Portfolio Optimization Report

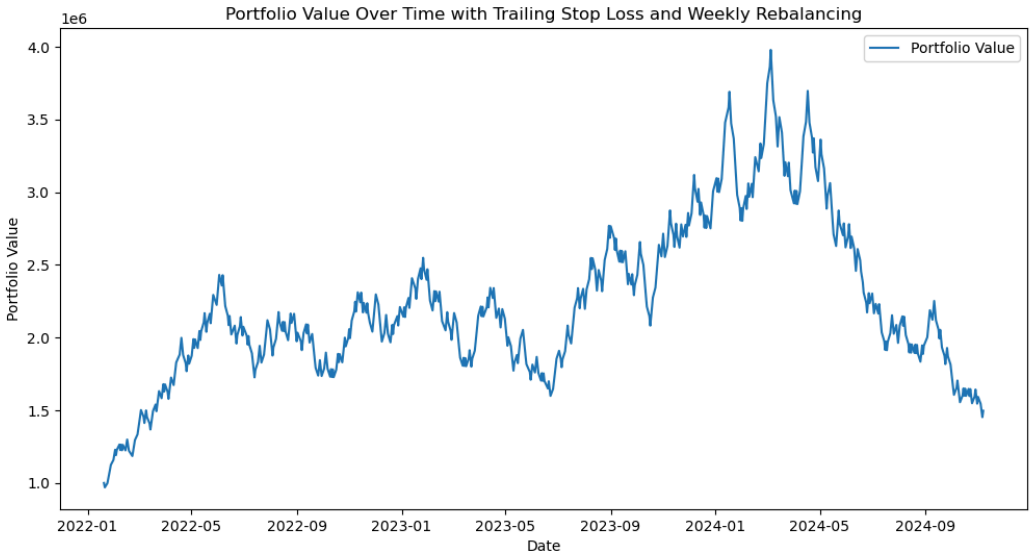
Objective:
In this project, I aimed to create a beta-constrained, market-neutral portfolio, balancing risk and return as part of an exploration into long-short investment strategies. The goal was to test whether a beta-neutral approach could stabilize returns while maintaining systematic neutrality, thus achieving an optimal balance between risk and reward.

Hypotheses and Theory:
I hypothesized that by constraining the portfolio's beta—essentially its sensitivity to the market—to near zero, I could build a strategy that performs consistently regardless of broader market fluctuations. The theory behind this approach is that a market-neutral stance would protect against significant market downturns, while allowing gains from both long and short positions. Additionally, I speculated that rebalancing the portfolio weekly and implementing a trailing stop-loss would help control risk and potentially enhance overall returns.

Approach:

1. **Data Collection and Preprocessing:**
    - I gathered historical prices for a diversified set of assets, spanning from January 1, 2022, to November 9, 2024.
    - I calculated daily returns for each asset, standardizing data to ensure comparability across all instruments.
2. **Optimization Framework:**
    - To construct the portfolio, I applied a mean-variance optimization model. This method seeks to maximize the Sharpe Ratio, balancing expected returns with volatility to achieve the best possible risk-adjusted performance.
    - I implemented a beta constraint, calculated using a 90-day rolling regression to measure each asset's beta relative to the market. This constraint aimed to keep the portfolio's net beta within ±0.05, theoretically neutralizing market exposure.
    - To ensure diversification, I added constraints on sector weights, individual position limits, and leverage, promoting a balanced risk distribution across different asset types.
3. **Backtesting and Results:**
    - The portfolio's cumulative value over time, shown in the attached graph, reflects the strategy's overall performance. The graph tracks the portfolio value, rebased weekly with a trailing stop-loss mechanism to limit downside risk.
    - I observed a total return of 49.67% over the period, with an annualized return of 15.51%. While this is promising, the annualized volatility of 47.63% suggests a considerable level of fluctuation.
    - The Sharpe Ratio, a measure of risk-adjusted return, came to 0.30, indicating moderate returns given the portfolio's risk profile. Notably, the maximum drawdown of -63.48% highlights the portfolio's susceptibility to sharp declines, even with the stop-loss in place.
4. **Graph Interpretation:**
   The attached graph shows the portfolio's value progression over time, reflecting both gains and

losses. The steady rise in value during certain periods aligns with market-neutral expectations, as gains from long and short positions contributed regardless of market direction. However, the significant drawdowns, especially towards the end, suggest that while the beta-neutral approach helped manage systematic risk, it couldn't completely mitigate high volatility.



Key Takeaways and Reflections:
This exploration highlighted the strengths and limitations of a beta-constrained, market-neutral portfolio. On one hand, the strategy demonstrated potential for capturing gains in both up and down markets, aligning with the original hypothesis. However, the results also underscored that market-neutrality alone doesn't fully shield against drawdowns. Future refinements could involve exploring more adaptive stop-loss thresholds or integrating additional factors to better handle high volatility periods.

Ultimately, this experience has illustrated the value and complexity of market-neutral strategies, showcasing the balancing act between risk management and return maximization.

Attached Github: https://github.com/Sonok/BetaConstrainedPortfolio