirical relevance and reliability. Using data from 1974 onward, “high” and “low” regimes are defined as the top and bottom quartiles of observed changes or levels for these indicators. For instance, a high-volatility regime includes months when market volatility reaches the highest quartile.

## Regime Insights: Duration and Historical Representativeness

Macro regimes typically last about a quarter, with some persisting up to two years. Most regimes are short-lived, with one-third lasting only a month before transitioning to non-regime periods. This variability impacts investment strategies: shorter regimes may call for derivatives, while longer regimes might require strategic portfolio reallocations.

Historical representativeness is another critical factor. Regimes should recur over time to offer reliable statistical insights. For example, high interest rates have occurred only during one decade over the past 40 years, leading to potential biases if such events are treated as isolated cases. In contrast, change-based regimes are more evenly distributed, mitigating biases tied to specific periods and providing a balanced framework for analysis.

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# Measuring the Impact of Macro Regimes on Equity Portfolios

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Institutional investors often face challenges in managing macroeconomic risks due to the elusive and dynamic nature of macroeconomic scenarios. Static measures of risk exposure can be unreliable, making it difficult to predict portfolio behavior under future conditions. A regime-based approach provides a more robust framework for analyzing portfolio performance within specific macroeconomic regimes, offering several benefits:

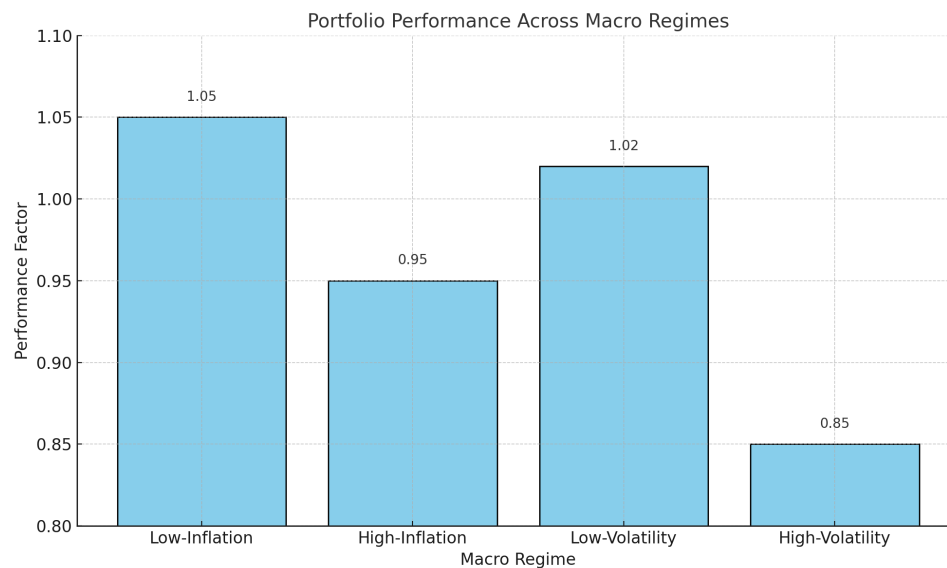


Figure 1: Portfolio Performance Across Macro Regimes

- **Enhanced Risk Management:**

Provides deeper insights into how external shocks may affect returns.

- **Realistic Scenario Testing:**

Surpasses traditional "what-if" approaches with comprehensive stress testing.

- **Dynamic Rebalancing:**

Supports informed decisions on adjusting portfolios to align with desired risk levels.

- **Reliable Forecasting:**

Offers a forward-looking framework for anticipating portfolio performance.

## Key Conditions for Relevant Macro Regimes

To be relevant, a macro regime must:

1. **Significantly Impact Performance:**

The regime must meaningfully affect portfolio returns or risk relative to long-term averages.

2. **Maintain Statistical Stability:**

Return properties must be reliable both in-sample and out-of-sample.

## Observations from Testing

Empirical tests reveal the following insights about regime-specific portfolio behavior:

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- **Volatility Sensitivity:**

Regimes tied to credit spread increases often show heightened market volatility, even when returns are less impacted.

- **Regime-Specific Returns:**

Strategies like small-cap portfolios are more sensitive to credit events, while sector portfolios, such as energy, exhibit pronounced swings during high-volatility regimes.

- **Distinct Return Distributions:**

Returns in macro regimes differ significantly from long-term averages, highlighting the value of regime-based analysis for realistic performance assessments.

## Stability and Robustness

Regime-based analysis has proven robust and consistent, offering:

- **Stable Return Distributions:**

Lower excess kurtosis within regimes indicates reduced volatility variation and more predictable performance.

- **Out-of-Sample Reliability:**

Returns within regimes show much higher consistency across time compared to broader market returns, improving confidence in forecasting.

## Empirical Results and Summary

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### Key Findings from Regime-Based Testing

To validate the regime-based methodology, the SP team tested its application on seven equity investment strategies, each built from U.S. funds following distinct factor or sector approaches. Strategies included Low-Risk, Value, Small Size, Technology, Energy, SP 500 Tracker, and ESG Tracker portfolios. These portfolios were analyzed for their sensitivities to macroeconomic regimes, revealing several critical insights:

- **Low-Risk Portfolio:**

Outperformed in downturns but was highly sensitive to interest rate changes.

- **Small Size Portfolio:**

Displayed higher volatility and heightened sensitivity to credit events.

- **Energy Portfolio:**

Most volatile and responsive to oil price changes, with significant swings during high-volatility regimes.

- **Broad Market and ESG Trackers:**

Minimal sensitivity to regimes, though tracking error increased in high-volatility environments.

### The Role of Equity Risk Factors

Equity risk factors, such as value and profitability, exhibited regime-specific variations in correlations and volatilities. For instance, the Profitability factor had a correlation of -0.28 in low-inflation regimes but -0.12 in up-inflation regimes. Factor volatilities were up to three times higher in extreme regimes, emphasizing the importance of regime-based analysis for understanding performance drivers.

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## Implications for Portfolio Management

The findings demonstrate that regime-based analysis offers critical tools for portfolio construction and risk management:

- **Extrapolated Returns:**

A factor-based model reliably simulated returns with a mean R-squared of 75

- **Enhanced Risk Management:**

Sensitivity to macro regimes revealed opportunities for better hedging and risk mitigation.

- **Dynamic Insights:**

Factor correlations and volatilities varied widely across regimes, underscoring the need for adaptive strategies.

## Future Applications

Looking ahead, conditional simulations can support two distinct investor approaches:

1. **Active Investors with Macro Views:**

Tactical portfolio adjustments can capitalize on anticipated macro trends, leveraging stock-level data to align with short-term economic shifts.

2. **Macro Risk Management:**

For investors focused on non-macro performance drivers, conditional simulations mitigate tail risks and maintain risk-adjusted returns in volatile environments.

By leveraging regime-based insights, institutional investors can enhance portfolio resilience and optimize performance in an evolving macroeconomic landscape.