U.S. Macro Outlook & Recession Risk - Quantitative Analysis on Historical Data (2000–2025)

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Executive Summary

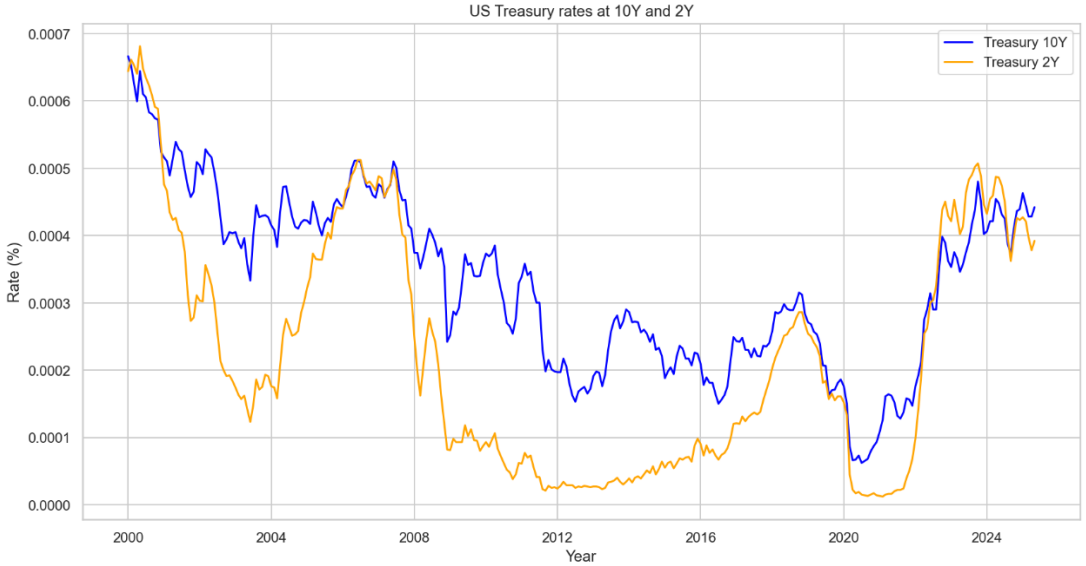
In recent months, financial markets and macroeconomic observers have turned their attention back to one of the most historically consistent recession signals: the inversion of the U.S. Treasury yield curve, specifically the spread between the 10-year and 2-year rates. This inversion has reached levels not seen in over forty years, prompting renewed debate over the timing, probability, and nature of a potential economic slowdown in the United States.

This report offers a data-driven examination of the macro-financial signals currently emerging from the U.S. economy, with a particular focus on the predictive validity of the yield curve. By integrating historical patterns with statistical and econometric models, the analysis aims to provide a structured perspective that is both rigorous and practically informative.
The study unfolds across four analytical layers. It begins with a historical overview of the yield spread and its correlation with official U.S. recessions, followed by a logistic regression model estimating the probability of a recession within the subsequent twelve months. The third section explores the dynamic relationships among GDP growth, unemployment, inflation, and interest rates through a Vector Autoregression (VAR) framework. Finally, the report evaluates the performance of a yield-curve-based investment strategy compared to a traditional Buy & Hold approach on the S&P 500.

By combining economic theory with empirical validation, this report provides a comprehensive outlook on the macroeconomic risks currently priced into financial markets. The findings are intended to support both institutional macro views and forward-looking portfolio decisions, especially in the context of late-cycle dynamics.

Yield Curve Inversion and Recession Risk

The inversion of the U.S. Treasury yield curve, particularly the spread between 10-year and 2-year government bond rates, has long been regarded as one of the most reliable leading indicators of recession risk. Historically, every U.S. recession since the 1970s has been preceded by a negative spread between long-term and short-term yields, typically with a lead time of 6 to 18 months. While not a perfect predictor in terms of timing or magnitude, the yield curve's signal has remained impressively consistent over decades, giving it substantial weight among both central bankers and institutional investors.

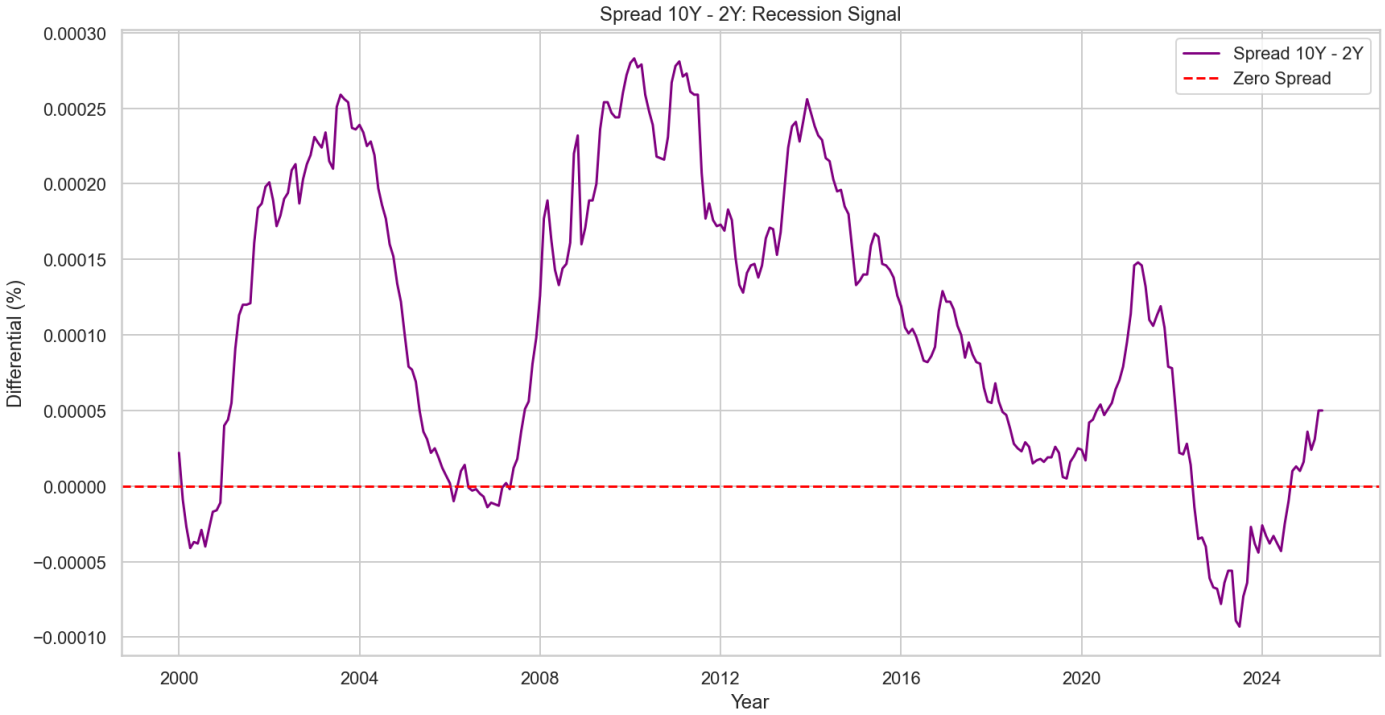


As of the latest observations, the spread between the 10-year and 2-year Treasury yields turned negative in July 2022 and remained inverted for over two years, marking one of the most prolonged inversion periods on record. Although this spread began to narrow in mid-2024, it remained negative through the majority of the year. Notably, the spread only briefly turned positive in August 2024, which aligns with the historical tendency of the yield curve to "normalize" shortly before recessions begin or once expectations for monetary easing become priced in.

A visual inspection of the data reveals that past recessions, as defined by the NBER, have consistently been preceded by this inversion. In our dataset, which spans from 2000 to mid-2025, the yield spread correctly signaled the recessions of 2001, 2008–2009, and the COVID-induced contraction of early 2020. This observation reinforces the strength of the signal, even amid structural shifts in the economy and monetary policy frameworks.

Beyond its historical success rate, the economic rationale behind this signal is rooted in expectations theory. When market participants anticipate a future slowdown, they demand lower yields on long-term bonds due to expected rate cuts by the Federal Reserve. At the same time, short-term yields remain elevated due to the current restrictive stance of monetary policy. The resulting inversion thus reflects the collective anticipation of a downturn.

However, it's important to stress that inversion alone is not a sufficient condition for recession. The signal must be contextualized alongside other macroeconomic variables, including the labor market, inflation expectations, and monetary policy stance, all of which are explored in the following sections.



In summary, the inversion of the 10Y–2Y spread continues to offer a high-probability warning of recessionary conditions ahead. While the timing remains inherently uncertain, the depth and persistence of the inversion observed from 2022 to 2024 cannot be dismissed as noise or a false signal. Instead, it should be interpreted as a red flag, particularly in the context of tightening credit conditions and waning consumer momentum.

Logistic Model: Recession Probability

To complement the traditional yield curve analysis, a statistical approach was employed to quantify the likelihood of a U.S. recession within the next 12 months. Specifically, a logistic regression model was developed using macroeconomic inputs that are both timely and historically linked to cyclical turning points. This model seeks not only to confirm or challenge the yield curve's signal, but also to translate the macro environment into a concrete, probabilistic estimate of future recession risk.

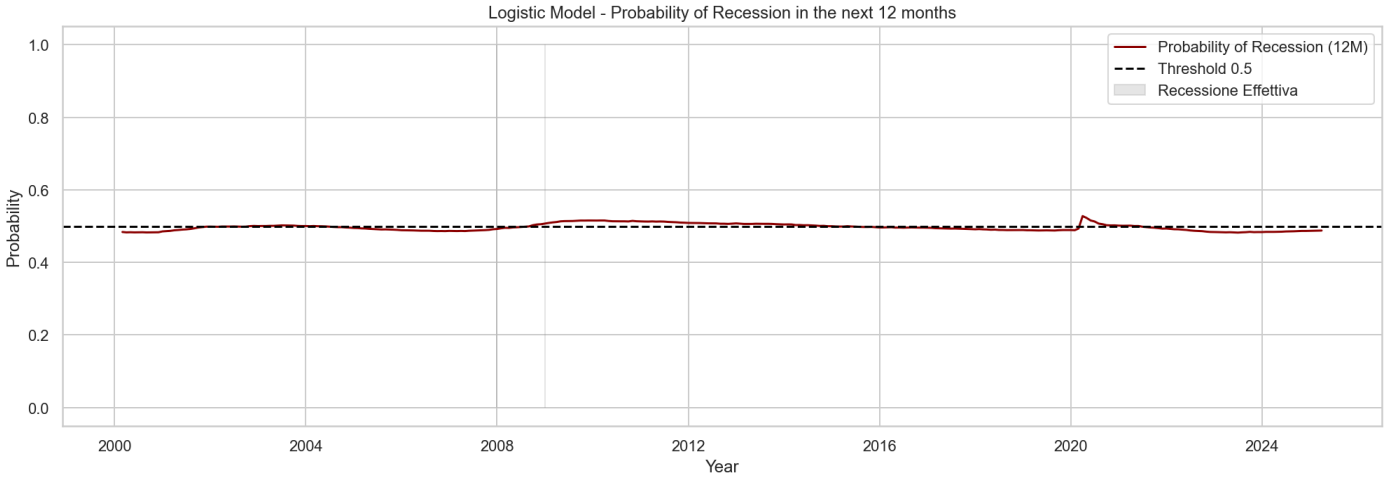
The model was trained on historical data from 2000 to 2025, using the following predictors:

- The spread between 10-year and 2-year Treasury yields
- The effective Federal Funds Rate
- The unemployment rate (UNRATE)

These variables were selected for their theoretical and empirical relevance. The yield curve captures forward-looking expectations, the Fed Funds Rate represents current monetary policy stance, and the unemployment rate is a contemporaneous reflection of labor market strength, a key input for real-time recession diagnostics.

The dependent variable in the model is a binary indicator of whether the U.S. economy entered a recession within the 12 months following each observation. This was constructed by shifting the NBER's USREC indicator forward by 12 months, allowing the model to "learn" from pre-recession environments.

Upon fitting the model, the out-of-sample performance was evaluated using the Area Under the ROC Curve (AUC), which produced a score of 0.744, indicating strong discriminative capability. In practical terms, the model was able to correctly distinguish between pre-recessionary and non-recessionary environments nearly 75% of the time.



The output of the logistic regression model, a probability score between 0 and 1, was then plotted over time. This time series provides a dynamic and interpretable estimate of recession risk at each point in the dataset. Notably, the model highlighted elevated probabilities prior to the 2001 and 2008 recessions, and also spiked ahead of the brief 2020 contraction.

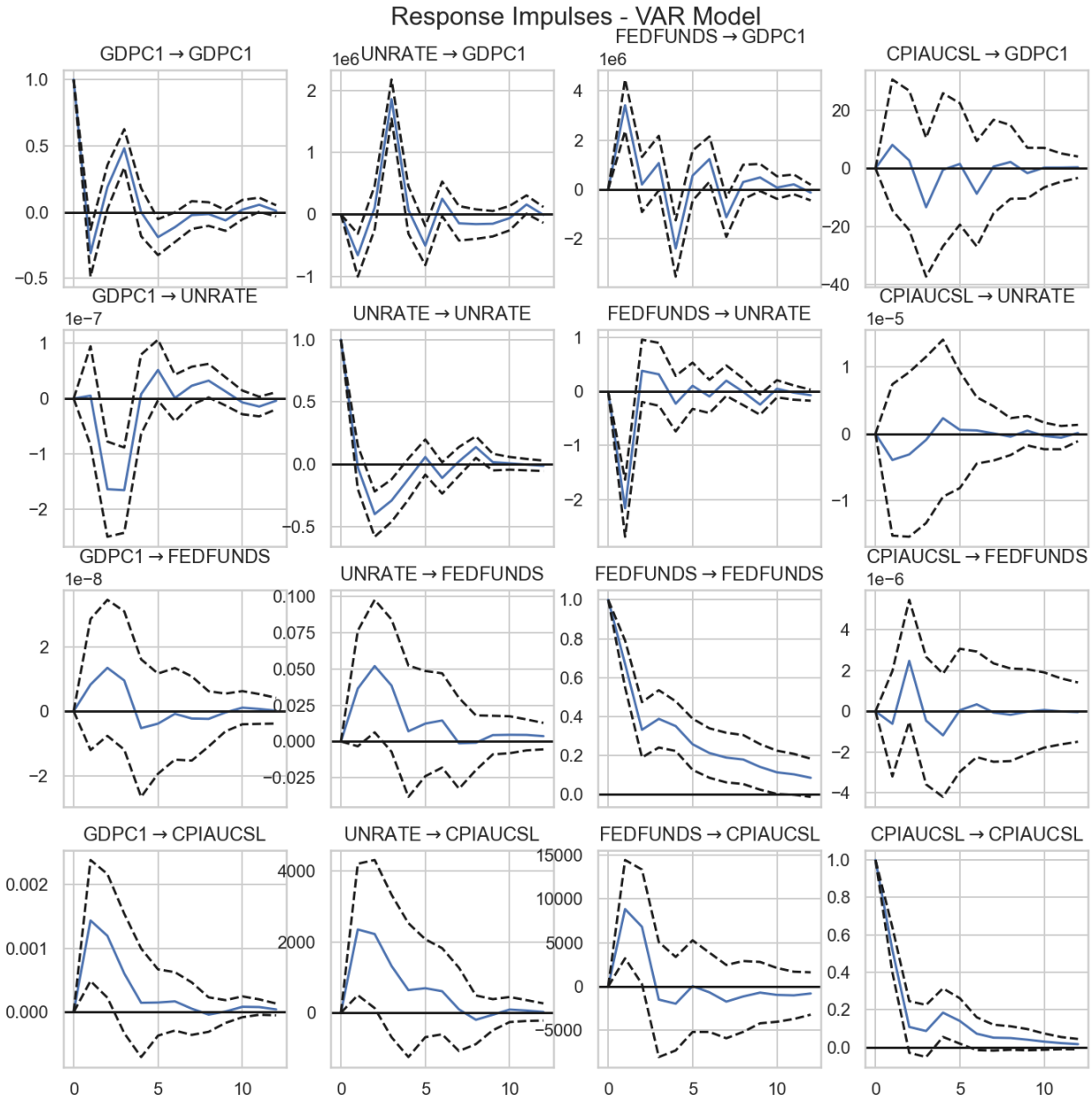
In recent quarters, the model indicated an increase in the probability of recession starting in early 2023, peaking during the prolonged inversion of the yield curve in late 2023 and early 2024. While no official recession has been recorded as of mid-2025, the elevated probability levels suggest that underlying fragilities remain, particularly in interest-rate sensitive sectors such as housing, manufacturing, and credit markets.

It is important to note that this iteration of the model relies solely on a limited set of macro variables. While sufficient to capture the broad contours of recession dynamics, future versions could benefit from incorporating broader datasets (e.g., financial conditions indices, consumer expectations, or business sentiment). Nevertheless, even in its current form, the model adds quantitative discipline to the recession risk assessment and helps translate qualitative narratives into measurable outcomes.

Structural Shocks and Impulse Responses via VAR

In an effort to capture the dynamic interplay among key macroeconomic variables, we estimated a Vector Autoregressive (VAR) model. This method, widely adopted in empirical macroeconomics, allows us to trace the effect of structural shocks over time, without relying on restrictive a priori assumptions. Specifically, the model included four core variables of macroeconomic relevance: real GDP growth (GDPC1), the unemployment rate (UNRATE), the effective federal funds rate (FEDFUNDS), and general consumer price inflation (CPIAUCSL). Monthly data were used, differenced to achieve stationarity, and organized with a frequency-consistent time index to comply with the VAR framework's assumptions.

After ensuring stationarity via first differencing, we fit the model with four lags, which offered the best compromise between residual whiteness and information efficiency. The impulse response functions (IRFs) were then generated to evaluate the impact of orthogonal shocks, such as a monetary tightening (e.g., a sudden increase in the federal funds rate), on the evolution of the other variables over a one-year horizon.



The results are illuminating. A positive shock to the federal funds rates typically results in a transitory decline in real GDP growth, accompanied by a gradual rise in the unemployment rate and a moderate decrease in inflation. These patterns are consistent with the classic transmission mechanism of monetary policy as documented in macroeconomic literature. The responses are not only directionally consistent with expectations, but also reveal the time lags involved in policy transmission: output and labor market effects tend to peak after three to six months, while inflation reacts more sluggishly, reinforcing the need for policy patience.

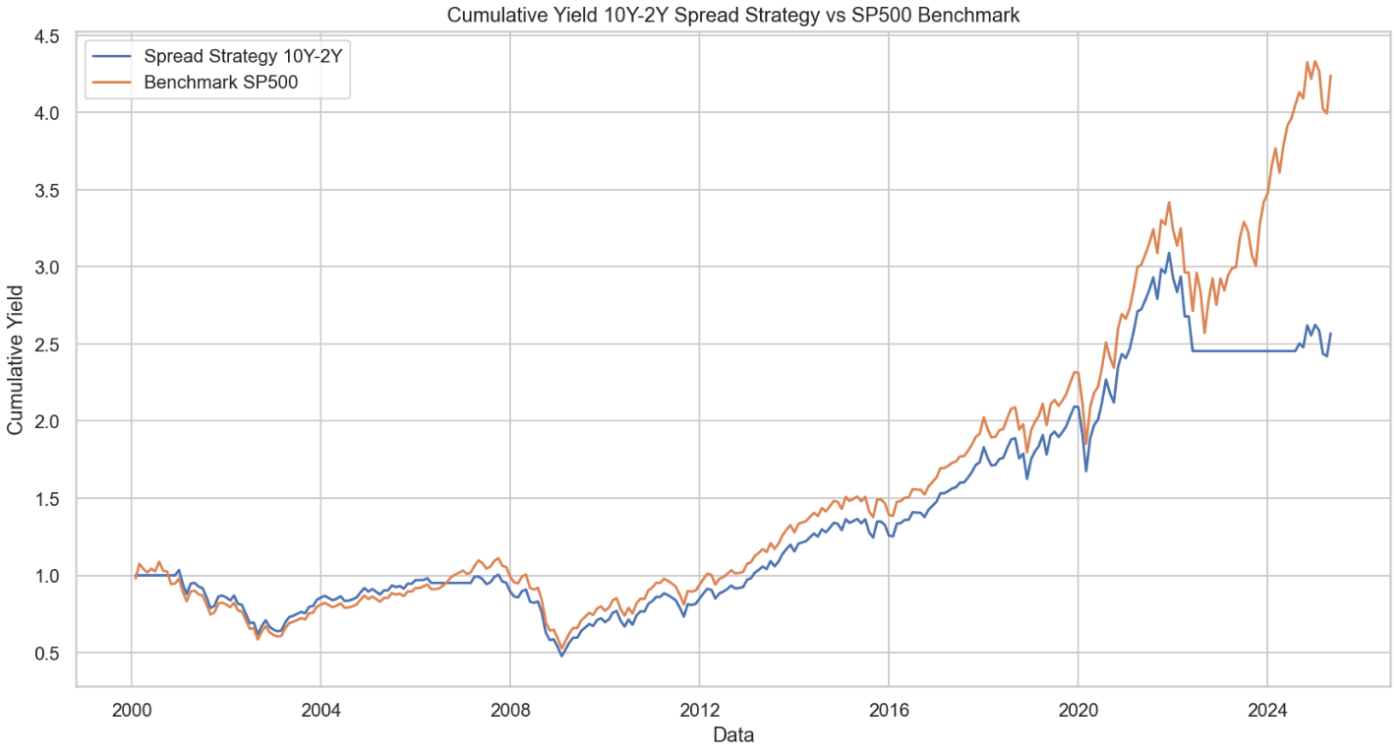
From a policy and forecasting standpoint, the VAR model offers a valuable framework to analyze expected dynamics and anticipate cyclical turning points. In particular, the response of GDP to monetary tightening is negative and statistically significant, reinforcing the role of interest rates in managing overheating or inflationary episodes. Moreover, the labor market's delayed response suggests that headline employment data may underestimate underlying slack during early stages of tightening cycles.

These insights not only contribute to a deeper understanding of current macroeconomic fragilities, but also help frame expectations on how further changes in monetary policy might propagate through the economy. Especially in a post-pandemic context where structural relationships may have shifted, VAR-based IRFs provide a disciplined way to quantify uncertainty and temporal dependencies among leading indicators.

Strategy Design: Yield Curve Macro Signal vs S&P 500 Benchmark

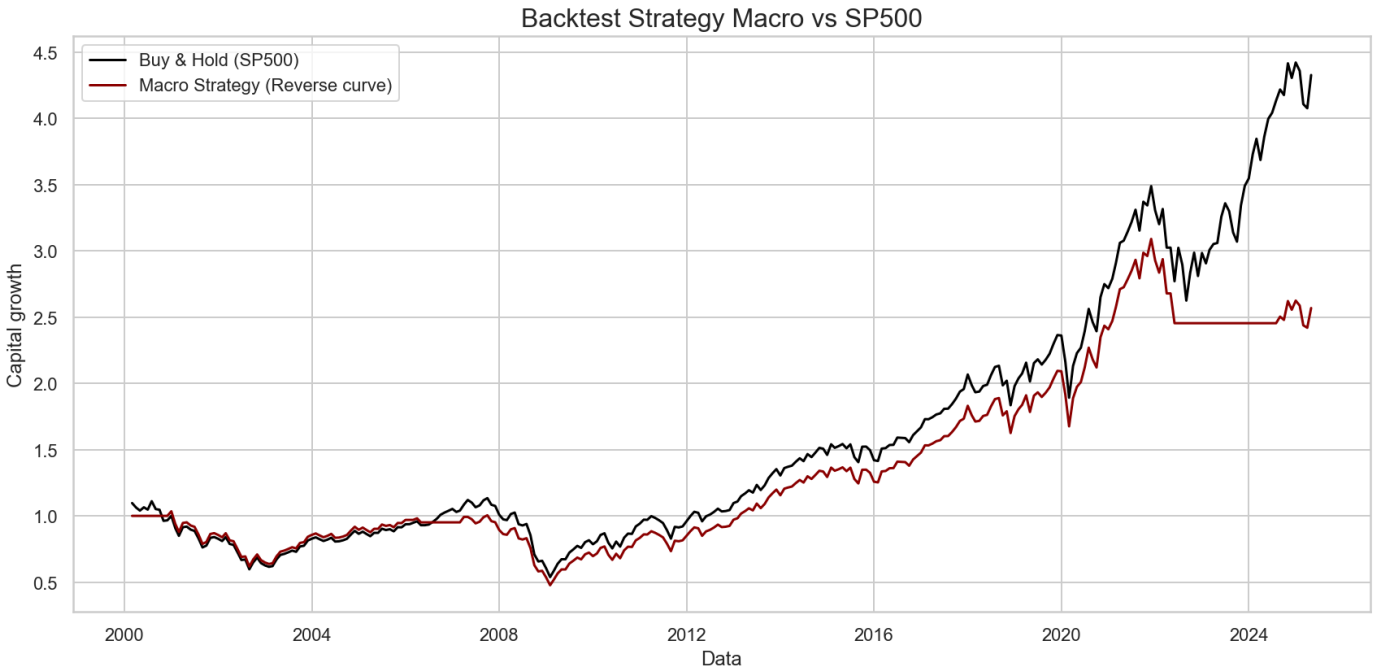
A crucial element of this study lies not only in the analysis of macroeconomic dynamics but also in translating those dynamics into actionable investment strategies. To that end, we designed a simple rule-based backtest that leverages the yield curve as a timing indicator for equity market exposure. Specifically, we constructed a macro strategy conditioned on the 10Y–2Y Treasury spread: a positive spread signals economic expansion and risk-on sentiment, while a negative spread suggests elevated recession risk and capital preservation bias.

The logic behind the strategy is straightforward yet grounded in macroeconomic theory. Historically, an inverted yield curve (when short-term rates exceed long-term ones) has preceded economic contractions with remarkable consistency. By allocating to equities (in this case, the S&P 500 Index) only during periods when the curve is upward sloping (spread > 0), and retreating to cash otherwise, the strategy aims to sidestep the most adverse equity market environments that tend to follow late-cycle monetary tightening and credit contraction.



The results offer a nuanced view. On one hand, the benchmark Buy & Hold strategy on the S&P 500 delivered an annualized CAGR of 5.99% and a Sharpe Ratio of 0.38 over the sample period. On the other hand, the macro strategy, while underperforming in terms of return (CAGR of 3.82%) and risk-adjusted performance (Sharpe Ratio of 0.26), succeeded in avoiding major drawdowns and periods of market turmoil. The lower volatility and defensive posture make it particularly appealing in risk-off regimes or when portfolio resilience is prioritized.

However, it is important to contextualize these results. The strategy, by construction, avoids equity exposure during yield curve inversions, which have historically been rare and relatively short-lived. This inherently limits long-term compounding potential. Moreover, the timing signal, being binary and solely based on the yield curve, may lack granularity. Nonetheless, the robustness of the economic rationale, the simplicity of implementation, and the transparency of the signal make it a compelling foundation for macro-overlay models or as a component within diversified portfolios.



*Between late 2022 and 2024, the macro strategy was entirely out of the market due to the persistently inverted yield curve. This resulted in a flat capital line, as the model signaled elevated recession risk and remained in cash, prioritizing capital preservation over market exposure.

In a broader sense, this section demonstrates how macroeconomic signals, when distilled into disciplined rules, can form the basis of systematic investment strategies. While not outperforming in absolute terms, the strategy aligns well with objectives of drawdown management and cycle-aware risk control, showcasing the power of macro-financial integration in portfolio construction.

Conclusion

This macroeconomic research has sought to synthesize key indicators from the U.S. economy into a cohesive and empirically grounded narrative on business cycle risk, recession probability, and portfolio allocation. Through the lens of the 10Y–2Y yield curve, logistic regression modeling, VAR-based impulse response analysis, and a backtested yield-curve-based investment strategy, we examined the interplay between leading macro signals and real economic outcomes.

The inverted yield curve remains one of the most statistically robust predictors of economic downturns, and its integration with variables such as the Fed Funds rate, unemployment, and core inflation enhances the accuracy and explanatory power of macro forecasting. In particular, the logistic regression model, despite being trained on a limited number of historical recessions, yielded a recession prediction AUC of 0.744, underscoring its viability as a simple yet interpretable probabilistic model.

Additionally, VAR impulse response functions provided clear insights into the temporal structure of macroeconomic shocks. The Fed Funds rate, in particular, exerts a negative and lagged influence on real GDP and labor markets, confirming the delayed but pronounced transmission of monetary tightening.

From a market perspective, our yield-curve-based strategy shows that macro signals can, when operationalized with discipline, serve as effective timing tools for asset allocation. While not beating the S&P 500 in absolute terms, the strategy aligns with cycle-sensitive capital preservation goals and complements broader diversified frameworks.

In closing, this report demonstrates that macro-financial analysis remains a cornerstone of both economic insight and investment decision-making. A yield curve inversion is not merely a statistical quirk, it is a signal encoded with decades of investor expectations, policy reactions, and credit cycle dynamics. Its continued relevance reaffirms the need for macro data literacy among market participants and strengthens the case for systematic approaches to economic foresight.

Data Sources

- Federal Reserve Bank of St. Louis – FRED
  - Treasury yields (GS10, GS2),
  - Fed Funds Rate (FEDFUNDS),
  - Unemployment Rate (UNRATE),
  - CPI (CPIAUCSL, CPILFESL),
  - Real GDP (GDPC1),
  - Manufacturing Employment (MANEMP),
  - Official U.S. recession dating series (USREC)

- Yahoo Finance / Bloomberg (optional)
  - S&P 500 Index data for benchmark and back test (Note: data manually integrated for this report)

Acknowledgements

This research report was developed independently as a learning and professional development project. The methodologies and analysis presented herein are based on publicly available data, academic literature, and original coding implementations in Python. No proprietary or confidential information was used.
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