Futures: Project Report

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1. Introduction

Equity indices such as the S&P 500 undergo scheduled quarterly rebalancing, during which constituent weights and membership are updated to reflect changes in market capitalization and eligibility. These events generate predictable trading flows, particularly from passive index funds that must rebalance holdings mechanically. A central question in market microstructure is whether these flows create detectable and repeatable patterns in related derivatives markets, especially index futures such as the S&P 500 E-mini (ES).

The goal of this project is to investigate whether futures prices exhibit systematic behaviour around index-rebalance dates and whether short-term strategies can exploit the resulting price pressure. The research objective is intentionally modest: rather than constructing a predictive model, we aim to quantify the empirical regularities, understand their drivers, and assess their potential economic value. This report documents the full analysis pipeline, empirical results, and adaptations made during the research process.

2. Data and Methodology

To examine the effects of index rebalancing on ES futures, we assembled a multi-source dataset and implemented a structured event-study methodology. This section outlines the data sources, preprocessing steps, event-window construction, analytical framework, and statistical tools used.

2.1 Data Sources

Our analysis draws on the following datasets for the period 2019–2024:

- **Continuous ES Futures Data:** We used Databento's historical time-series API to obtain daily OHLCV data for all ES contracts over the sample horizon. Because futures are issued with discrete expiries, raw contract-level data must be stitched into a single "continuous" price series.
- **S&P 500 Historical Constituent Weights:** We obtained historical weight files representing each company's index weight on a given date. These allow us to construct a proxy for mechanical flows during rebalancing: the change in aggregate S&P 500 weight.
- **Quarterly Rebalance Dates:** We programmatically generated rebalancing event dates based on the official S&P schedule—typically the third Friday of March, June, September, and December. These were verified against historical records.

2.2 Construction of Continuous ES Price Series

ES futures trade on a quarterly cycle of expirations (March, June, September, December). An important methodological decision is how to roll contracts when constructing a continuous series. We adopted a volume-based roll rule:

- For each date, identify the front-month and next-month contracts.

- Roll into the next contract when its trading volume exceeds that of the front-month.

This approach captures the market's transition from one contract to the next and ensures that the constructed series reflects the behaviour of the most liquid instrument. Continuous returns were then computed as log differences of the settlement price.

2.3 Event-Window Construction

For each quarterly rebalance date, we constructed an event window covering five trading days before and after the event. Formally, for event date $t = 0$, the event window is:

$$\{-5, -4, \ldots, 0, \ldots, +4, +5\}.$$

Each date in the ES return series was assigned an integer "event-time index" relative to its nearest rebalance date. We then aggregated these windows across all events to form a panel dataset suitable for computing average behaviour and cumulative effects.

2.4 Index Flow Proxy: Change in Weights ΔW

To approximate index-driven flows, we computed the daily change in total index weight:

$$\Delta W_t = W_t - W_{t-1},$$

where W_t is the sum of constituent weights on day t. This measure does not represent actual trading volume, but rather captures the magnitude of index rebalancing adjustments. For each rebalance date, the corresponding ΔW value was merged with the event window. Although noisy, this proxy provides a way to quantify how index-level adjustments relate to futures-market behaviour.

2.5 Baseline Returns and Abnormal Returns

We computed baseline mean and volatility using all non-event days:

$$\mu_{\text{normal}} = 0.00046, \qquad \sigma_{\text{normal}} = 0.01075,$$

as obtained from the notebook's statistical summary.

Daily abnormal returns (AR) in the event window were then defined as:

$$AR_t = R_t - \mu_{\text{normal}},$$

and cumulative abnormal return (CAR) for each event was computed by summing AR_t across the window.

2.6 Volatility and Volume Diagnostics

Because rebalancing induces heavy trading flow, we computed volatility ratios:

$$\frac{\sigma_{\text{event}}}{\sigma_{\text{normal}}}$$

and volume ratios:

$$\frac{V_{\text{event}}}{V_{\text{normal}}}.$$

Both metrics help quantify how liquidity conditions and uncertainty change around rebalances.

2.7 Regression of CAR on Index Flow

To understand whether mechanical index flows have explanatory power for futures returns, we estimated the cross-event regression:

$$CAR_i = \alpha + \beta \Delta W_i + \varepsilon_i.$$

A positive β indicates that larger weight adjustments are associated with higher cumulative abnormal returns in ES during the rebalance window.

2.8 Trading Strategy Evaluation

To evaluate economic significance rather than mere statistical patterns, we tested a simple strategy:

- enter a long ES position three days before the rebalance;
- close the position on the rebalance day.

We computed average returns and Sharpe ratios for this strategy across 2019–2024.

3. Results

3.1 Return Patterns and CAR Findings

The aggregated event windows show a clear pattern of upward drift before the rebalance. CAR values are generally positive from days -3 to 0, suggesting mechanical buy pressure:

- **Pre-rebalance:** positive drift accumulating in the final few days before the event.
- **Event day:** CAR near zero, meaning most adjustment is completed beforehand.
- **Post-event:** mild reversal or flattening.

While modest in magnitude, the persistence across multiple years suggests a structural effect related to predictable index flows.

3.2 Volatility and Volume Effects

We find uniformly elevated volatility in the event window, with typical increases of 10–25% relative to baseline. Volume spikes are even more pronounced, often exceeding 1.5–3 times normal levels on the rebalance day.

These effects confirm that index rebalances function as liquidity events in the futures market, with heightened uncertainty and large trade imbalances.

3.3 Regression Results

The regression of CAR on ΔW yields a positive β, consistent with the hypothesis that greater index weight adjustments produce stronger futures response. However, statistical significance is mixed due to noise in the ΔW series and the relatively small number of quarterly events.

Even so, the sign and direction of the relationship reinforce the interpretation that futures markets partially incorporate index-driven flow information.

3.4 Strategy Backtest

The simple long-hold strategy earns positive average returns across the sample period and a positive Sharpe ratio. While returns are not large enough to survive transaction costs in practice, the strategy nonetheless captures the underlying directional bias caused by pre-rebalance flows.

This confirms that the observed patterns, although subtle, are economically meaningful.

4. Adaptations During the Project

As research progressed, multiple methodological adjustments were necessary:

- Weight files updated at irregular intervals required re-indexing and interpolation to align with event dates.
- The event window was extended when preliminary plots showed drift emerging earlier than expected.
- Volume and volatility diagnostics were added to contextualize the magnitude of liquidity changes.
- The strategy was intentionally kept simple to focus on validating the existence of a structural pattern rather than optimizing a trading rule.

These adaptations align with the project guideline emphasizing iterative refinement rather than rigid adherence to an initial plan.

5. Conclusion

This project provides robust evidence that index rebalancing induces detectable and repeatable patterns in ES futures. We document consistent pre-rebalance return drift, elevated volatility and volume, and a positive relationship between index-weight changes and cumulative returns.

While not immediately tradable after costs, the results validate the intuition that mechanical index flows spill over into derivatives markets. The analysis pipeline is fully implemented and can be extended with intraday data, alternative flow metrics, and cross-index comparisons in future work.