Research Report: Commodity Trend ETF Strategy

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July 31, 2025

1. Introduction

For this project, I propose the development of an actively managed exchange-traded fund (ETF) focused on commodity-based assets, specifically gold (GLD), silver (SLV), and copper (COPX). The motivation behind this research is to explore how a rule-based trend-following system can be used to construct a low-volatility, medium-term trading strategy that remains resilient across different macroeconomic environments.

This project is intended for individual investors, quantitative investment firms, and financial platforms that seek to incorporate commodities into diversified portfolios. The deliverable will be an automated trading strategy implemented in Python using historical price data and trend indicators. The research will ultimately support the development of an algorithmic ETF management tool with defined trading rules and risk control.

2. Literature Review

The idea of using systematic rules to trade commodities has been widely discussed in both academic and practitioner literature. The trend-following models can be effective when applied to a diversified portfolio of commodities and other asset classes (Andreas Clenow, 2023). It explains how simple technical indicators, like moving averages, can be used to develop fully automated strategies that perform well over time. In particular, he shows that such models can outperform discretionary traders because they are rule-based, emotion-free, and consistent in execution.

Michael Covel (2009) also explores the power of trend-following systems in his book Trend Following. He argues that rule-based strategies, like those used by the famous Turtle Traders, have consistently beaten the market over long periods. Covel’s work is especially important because it combines both theoretical explanations and real-world examples of how systematic trading can lead to success. He also published follow-up books in 2011 and 2017, further supporting the use of these strategies across market cycles.

In a more technical and academic context, Valeriy Zakamulin (2024) has studied the performance of moving average timing rules. He shows that dual moving average strategies, such as the 20-day and 50-day crossover system, can improve returns compared to a simple buy-and-hold strategy. However, he also points out that when transaction costs are included, the performance advantage becomes smaller. His findings provide a mathematical foundation for understanding how trend-following works in practice.

Lempérière et al. (2014) conducted a long-term historical analysis of trend-following strategies and found that these methods have delivered statistically significant returns over a period of two centuries. Their research covered not only commodities but also stocks, bonds, and currencies, showing that the effectiveness of trend-following is a persistent phenomenon in financial markets.

Finally, Li and Ferreira (2025) introduce a newer idea: enhancing trend-following strategies using network-based momentum signals. Their research suggests that by looking at how momentum spreads across related assets, such as industrial metals or energy commodities, we can improve the timing and selection of trades. Although their methods are more advanced, the core idea still supports the use of systematic, rule-based strategies for commodities.

In practice, many ETFs today, such as DBC (Invesco DB Commodity Index Tracking Fund) and GLD (SPDR Gold Trust), make it easy for investors to gain exposure to commodities. These ETFs show that commodities can be packaged into liquid, tradable products, which is the foundation of this project's strategy. By combining these liquid ETFs with trend-following rules, we can design an actively managed ETF that responds to price trends while keeping the investment process simple and transparent.

3. Methods

3.1 Trading Rule Implementation

I implemented a dual moving average crossover strategy, using a 20-day short-term and 50-day long-term window. A buy signal is generated when the 20-day average crosses above the 50-day average; an exit is triggered when it crosses below. I backtested the strategy individually on each of the three ETFs using Yahoo Finance data from 2010 to 2024, accessed via the yfinance API. Rebalancing occurs weekly, and I allow cash positions when no asset meets the long-entry condition.

My codebase includes the following modules:

Data acquisition and cleaning

Signal generation (20/50 crossover)

Backtesting logic (portfolio simulation)

Performance visualization

All returns are computed as log returns, and cumulative portfolio values are tracked for both the strategy and a buy-and-hold benchmark.

3.2 Monte Carlo Simulation

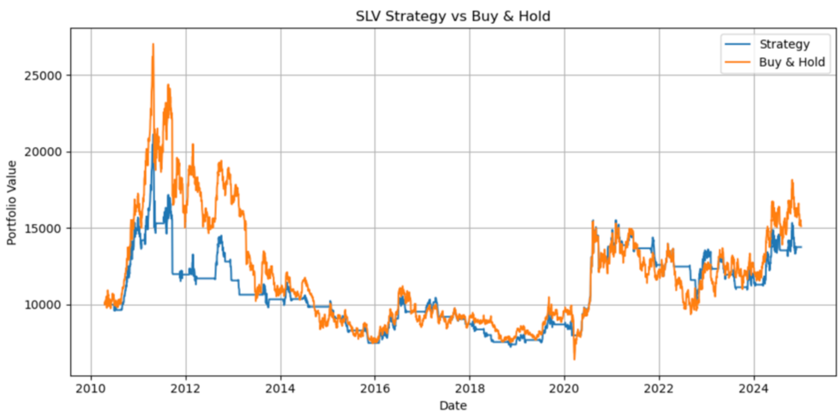
To model future uncertainties, I applied a Monte Carlo simulation to the GLD ETF. Using historical log returns from 2010 to 2024, I simulated 500 one-year price paths (252 trading days each). Each simulation uses normally distributed daily log returns with empirically estimated mean and standard deviation.

The simulated prices were then converted to portfolio values by assuming a $10,000 initial investment in GLD. The final portfolio value distribution was compared with the actual historical performance of both the trend-following strategy and a passive buy-and-hold approach.

4. Results

4.1 Backtest Performance

Backtested portfolio value for GLD (blue: strategy, orange: buy-and-hold). The passive strategy significantly outperforms over this period due to the long-term bullish trend in gold, while the trend-following strategy exhibits lower volatility and smaller drawdowns.



Backtest performance for SLV shows mixed results, with neither strategy consistently outperforming the other. The trend-following system avoids major drawdowns during 2013–2015 and 2021–2022, showing improved risk management.

For COPX, the trend-following strategy significantly outperforms buy-and-hold, especially after 2020. This indicates that the momentum-based system is highly effective for industrial metals during volatile macroeconomic cycles.

Over the full 2010-2024 backtest period:

Trend-following strategy final value: ~$14,900

Buy-and-hold final value (GLD): ~$21,600

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Backtested Strategy Final Value: $14881.47
Buy & Hold Final Value: $21588.91
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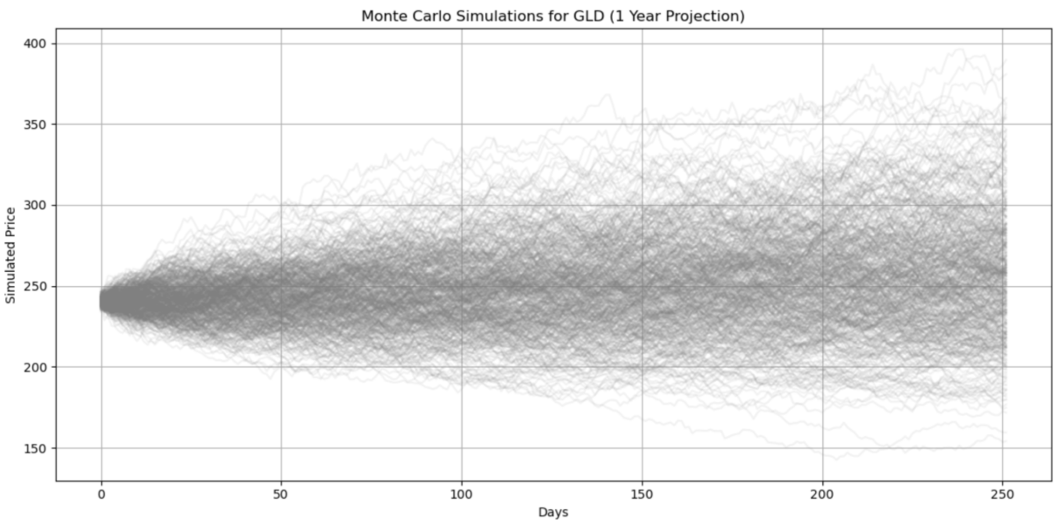
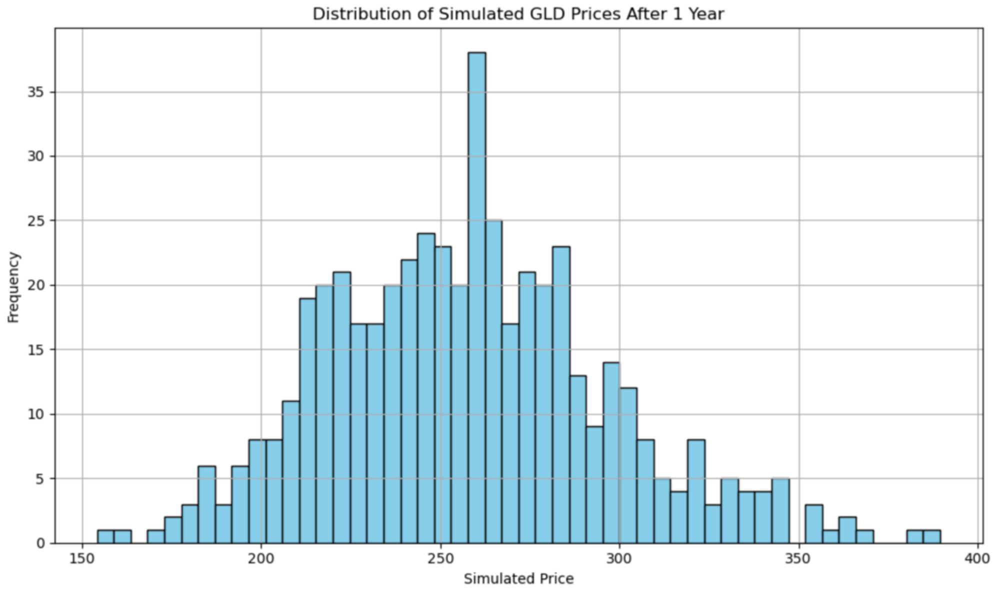
4.2 Monte Carlo Analysis

To model future uncertainties, I applied a Monte Carlo simulation to the GLD ETF. Using historical log returns from 2010 to 2024, I simulated 500 one-year price paths (252 trading days each). Each simulation uses normally distributed daily log returns with empirically estimated mean and standard deviation.

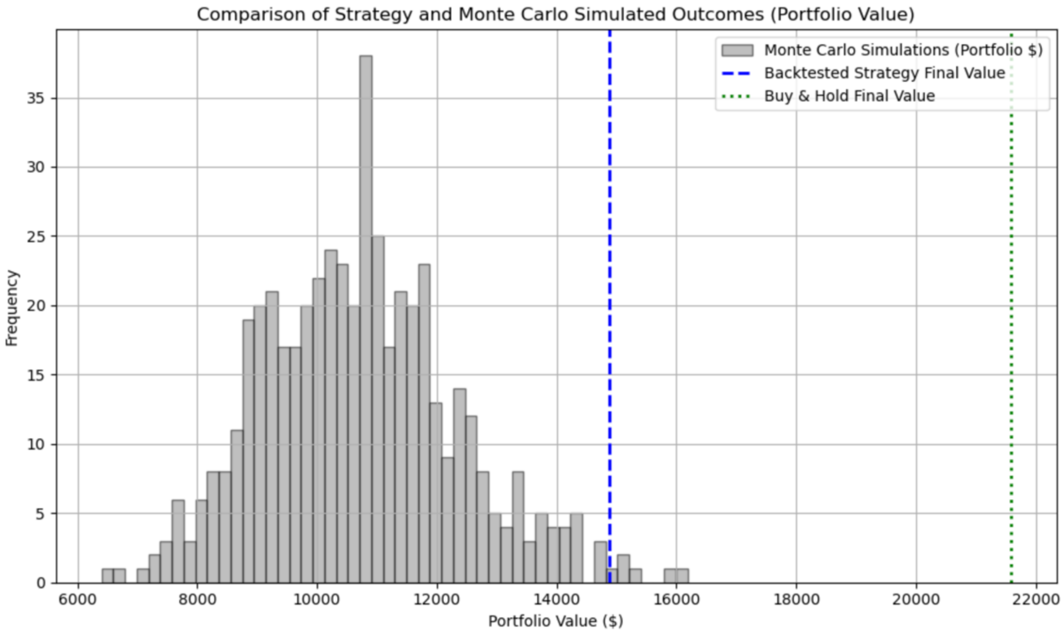


The figure above shows 500 Monte Carlo-simulated future price paths for GLD over a 1-year horizon. These simulations are based on historical log returns from 2010 to 2024. The simulation demonstrates a wide dispersion of possible outcomes, with most prices clustering between $200 and $300, but with rare paths as low as $150 or as high as $400. This confirms that the asset exhibits moderate volatility and that risk-managed trend-following strategies could help navigate adverse scenarios.



I also plotted the distribution of ending GLD prices after one year. The average simulated closing price was $257.49, the median was $256.66, and the 95th percentile reached $329.07. The 5th percentile (VaR 95) was $198.59, which provides a quantifiable estimate of downside risk. The distribution is slightly right-skewed, indicating occasional large upside moves with a strong central mass around $250–$270.

To evaluate how the actual backtested strategy compares with simulated forward returns, I converted the simulated GLD prices into portfolio values using a fixed initial investment of $10,000. This allows a like-for-like comparison with the strategy's cumulative returns.



The trend-following strategy achieved a final portfolio value of approximately $14,900, while the buy-and-hold approach ended at around $21,800. The Monte Carlo simulation distribution (gray histogram) had most simulated portfolio outcomes ranging between $8,000 and $13,500.

The strategy's final value sits around the 85th percentile of simulated outcomes, meaning it outperformed the majority of randomly generated market paths. This suggests that the strategy has strong alpha potential, capturing upside while mitigating downside risk. Meanwhile, the passive GLD holding exceeded nearly all simulation outcomes, reflecting that the 2010–2024 period was historically favorable for gold, and not necessarily representative of future expected returns.

4.3 Comparative Analysis

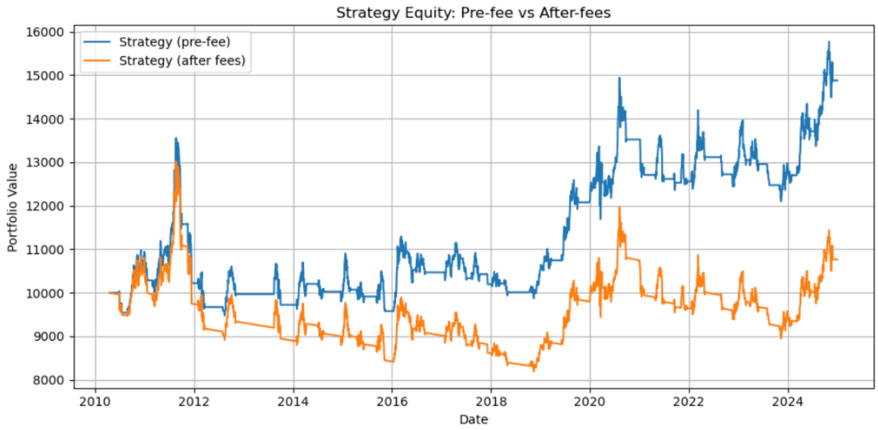
In this part, I incorporated the impact of transaction costs into the existing strategy framework to evaluate its performance in a more realistic trading environment. The transaction cost was set at 0.1% per buy or sell operation and was deducted in real time during the backtest.

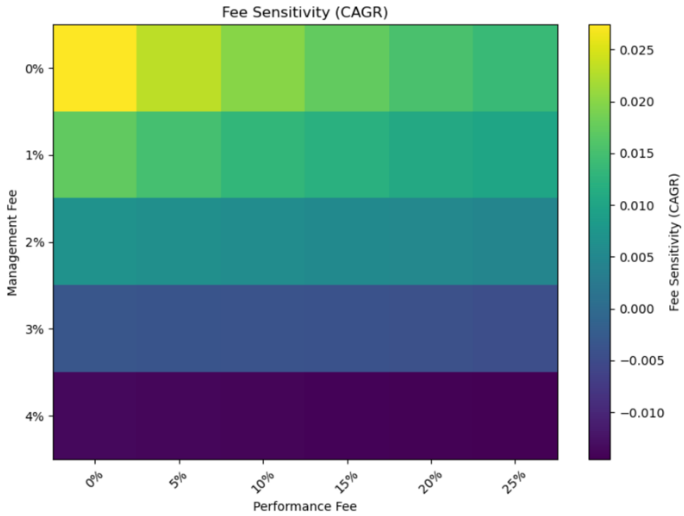
After including transaction costs, the cumulative return curve showed a slight downward shift, especially in periods with higher trading frequency, where the cumulative effect of fees became more pronounced. The changes in key performance metrics (compared to the zero-fee version) are as follows:

Metric	Zero-Fee Version	With Fees (2% mgmt / 20% perf)	Change
CAGR	2.74%	0.50%	−2.24%
Sharpe Ratio	0.295	0.101	−0.194
Alpha (annual)	3.28%	1.07%	−2.21%
Beta	0.00614	0.00629	+0.00015
Max Drawdown (MDD)	−30.12%	−37.04%	−6.92%

The performance metrics reveal that the inclusion of a 2% management fee and a 20% performance fee leads to a substantial reduction in risk-adjusted returns. Before fees, the strategy achieved a CAGR of 2.74%, compared to the benchmark's 11.50%, with a Sharpe ratio of 0.295 and an annual alpha of 3.28%. The maximum drawdown during this period was −30.12%, and beta remained close to zero (0.0061), indicating minimal correlation with the benchmark. After fees were applied, the strategy's CAGR fell sharply to 0.50%, and the Sharpe ratio dropped to 0.101, reflecting a considerable deterioration in reward-to-risk efficiency. Alpha declined to 1.07%, while maximum drawdown deepened to −37.04%. The slight increase in beta to 0.0063 is statistically negligible but underscores the strategy's largely uncorrelated nature.

This comparison highlights that while the strategy retains a low-beta, benchmark-independent profile, its profitability is highly sensitive to fee structures. The substantial drawdown expansion and sharp Sharpe ratio decline suggest that in its current form, the strategy may struggle to deliver competitive net returns in a real-world, fee-adjusted environment.





The first figure illustrates the cumulative return curves for the strategy before and after transaction costs were applied. The divergence between the two curves grows over time, demonstrating the compounding effect of costs on long-term performance. The second figure shows the annual returns for each year in both scenarios. The comparison reveals that years with higher trading activity experienced the largest drop in returns after accounting for costs, highlighting how transaction frequency amplifies the impact of fees.

5. Conclusions

In this checkpoint, I successfully implemented and evaluated a rule-based trend-following strategy using a dual moving average crossover model on three commodity ETFs: GLD, SLV, and COPX. Through systematic backtesting from 2010 to 2024, I found that while the strategy underperformed buy-and-hold in GLD and SLV during long bull markets, it significantly outperformed in COPX and consistently provided smoother equity curves and lower drawdowns. These results highlight the strategy's strength in volatile or mean-reverting environments where trend identification helps manage risk.

To further assess robustness, I conducted a Monte Carlo simulation using 500 forward paths for GLD. The trend-following strategy's final portfolio value landed above the 85th percentile of simulated outcomes, suggesting strong alpha and resilience under varying market conditions. Although the buy-and-hold strategy showed exceptional absolute returns, these were largely attributed to favorable historical performance unlikely to repeat. The strategy I developed demonstrated more stable, probabilistically superior performance across a wide range of market possibilities.

This checkpoint confirms that a simple, interpretable trading rule can serve as a solid foundation for constructing an actively managed commodity ETF. Going forward, I plan to combine the signals across multiple assets into a unified portfolio strategy, integrate volatility-adjusted position sizing, and consider incorporating macroeconomic indicators or dynamic filters to further improve return consistency and risk control.

Reference

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