

Preliminary Report: Quantitative Hybrid Trading Strategy

Dong Wang, Tianyu Zhang, Ji Sung Han, Vanessa Cheung

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Data Selection

The selection of stocks and data is critical for developing an effective quantitative hybrid trading strategy. Monthly adjusted closing prices from Yahoo Finance were specifically chosen due to their comprehensive coverage, consistency, and accessibility for long-term historical analysis. The selected stocks are: Celestica Inc. (CLS.TO), Direxion Daily Semiconductor Bull 3X Shares (SOXL), NVIDIA Corporation (NVDA), and Exxon Mobil Corporation (XOM).

Justification for Stock Selection Stocks were selected based on their volatility profiles and sensitivity to market events, which are essential traits for evaluating the effectiveness of technical indicators and economic signals:

- **High Volatility (SOXL, NVDA):** These stocks experience significant price fluctuations, making them ideal for assessing technical indicators' responsiveness.
- **Economic Sensitivity (XOM, CLS.TO):** Stocks like XOM, closely linked to macroeconomic indicators such as commodity prices and global economic activity, serve as suitable candidates to validate the effectiveness of economic-based signals.

Relevance of Adjusted Closing Prices Monthly adjusted closing prices capture dividends, splits, and other corporate actions, providing a more accurate representation of historical returns. Using adjusted data ensures the reliability of calculated indicators and the robustness of subsequent strategy backtesting.

Moving Average Crossover Analysis for Data Selection

The probability-based moving average signal (P_{MA}) is calculated as:

$$P_{MA} = \sigma(\text{Short-term MA} - \text{Long-term MA}), \quad \sigma(x) = \frac{1}{1 + e^{-x}}$$

A **Golden crossover** (short-term MA crossing above long-term MA) indicates an upward trend, suggesting a buy signal. Conversely, a **Death crossover** (short-term MA crossing below long-term MA) signals potential price declines and suggests selling.

As shown in the following figure, these stocks exhibit characteristics similar to P_{MA} , demonstrating why they are strong candidates for data selection.

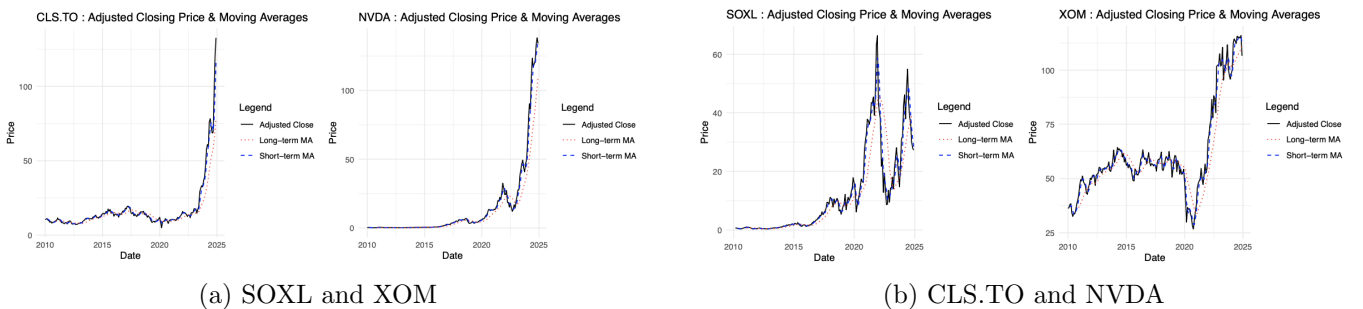


Figure 1: Adjusted Closing Price and Moving Average Crossovers for Selected Stocks

1 Methodology

This project employs two primary strategies: **Technical Analysis** and **Hybrid Trading Strategy**. Instead of fixed signals, each function returns a probability score, which is optimized dynamically and where $P \in [0, 1]$.

1.1 Probability-Based Technical Trading Strategy

Our probability-based technical trading strategy adopts the classic moving average (MA) model and risk model, which appear as two probabilities in the definition of $f_{technical}$ as follows:

$$f_{technical} = w_1 \cdot P_{MA} + w_2 \cdot P_{Risk}, \quad (1)$$

where

$$P_{MA} = \sigma(\lambda_{MA}(Short_{MA} - Long_{MA})) \quad (2)$$

$$P_{Risk} = \sigma(\lambda_{Risk}(VaR - ATR) + Outlier_{score}) \quad (3)$$

and $\sigma(x) = \frac{1}{1+e^{-x}}$ is the sigmoid function. Here $\lambda_{MA}, \lambda_{Risk}$ are adaptive scaling parameters. They're both set to 1 and are to be optimized across multiple time frames based on the result from backtesting. The macroeconomic probability is calculated by the following:

$$P_{Econ} = \sigma(\lambda_{Econ}(GDP - InterestRate)). \quad (4)$$

For the final hybrid signal

$$f_{hybrid} = w_1 \cdot P_{MA} + w_2 \cdot P_{Risk} + w_3 \cdot P_{Econ}, \quad (5)$$

2 Backtesting

This backtesting evaluates two primary strategies: **(1) A Hybrid Strategy**, driven by a probability-based hybrid signal, and **(2) A Technical Strategy** that uses threshold-based indicators (e.g., short and long MA crossover). Both are compared against a Buy & Hold benchmark for multiple stocks (e.g., NVDA, SOXL, XOM, and CLS-TO). Key metrics include cumulative returns, drawdowns, Sharpe Ratio, and Win/Loss performance. Even if our strategies do not outperform in all scenarios, we aim to demonstrate a preliminary framework and highlight possible improvements.

2.1 Hybrid Strategy Results

We calculate the hybrid signal and invest when $f_{hybrid} > 0.7$. The blue line in each figure (Fig. 3) represents our Hybrid Strategy's cumulative performance, while the black line is the Buy & Hold baseline. A pronounced gap indicates consistent outperformance over the benchmark. Conversely, when the lines converge or cross, it suggests reduced alpha or a period where the hybrid signal underperforms.

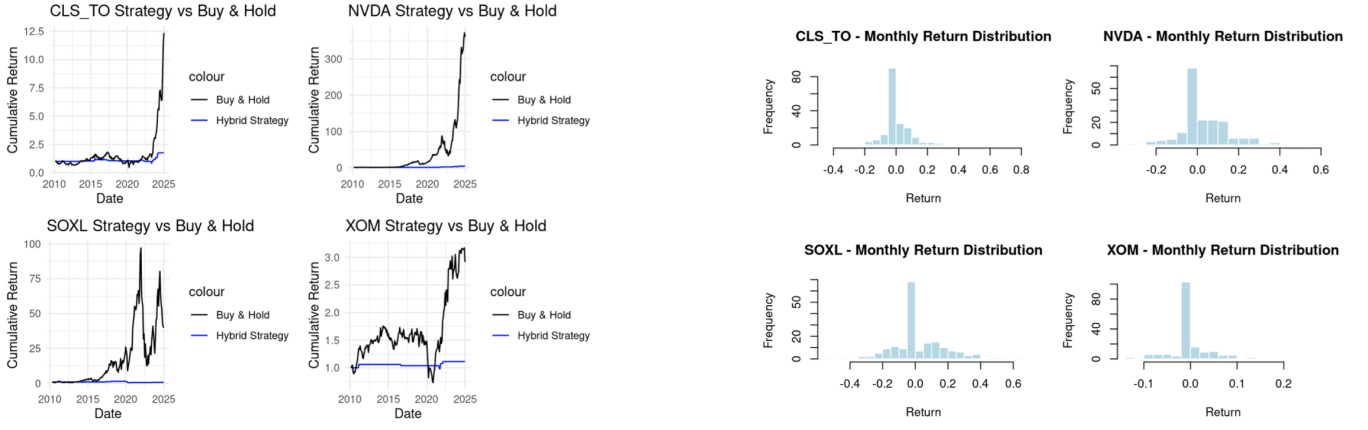


Figure 2: Left Figure: Hybrid Strategy vs. Buy & Hold for two sample stocks. The Hybrid (blue) invests if $f_{\text{hybrid}} > 0.7$, potentially reducing drawdowns compared to a simple Buy & Hold (black).

Figure 3: Right Figure: Monthly Return Distribution for CLS_TO, NVDA, SOXL, and XOM. We observe narrower spreads (e.g., XOM) vs. more volatile distributions (SOXL, NVDA). Note In Figure 2, the histograms highlight how certain assets (e.g., SOXL) have wider tails on both positive and negative sides, implying that a static threshold may be ineffective. Need to do more thest like win/loss ratio to see the returns

Observations:

- The Hybrid line often appears flatter during market dips, implying smaller drawdowns.
- However, in some timeframes the strategy lags the index, indicating possible late entries or exits.
- Further threshold refinement or weighting could improve both upside capture and downside mitigation.

2.2 Technical Strategy Results

A simple threshold (e.g., 0.5) is applied on $f_{\text{technical}}$. We then compute monthly returns and plot cumulative performance over time. While this can yield strong gains for certain high-growth stocks (e.g., NVDA), highly volatile stocks like SOXL may experience significant drawdowns.

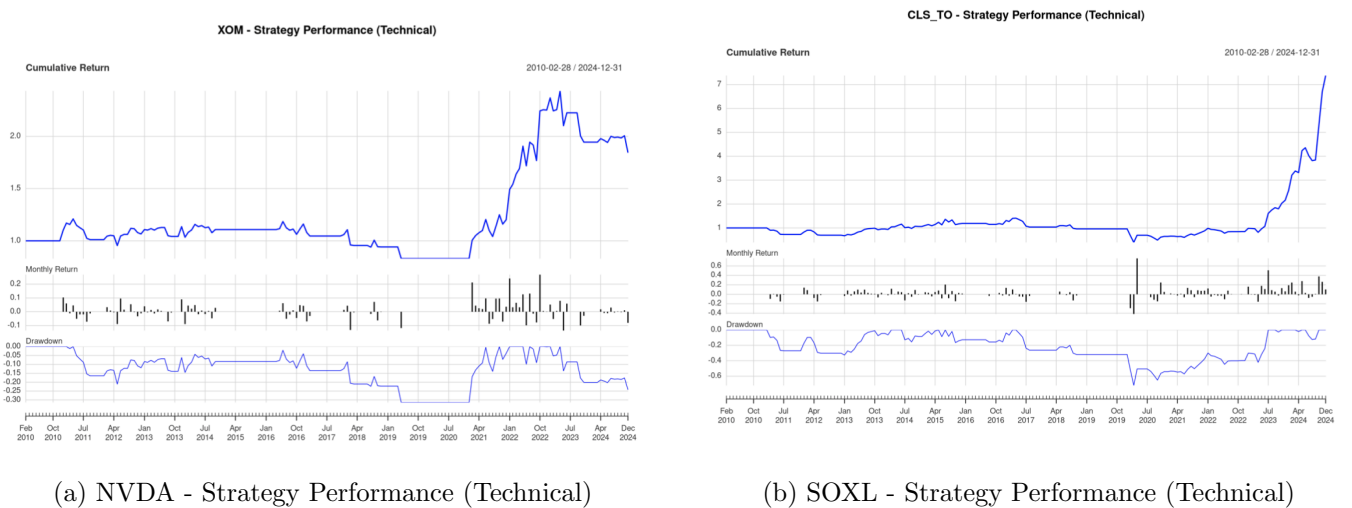


Figure 4: Equity curve, monthly returns, and drawdown for the Technical Strategy. Despite large gains in select periods, the fixed threshold struggles in choppy markets.

2.3 Win-Loss Ratio Analysis

Although some stocks (NVDA) show promising total returns, the win-loss ratio can be unbalanced for others. In Fig. 5, many trades end in small losses, offset by fewer but larger gains.

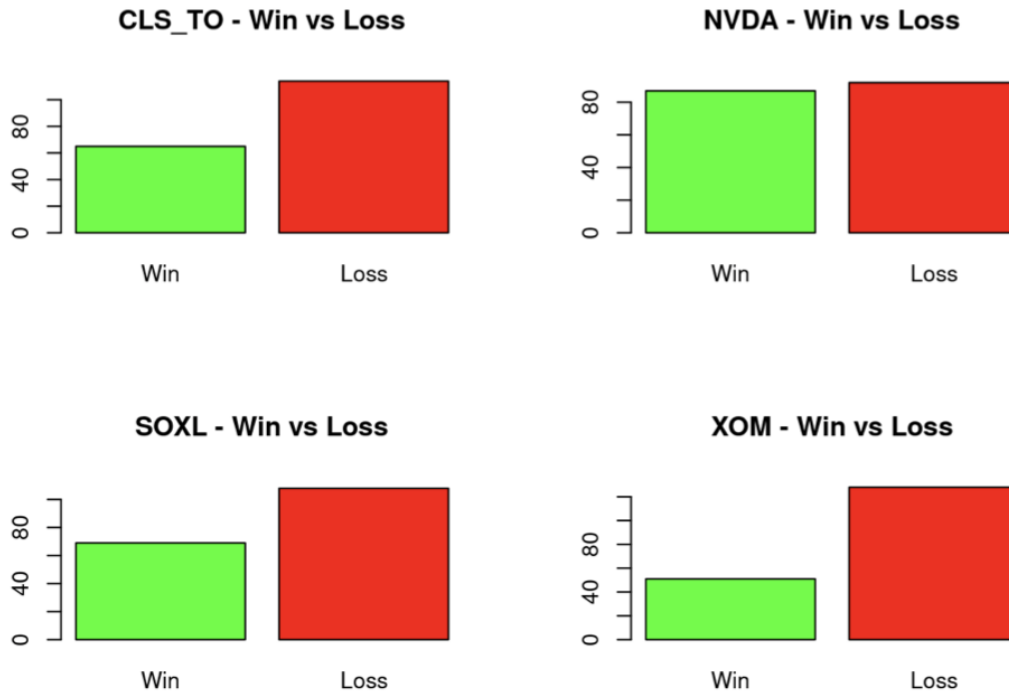


Figure 5: Win vs. Loss frequency for each stock. CLS_TO and SOXL, for example, exhibit more losing months than winners, yet can still yield net profit if the winning months are sufficiently large.

Implications:

- A low monthly win rate indicates frequent but smaller losses.
- Large but infrequent gains may yield overall profits; however, risk management is paramount.
- Future enhancements include dynamic weighting (partial positions) and improved thresholds to avoid consistently marginal trades.

3 Conclusion

Both the Hybrid and Technical strategies can outperform Buy & Hold for certain stocks and timeframes. However, the combination of high volatility (e.g., SOXL) and poor win-loss balance for many stocks underlines a need for **threshold optimization**, **risk management**, and **dynamic position weighting**. In the next iteration, we will implement stop-loss/take-profit rules alongside adaptive signal thresholds, aiming to improve monthly win rates without sacrificing upside potential.