Quantitative Strategies Group - Index-Rebalancing Alpha Project

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1 | Executive summary

As part of this assignment, I explored two systematic equity strategies that attempt to monetise the predictable flow surrounding S&P-400/500/600 additions. Below are the overarching results of the strategies I developed across the training and testing periods.

Strategy	Edge targeted	Train (≤ 2023-12-31)	Test (OOS) (>2024-01-01)
Add-day Momentum	Aimed to ride the momentum of stocks between the public announcement and the official trade-date as passive index funds seek to rebalance their portfolios	Sharpe ≈ 0.02	CAGR 6.1 %, vol 4.7 %, Sharpe 1.29; max DD -0.9 %
Event-day Reversion	Seeked alpha by getting exposure to the mean-reverting nature of stocks in the days following the index rebalance “trade-date”	Sharpe ≈ 2.46	CAGR -14.6 %, Sharpe -1.36; max DD -6.2 %

2 | Overall Approach Summary

- Data ingestion & cleaning – normalised event spreadsheet, removed rows with missing prices, dropped delisted tickers, pulled daily OHLCV via yfinance.
- Feature engineering – calculated gap, drift, ADV, volume ratio, excess return vs SPY; flag quarterly versus ad-hoc events.
- Parameter search on train period – small grid search for momentum and reversion.
- Out-of-sample evaluation – locked parameters and replayed on 2024-2025 events.
- Performance Evaluation– custom portfolio engine applies commission, financing, β-hedge, prints equity curves and metrics.

Key assumptions & constraints:

- Capital: $5 mm gross, no compounding
- Liquidity cap: ≤ 1 % of 20-day ADV per leg
- Execution: entries at next-day open, exits at close
- Costs: $0.01/sh + Fed funds +1.5 % (long) / +1 % (short)
- Hedge: 60-day rolling β to SPY; fall back to β=1 when unavailable

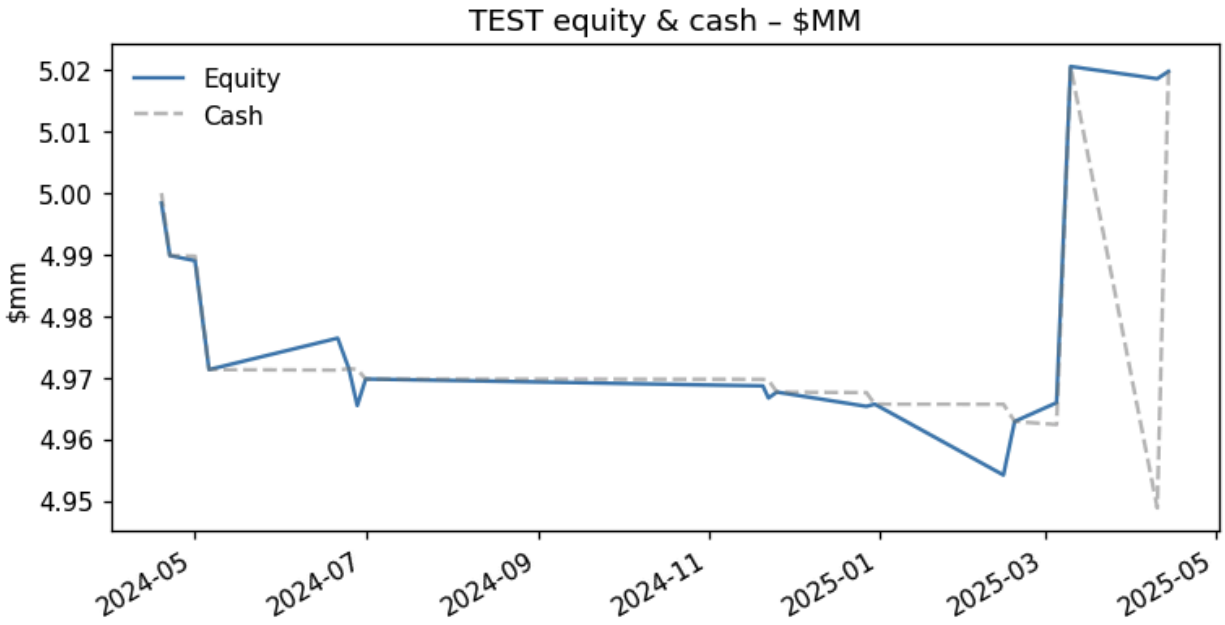
3 | Technical tools

Python 3.11 in Jupyter; pandas, numpy, yfinance, fredapi, matplotlib;

4 | Strategy design & results

4.1 a Add-day Momentum (all indices)

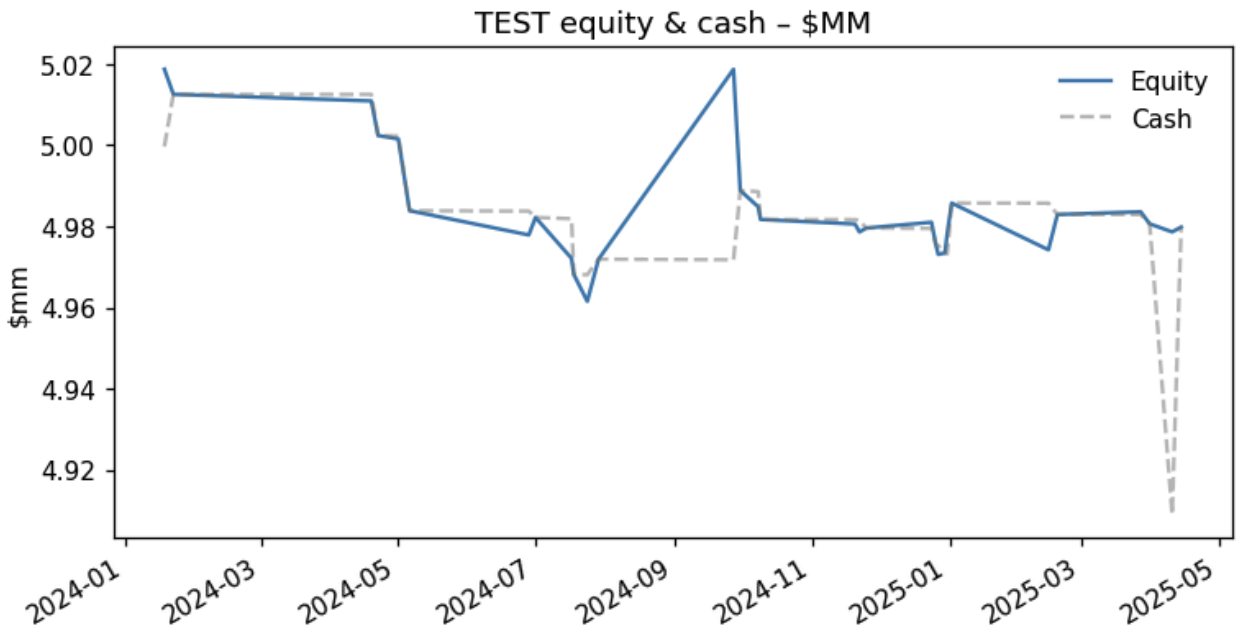
- Signal – overnight gap ≥ 2 % and volume ≥ 7 × ADV.
- Trade – buy on next-day open, exit two days (offset=2) before trade-date; hedged with SPY.
- OOS – CAGR 6.15 %, vol 4.7 %, Sharpe 1.29, hit-rate 30 %; max DD < 1 %.



Add-Day Momentum Equity Curve with tuned hyperparameters

4.2 a Add-day Momentum (only S&P600)

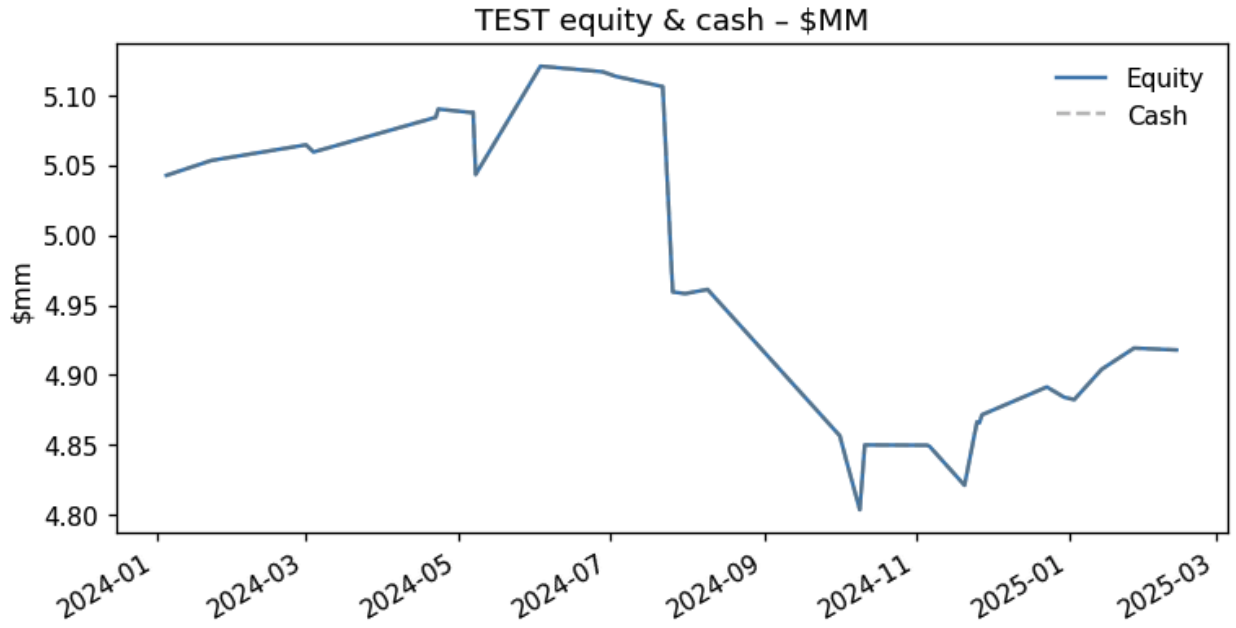
- Signal – no filters other than S&P600 only as this was the strongest during training period.
- Trade – buy on next-day open, exit one day before trade-date; hedged with SPY.
- OOS – CAGR -6.33 %, vol 3.81 %, Sharpe -1.70, hit-rate 31 %; max DD 1.14 %.
- S&P 600 looked great in-sample but reversed OOS.



Add-Day Momentum S&P600 Equity Curve (with offset = 1)

4.2 Event-day Reversion

- Signal – on trade-date, short if stock outperforms SPY intraday; long if under-performs.
- 1-day hold delivered Sharpe ≈ 2.46 in-sample; but OOS Sharpe -1.36.



Trade-Date Reversal Equity Curve

5 | Performance metrics & presentation

Metric	Purpose
CAGR & raw P/L	To understand the absolute economic impact on capital
Annualised vol & Sharpe	Risk-adjusted efficiency of these strategies
Max draw-down / worst day	To understand what the negative tail-risk of these strategies
Hit-rate	To understand the consistency of the edge across events

6 | Which indexes offered more opportunity?

Given the small sample size, we tested the hyperparameters described above on the full dataset of events and then tested the performance of the different indices separately. This way we could ensure we had as much data as possible to give us confidence in our conclusions. In-sample, S&P 600 additions showed the strongest momentum Sharpe, but the edge did not generalise out-of-sample. Liquidity and event-specific metrics seem to matter in this reduced sample set than the index bucket alone. Below are the results of the different indices using the training set of the momentum strategy. We considered the S&P 600 to have the most significant results given the S&P 500 only had 10 trades during the training period.

	offset	index	trades	CAGR	Sharpe
0	2	S&P 500	10	3.172828	8.252320
1	1	S&P 500	10	3.772183	7.690237
2	0	S&P 500	10	2.931296	7.483173
3	1	S&P 600	48	0.182489	2.837348
4	3	S&P 600	48	0.134215	2.626060
5	2	S&P 600	48	0.111799	2.219915
6	0	S&P 600	48	0.120542	2.083341
7	3	S&P 400	47	-0.571196	-1.446412

Training-period grid search using combinations of index and offset

7 | Hedge impact

In order to hedge the momentum and mean reversion strategies, we balanced each long/short position with an opposite β-adjusted SPY hedge. Therefore, if we observed a given stock had a

β = 1.5. We would go long/short 1.5X the amount of SPY as we did the stock in question. This hedge cut annualised vol to 3-5 % and capped draw-downs below 1 % for the momentum book; it halved vol for reversion but could not offset tail losses. Additionally, this hedge allowed us to explore a market-neutral strategy that could offer uncorrelated returns from the market.

8 | Risk assessment

Overall, I approached risk management in a couple different ways apart from the Beta-hedging. Specifically, these centered around reducing overfitting and preventing biases from obscuring our results.

Risk	Mitigation in prototype	Future enhancement
Execution slippage/impact	Capped position sizes to 1 % ADV	Add limit orders, model spread & impact to trade at times of day with higher liquidity
Parameter over-fit	Split the dataset into a training and testing period in order to prevent lookahead bias	Walk-forward cross-validation
Survivorship bias	Dropped delisted tickers	Line up delisted tickers or merged tickers with historical data to ensure continuity and expand dataset.
Financing / borrow cost drift	Fed funds + fixed spreads	Pull security-specific borrow rates

9 | Conclusions

This project demonstrates the potential for systematic alpha capture around predictable index events, particularly S&P rebalancing flows, though with varying degrees of robustness. The momentum-based strategy, which rides the drift between the announcement and inclusion dates, produced a modest but consistently positive Sharpe ratio out-of-sample. Despite its low hit rate, the strategy exhibited low volatility, minimal drawdown, and a defensible signal mechanism based on measurable pre-event flow indicators like overnight gaps and abnormal volume. This makes it a credible foundation for further development, especially if trade frequency and breadth can be expanded.

Conversely, the mean-reversion strategy, while promising in-sample, did not generalise well to future data. This suggests the trigger, fading intraday excess return on the trade date, may lack

sufficient strength or consistency, particularly as index-fund flow behavior evolves over time. The reversal strategy also suffered from more substantial drawdowns and greater sensitivity to tail events, which further emphasizes the need for tighter entry filters or a complete redesign of the trade logic.

Overall, I very much enjoyed working on this project and am very excited to continue exploring these index-rebalancing strategies and other alphas at Quantitative Strategies Group.

10 | Next steps

Going forward, several enhancements can improve performance and robustness:

- **Expand the trade sample for momentum:**
  Loosening the overnight gap and volume thresholds may capture more events, enabling better generalisation and statistical power. These broader filters can then be paired with a re-optimised exit strategy that balances risk and return.

- **Explore intraday and VWAP execution:**
  Both strategies assume next-day open/close execution, which may miss critical price action. Incorporating intraday data would allow for entry signals based on open-to-close momentum or reversal patterns and enable testing of VWAP or TWAP execution to reduce slippage and market impact.

- **Enhance hedging and isolation techniques:**
  While the SPY hedge reduced portfolio volatility, a more refined hedging layer, such as sector ETFs or residualization via factor models, could better isolate alpha from market or sector noise.

- **Introduce volatility-scaled position sizing:**
  Applying inverse-volatility scaling or Kelly-based allocation can help concentrate capital in high-confidence setups while capping total portfolio volatility.

- **Improve risk and cost modeling:**
  Future iterations should incorporate security-specific borrow rates and spread-based cost estimates to better approximate real-world P&L.