2025

Term Project Checkpoint B

MSDS451: FINANCIAL MACHINE LEARNING

BLADE HUNTER ROBELLY

Introduction

This study evaluates the performance of a simulated exchange-traded fund (ETF) composed of four technology companies—NVIDIA (NVDA), Meta (META), Microsoft (MSFT), and Amazon (AMZN)—compared against the S&P 500 (SPY) benchmark during the period 2015 to 2025. The purpose of the research is to determine whether a concentrated technology portfolio could outperform a broad-market benchmark while accounting for market downturns, fee structures, and risk-adjusted returns. The findings have practical implications for individual investors, institutional fund managers, and financial engineers interested in quantitative investment strategies. The applications extend to the design of thematic ETFs, portfolio allocation methods, and educational tools for training in financial data science.

Literature Review

The literature on trading strategies and portfolio evaluation is extensive. Momentum effects have been well documented in equity markets. Jegadeesh and Titman (1993) demonstrated that stocks with high prior returns tend to continue outperforming in the short term, a finding later confirmed by Asness, Moskowitz, and Pedersen (2014). In contrast, mean reversion strategies, studied by Chan (2020) and Chen (2021), exploit short-term reversals, though their effectiveness depends heavily on market regimes. Hybrid approaches, which combine momentum and mean reversion, have been suggested

by Velissaris (2020) as a means of adapting dynamically to changing conditions. Pairs trading is another classic quantitative strategy; Hudson and Thames (2024) showed that correlations between securities can be leveraged for relative-value arbitrage. Beyond individual strategies, Monte Carlo methods are essential in finance for modeling uncertainty. López de Prado (2018) and Trivedi and Kyal (2021) both argue that stochastic simulations provide more robust insights than single historical backtests. Finally, Gray (2020) emphasized the importance of evaluating strategies across market downturns, such as the 2008 financial crisis and the 2020 COVID crash, to assess resilience. This study builds on this literature by applying multiple strategies to a modern technology portfolio and explicitly testing robustness across downturns between 2015 and 2025.

Methods

The analysis followed a four-step methodology. First, daily adjusted closing prices were collected from Yahoo Finance for NVDA, META, MSFT, AMZN, and SPY, spanning January 2015 through January 2025. Adjusted close prices ensured that dividends were incorporated, allowing for total return calculations. Second, an equal-weighted, long-only ETF portfolio of the four technology stocks was constructed, assuming reinvestment of dividends. SPY was used as the benchmark index. Third, several strategies were evaluated, including buy-and-hold, mean reversion, momentum, hybrid approaches combining both, pairs trading, and walk-forward backtesting. In addition, Monte Carlo simulations were conducted to generate alternative return paths and capture uncertainty, particularly fat-

tailed risks. Finally, performance was assessed using standard metrics: return on investment (ROI), Sharpe ratio, alpha, and beta relative to SPY. Sensitivity tests were conducted by varying management fees from 2 to 4 percent and performance fees from 10 to 25 percent. Performance plots were annotated with crisis periods, including the 2018 correction, the COVID crash in early 2020, and the 2022 bear market.

Results

The simulated technology ETF substantially outperformed SPY over the 2015 to 2025 horizon. Gross returns for the ETF were significantly higher than those of SPY, and even after accounting for fees, the portfolio consistently maintained superior ROI and Sharpe ratios. For example, with a 2 percent management fee and a 10 percent performance fee, the ETF achieved an ROI above 280 percent, far surpassing the benchmark. Under more aggressive fees of 4 percent and 25 percent, net performance declined but remained stronger than SPY. Among the trading strategies tested, momentum and walk-forward approaches generated the highest excess returns, benefiting from the extended bull phases in the technology sector. Hybrid strategies provided smoother returns during volatile markets and outperformed buy-and-hold in downturns. Mean reversion strategies, in contrast, lagged significantly in trending environments, while pairs trading delivered diversification benefits but could not match the returns of momentum-driven strategies. Across market regimes, the 2018 correction produced drawdowns but was followed by rapid recovery. The COVID crash in 2020 triggered sharp losses, yet

momentum and hybrid strategies rebounded strongly. The 2022 bear market highlighted the stabilizing benefits of hybrid strategies, which cushioned the portfolio against steeper losses observed under momentum-only strategies.

Conclusions

This study demonstrates that a concentrated technology ETF, even when equally weighted, would have outperformed the S&P 500 between 2015 and 2025. Several conclusions emerge from the findings. Momentum-based strategies proved most effective during extended bull markets, particularly in phases of technology-driven growth, while hybrid strategies offered better resilience during downturns, making them more attractive for risk-averse investors. Fee sensitivity analysis confirmed that management and performance fees materially erode investor returns, underscoring the importance of efficient fund structures. Monte Carlo simulations provided further confidence by showing that the portfolio's outperformance was not path-dependent, but rather robust across a range of possible outcomes. Overall, the evidence suggests that a thoughtfully constructed technology ETF, with careful attention to fees and risk management, can generate meaningful alpha relative to the broader market.

References

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