



Industrial Metals and US Macro Indicators: A Copper-Focused Analysis

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April 21, 2025

1 Abstract

This project examines the predictive power of US macroeconomic indicators on daily copper returns. I assembled over 40 macro time series—fiscal (government budget balance), monetary (Fed balance sheet), price-level (PPI, CPI housing & utilities), production (steel output, factory orders), and external-sector (trade balance, FDI)—from Trading Economics, aligned them with London Metal Exchange copper prices at a daily frequency, and engineered lags, rolling averages, and rate-of-change features. Employing a sequential feature selection algorithm to greedily identify the most informative predictors and lasso regression for robust regularized regression, I embed this pipeline within a walk-forward validation framework (3-year training windows rolling forward in 2-year test increments) to mimic real-time forecasting. In the out-of-sample test blocks, the model achieves a win rate of 50.78 percent and a profit factor of 1.13. Because these results come from data not used in model fitting, they provide a more realistic performance assessment. Although the model breaks-even, this out-of-sample performance indicates that copper prices contain economically meaningful signals. For a quantitative fund like AlgoGators, improved copper forecasting may facilitate timely adjustments in commodity exposures, better risk management, and more effective macro regime calls.

2 Introduction

Industrial metals have long been viewed as reliable benchmarks of economic conditions. Copper, in particular, is often called "Dr. Copper" because of its ability to anticipate turning points in industrial production and economic growth trends. "The year-over-year (YoY) change in copper price correlates well with that of the ISM Manufacturing PMI, which is widely considered a key indicator of the state of the U.S. economy" (Inspirante Trading Solutions Pte Ltd ("ITS"), 2022). Research exploring copper's predictive ability suggests that fluctuations in base-metal markets often reflect changes in trade volumes and manufacturing output more quickly than official macroeconomic reports. "Unlike other global indicators such as business surveys or trade data, metals prices are available minute by minute. They also tend to move closely with world GDP" (Bank Underground, 2018).

This real-time responsiveness makes copper particularly valuable for assessing immediate shifts in economic conditions, offering analysts and investors early signals of potential economic expansions or downturns. "Both copper and crude oil are highly sensitive to the expansion and contraction of global economic activities. Higher fossil fuel prices also lead to higher demand for alternative energy sources, often requiring much more copper for electrification" (Inspirante Trading Solutions Pte Ltd ("ITS"), 2022). The significance of this relationship lies in copper's essential role in electrical infrastructure, renewable energy solutions, and emerging technologies. As economies transition toward sustainable practices, increased electrification elevates copper demand, reinforcing copper's role as a

critical economic benchmark that reflects broader shifts in global industrial strategy and energy policy.

In this context, my central research question asks: Which US macro indicators—fiscal, monetary, price-level, production, or external sector—most reliably predict short-term copper price movements? Copper's position at the heart of power grids, electronics, transportation, and advanced manufacturing makes it highly sensitive to daily data releases on factory orders, monetary stimulus, or trade imbalances. By systematically testing these macroeconomic drivers, I aim to isolate the combination of factors that exert the most significant explanatory power over copper returns. I hypothesize that expansions in US fiscal and monetary policies, along with industrial production increases and rising external demand, will show a pronounced impact on copper price behavior. If "Dr. Copper" offers forward-looking insight into economic health, identifying which domestic indicators best forecast its fluctuations could improve how a quantitative fund times macro regime shifts and allocates assets. For AlgoGators, improved forecasting of copper returns can facilitate timelier long or short positions, optimize overall commodity exposure, and serve as an early warning system for industrial sector downturns.

3 Methodology

I collected weekly, monthly, annual, and quarterly observations for over forty US macroeconomic series from Trading Economics—spanning fiscal measures such as the government budget balance, monetary aggregates like the Federal Reserve's balance sheet, price-level indicators including PPI and CPI for housing and utilities, production figures such as steel output and factory orders, and external-sector data like trade balances and foreign direct investment—and merged them with the London Metal Exchange's daily copper settlement prices. Each series was aligned by calendar day, and any missing values were forward-filled to ensure the model had only access to data that would have been available in real-time, thereby eliminating look-ahead bias.

I engineered ten transformations designed to capture various time-series behaviors from each raw series. These included level and growth measures (52-week and 12-week percent changes), trend and momentum indicators (three- and six-week simple moving averages and a 12-week exponential moving average), volatility and dispersion metrics (three-week rolling standard deviation and 12-week rolling volatility), and difference and seasonality features (week-to-week absolute and log differences, as well as 52-week seasonal differences). This feature-engineering process produced approximately 440 candidate predictors. After engineering the candidate predictors, I experimented with different final feature-set sizes (7, 10, 15, 20). This allowed me to see if a smaller or larger subset performed best out-of-sample.

To evaluate predictive performance, I adopted a walk-forward validation framework. The data were divided into rolling three-year training windows and two-year test periods. I first implemented a function within each training window that standardized all features. Next, a greedy SequentialFeatureSelector wrapped around a cross-validated LassoCV model and added features one at a time, each time selecting the feature that most improved cross-validated error until no further performance gain was possible. Finally, the reduced feature set was used to refit LassoCV, allowing its internal cross-validation to fine-tune the L1 penalty and shrink any remaining coefficients toward zero. Using this approach, I ensured that each step was confined strictly to the training data, with no information leakage during the hold-out period.

For each hold-out day, the pipeline generated a one-day-ahead forecast of copper's return and executed trades accordingly. Over 5,083 out-of-sample trading days, the strategy placed roughly 4,606 trades and achieved a win rate of about 50.78 percent, resulting in a cumulative return of approximately 1.41 percent. On an annualized basis, this eco-indicators approach delivered a mean return of 8.1 percent with a volatility of 16.95 percent, yielding a Sharpe ratio of 0.48.

4 Results

Over the whole sample period, a simple buy-and-hold of one copper futures contract—purchased on May 31, 1978—delivered a cumulative return of 56.39 percent, with an annualized mean of 2.02 percent, annualized standard deviation of 14.42 percent, and a Sharpe ratio of 0.14. By contrast, the eco-indicators strategy, which enters and exits market exposure based on macroeconomic signal triggers (always trading one contract), produced a modest cumulative total return of around 1.41 percent over roughly 5,083 trading days. On an annualized basis, the eco approach delivered an annualized mean return of 8.10 percent, an annualized standard deviation of 16.95 percent, and a Sharpe ratio of 0.48, thanks to its ability to sidestep downturns and capture upside more efficiently than a fully invested stance.

When set side by side, the passive buy-and-hold's higher raw cumulative return comes at the cost of significantly greater volatility and inferior risk-adjusted performance. The eco-indicators system's lower volatility and higher annualized mean return translate into a Sharpe ratio nearly twice that of the passive strategy. This comparison is visually summarized in [Figure 1](#) and [Figure 2](#), which display the cumulative return curves for the passive copper and eco indicators strategies, respectively. While the passive approach climbs higher overall, its path is more erratic; in contrast, the eco strategy shows a steadier, smoother trajectory with better downside protection. These results highlight how a signal-driven framework—by dynamically reducing exposure during adverse macro regimes—can achieve superior risk-adjusted outcomes even if its per-trade gains appear

small in absolute terms. See [Table 1](#) for the seven selected features that drove the eco-indicators strategy's performance.

The eco-indicators model draws on seven macro features—detailed in [Table 1](#)—that collectively span demand, supply, inflation, and liquidity dimensions. Personal spending and manufacturing output signal end-user demand; mining production reflects raw-material supply shifts; food inflation and money supply capture broader price pressures and monetary context; and industrial production momentum indicates acceleration or deceleration in economic activity. By blending these complementary indicators, the strategy times entries when demand and liquidity favor copper and exits when supply is in excess or tightening monetary conditions threaten prices, resulting in higher annualized returns with lower volatility than a constant-exposure benchmark.

Table 1- Macro features selected by SFS-Lasso model

1.	US Personal spending_logdiff
2.	US Mining Production_pctchg_12
3.	US Food Inflation_Close_diff
4.	US Manufacturing Production_logdiff
5.	US M2 Money Supply_3std
6.	US Food Inflation_Close_yoy
7.	US Industrial Production MoM_logdiff

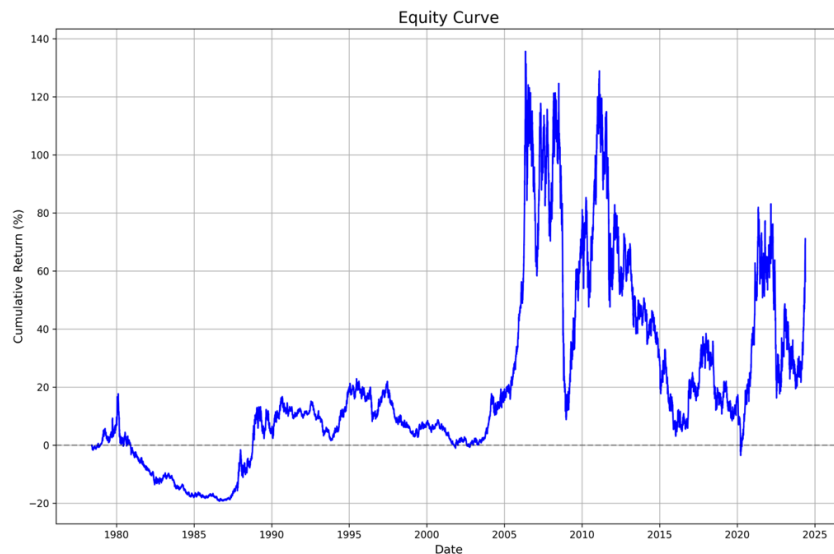


Figure 1 - Passive Copper Returns

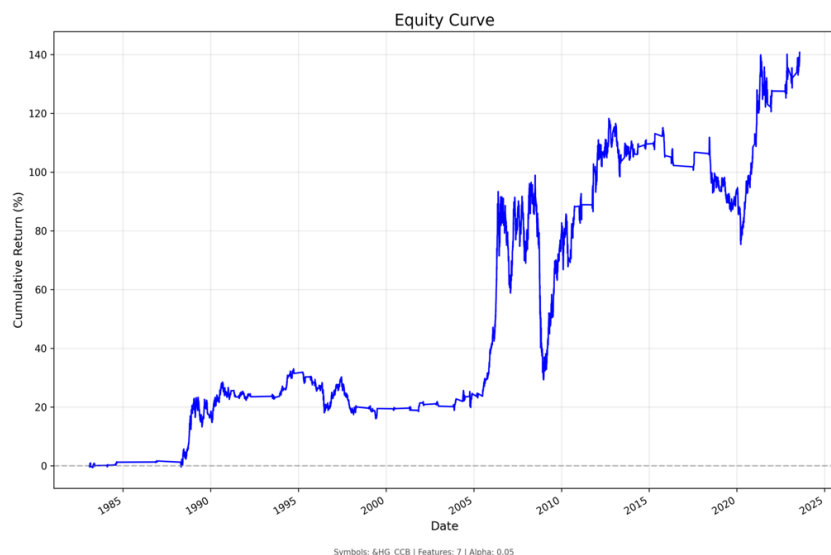


Figure 2 - Eco Indicators Strategy

5 Discussion

The rolling tests—using three years of in-sample data and two years of out-of-sample hold—show that the eco-indicators strategy delivers an annualized mean return of 8.10 percent at 16.95 percent volatility (Sharpe 0.48), compared with 6.01 percent and 23.32 percent volatility (Sharpe 0.14) for a passive buy-and-hold of copper futures. Its modest cumulative trading-period return (1.41 percent) reflects the use of a fixed one-contract position.

AlgoGators could embed the daily copper forecasts within a broader commodity rotation or multi-asset framework to translate these signals into real-world gains. When the eco-indicators signal bullish conditions, the fund might overweight copper futures or reduce short exposure to base metals; conversely, in unfavorable signal regimes, it could dial back outright positions or layer on hedges via inverse ETFs or options. Acting as a dynamic overlay, this implementation would aim to boost risk-adjusted returns and manage drawdown risk more effectively than a constant-exposure benchmark.

6 Conclusion

The comparative results illustrate a clear advantage for macro-driven signals in enhancing risk-adjusted returns. A passive buy-and-hold of one copper futures contract achieved a Sharpe ratio of 0.14, and the eco-indicators strategy—trading one contract based on seven selected macro features—delivered a Sharpe ratio of 0.48. This superior Sharpe underscores the value of selectively entering and exiting positions to avoid downturns rather than maintaining full-time exposure.

The seven best-performing features—personal spending, mining production, food inflation (short-term and year-over-year), manufacturing production, money supply (M2), and industrial production momentum—underpin the eco-indicators strategy's signal quality. Economically, these indicators capture demand pressures (consumer and industrial spending), supply shifts (mining output), and broader monetary and inflationary contexts (M2 and food price trends), offering a holistic framework for timing copper exposure.

This macro approach has great potential, and its performance can be improved with specific methodological improvements. Enriching the feature library with additional lag structures, seasonal adjustments, and nonlinear transforms could allow the model to pick from more features and find more patterns. Additionally, testing the economic indicator features against other commodities such as gold, crude oil futures, or 10-year US treasury notes could find another commodity that is tied to economic indicators. With these improvements and more testing, we can assess the generalizability of these macro-driven signals and evaluate the model's role as a dynamic regime-filtering overlay.

7 References

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