

# Index Rebalancing Algorithmic Strategies

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## Introduction

In this project, my goal was to take advantage of index rebalancing events from May 2022 to July 2024. Using historical data from SPY 400, 500, and 600. I focused on the months in which scheduled index rebalances occurred. March, June, September, and December.

Historical data were collected for all additions across all three indices. I looked for correlations between the month of the rebalance, the sector of the underlying, and the change in price of the underlying between the time of addition across multiple time frames.

I assumed that I could take advantage of the scheduled rebalancing events that occur quarterly by identifying opportunities to generate a positive return. Below, you will find an analysis of my findings represented through my thought process, data collection, and conclusions. Charts, Data, and Graphs are included in the Charts and Figures section following the conclusion.

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## 1 Thought Process and Decision Making

To begin, I sorted the provided index event data and noticed that the S&P 400 had the largest sample size of rebalances, and assumed the S&P 400 would be the best candidate to create and test my strategies against.

Since quarterly rebalances of the index are scheduled, I believe it would be advantageous to create strategies around these known events. I focused on all additions to the index during March, June, September, and December. I used Google Finance to pull historical price data for each asset and the index as a whole. After collecting all my data, I created tables and found that additions from the Financial, Healthcare, Utilities, and Energy sectors were the most volatile and offered significant opportunities. I collected more data and was able to finalize several different investment strategies:

- **Buying at the Announcement:** This strategy aims to capture the momentum from an asset's addition announcement to the S&P 400.
- **Event Day Reversion:** This strategy focuses on over- or under-performing stocks and takes positions based on mean-reversion metrics.
- **Trading Based on Sector:** This strategy considers a stock's sector and how that sector has historically performed after index additions.
- **Purchase by Month:** This strategy accounts for the time of year of the rebalance and the S&P 400's seasonal reactions.

I used Python to backtest these strategies across multiple holding periods and to graph the performance of a hypothetical portfolio under the given constraints.

Finally, I used the same assumptions, data collection, investment strategies, and Python code to investigate opportunities in the S&P 500 and 600. For the sector-specific strategy, the S&P 500 was the most volatile for the Utilities, Consumer Staples, Energy, and Information Tech sectors, and for the seasonal strategy, we will purchase the index during December and open no other positions. For the sector-specific strategy, the S&P 600 was the most volatile for the Information Tech, Real Estate, Health Care, and Consumer Discs, and for the season strategy, we will purchase the index during June and sell it during September.

## 2 Data Collection and Cleaning

The data I collected can be divided into the following categories:

- Index Add Event Data File
- Stock Data
- Sector-Specific ETF Data
- S&P 400, 500, and 600 Data

The purpose of collecting this data was to combine the provided index event information with historical price data from Google Finance, yielding a comprehensive dataset that captures the outcomes of scheduled, systematic index rebalances.

## 3 Trading Strategies and Results

### Strategy Parameters

- **Capital:** \$5,000,000
- **Transaction Costs:** \$0.01 per share
- **Overnight Rules:** Abide by Fed Fund Rates
- **Liquidity Constraint:** No position may exceed 1% of the 20-day average volume
- **Timing:** Trades executed at either the opening or closing price

### 1. Buying at the Announcement

**Summary:** Capture momentum from the announcement of an asset's addition to an index.

**Benefit:** Potential to ride the immediate positive reaction.

**Risks:** Announcement noise may reverse; transaction costs erode small moves.

**Time Frames:** One day holding period and holding until the event day.

**Results:** One Day Holding Period vs Holding Until the Event Day:

**400:** One Day: +\$879, Event Day: -\$39,312

**500:** One Day: -\$7,119, Event Day: +\$24,763

**600:** One Day: +\$18,850, Event Day: +\$448,692 (BEST INDEX FOR BUYING AT ANNOUNCEMENT)

## 2. Event Day Reversion

**Description:** If a stock has increased  $x\%$  from announcement day to event day, then sell at event day; if it has decreased  $x\%$ , then buy at event day.

**Summary:** Mean-reversion approach around event-day over/underperformance.

**Benefit:** Exploits the tendency for extreme moves to revert.

**Risks:** Trends may continue; whipsaw risk.

**Time frames:** One week holding period and one month holding period.

**Results:** After testing over several different thresholds, the most profitable findings were:

**400:** Buy after a loss of at least 10%, sell up to a loss of a maximum of 5%: 1-Week: +\$28,061, 1-Month: -\$7,832

**500:** Buy after a loss of at least 5%, sell up to a loss of a maximum of 4%: 1-Week: +\$81,451, 1-Month: -\$7,239

**600:** Buy after a loss of at least 10%, sell up to a loss of a maximum of 5%: 1-Week: +\$295,425, 1-Month: -\$132,280 (BEST FOR 1-Week, WORST FOR 1-MONTH)

## 3. Trading Based on Sector

**Description:** If a stock belongs to a sector  $X$ , then buy; if the sector  $Y$ , then sell. Hedge by taking an opposite position in the sector-specific ETF.

**Summary:** Sector-driven momentum or reversal trades.

**Benefit:** Diversifies idiosyncratic risk; captures sectoral moves.

**Risks:** Sector ETF may not perfectly track constituents; correlation breakdowns.

**Hedging Opportunities:** Use sector ETFs (e.g. XLF, XLE, XLV, XLU, etc).

**Time Frames:** One week holding period and one month holding period.

**Results:** After testing this strategy over several different hedging proportions and two time periods, the most optimal strategy involved:

**400:** Hedge: 0%, 1-Week: +\$35,312, 1-Month: +\$104,208

**500:** Hedge: 100%, 1-Week: +\$359,853, 1-Month: +\$244,778

**600:** Hedge: 100%, 1-Week: +\$2,112,844, 1-Month: -\$84,241 (BEST FOR 1-Week, WORST FOR 1-MONTH)

**Note:** For 400, adding any hedge lowered the outcome, but for 500 and 600, the higher the hedge percentage, the larger the return. This return can be attributed to the higher amount of daily volume in the stocks added to the 500 and 600, thus allowing for a larger position in each sector ETF and generating a larger return.

#### **4. SPY and Asset Purchase by Month**

**Description:** Instead of purchasing the stocks added to an index, we will open a position in the index itself during the months in which the index is most volatile.

**Summary:** Seasonal Calendar Strategy.

**Benefit:** Leverages documented seasonality and hedges individual additions.

**Risks:** Seasonality may change; hedges incur extra costs.

**Time Frame:** One week, One Month, and a Combination holding period

**Results:** After testing this strategy over several different holding periods:

**400:** 1-Week: +\$23,094, 1-Month: +\$47,085, Special: +\$107,482

**500:** 1-Week: -\$258,328, 1-Month: +\$1,049,759, Special: N/A (BEST FOR 1-Month, WORST FOR 1-Week)

**600:** 1-Week: +\$10,769, 1-Month: +\$144,184, Special: N/A

## **4 Conclusion and Key Takeaways**

### **Conclusion**

From the research, I can conclude that among all of the indices, the S&P 600 was the most profitable index across 3 of the 4 trading strategies. For the Event Day Announcement Strategy, trading the 600, we were able to generate a profit of \$448,692 (if holding until Event Day). For the Reversion Strategy, we were able to generate a profit of \$295,425 (if holding for a week, under a 10%, -5% threshold). Lastly, for the Sector Specific strategy, we were able to generate a profit of \$2,112,844 (under a one-week holding period, and a 100% hedge). The one strategy that generated a better return through a different index was the Seasonal Strategy, as investing in the 500 generated a profit of \$1,049,759 (under a one-month holding period)

Generalizing my findings, the best overall strategy was the Sector Specific Strategy through the S&P 600, which generated over \$2,000,000 in profit.

### **Key Takeaways**

In my initial assumption, I mainly focused on the S&P 400, to create my strategies. However, after backtesting and tracking my results, I noticed that the S&P 400, generated the worst results across the board. Using the same strategies I found under the S&P 400, and adjusting for specifics like sector and seasonal volatility, I was able to generate a much larger and more profitable return through both the S&P 600 and 500. However, it is important to consider why this happened.

I assume that the S&P 600 and 500 have larger average volume attributed to larger positions being taken for stock purchases, ETF hedges, and index purchases. This increased position is a key driver for the larger returns.

For future consideration, I believe that in order to maximize returns and minimize risk, the best possible strategy for this index rebalancing project would be a combination of each strategy (with a larger weight on the S&P 600), and tested over a larger historical data set.

## Potential Future Strategies

- Short stocks that were expected or projected to be added to an index but were not, and track the resulting price impact.
- Convert one of the above strategies into a derivatives strategy (e.g., purchasing calls for newly added or underperforming stocks, and purchasing puts for overbought or overperforming stocks that rallied after being added to an index).
- Develop a strategy focusing on one-off and unscheduled events rather than only March, June, September, and December.
- Combine sector-based trading for all months except June and December, reverting to the monthly-based strategy during those two months.
- Combine SP 400, 500, and 600 statistics to find trends, regressions, and correlations that can be used to create investment strategies across all three indices.

## 5 Charts and Figures

Index	PERCENTAGE of Month Change	AVG of Month Change	STD of Month Change	PERCENTAGE of Month Change	AVG of Month Change	STD of Month Change
Information Services	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Information Technology	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Industrials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Healthcare	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Consumer Staples	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Consumer Discretion	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Materials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Real Estate	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Utilities	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Financials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Avg Total	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Grand Total	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%

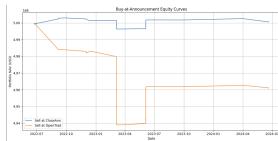
(a) Sector and Seasonal Data for SPY 400

Index	PERCENTAGE of Month Change	AVG of Month Change	STD of Month Change	PERCENTAGE of Month Change	AVG of Month Change	STD of Month Change
Information Services	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Information Technology	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Industrials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Healthcare	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Consumer Staples	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Consumer Discretion	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Materials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Real Estate	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Utilities	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Financials	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Avg Total	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%
Grand Total	-1.9%	-0.8%	4.8%	-0.4%	0.0%	0.0%

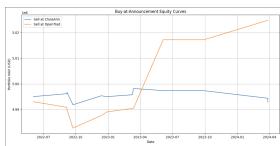
(b) Sector and Seasonal Data for SPY 500

Sector	PERCENTAGE of Month Change	AVG of Month Change	STD of Month Change
Information Services	-0.1%	0.0%	0.0%
Information Technology	-0.1%	0.0%	0.0%
Industrials	-0.1%	0.0%	0.0%
Healthcare	-0.1%	0.0%	0.0%
Consumer Staples	-0.1%	0.0%	0.0%
Consumer Discretion	-0.1%	0.0%	0.0%
Materials	-0.1%	0.0%	0.0%
Real Estate	-0.1%	0.0%	0.0%
Utilities	-0.1%	0.0%	0.0%
Financials	-0.1%	0.0%	0.0%
Avg Total	-0.1%	0.0%	0.0%
Grand Total	-0.1%	0.0%	0.0%

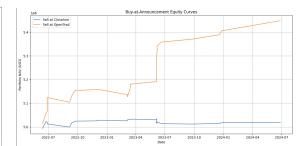
(c) Sector and Seasonal Data for SPY 600



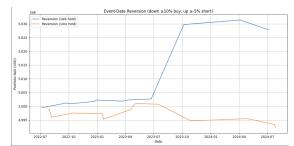
(d) Buy At Ann SPY 400 Chart



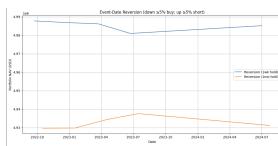
(e) Buy at Ann SPY 500 Chart



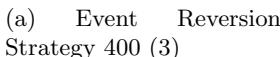
(f) Buy at Ann SPY 600 Chart



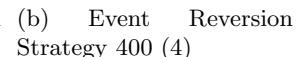
(g) Event Reversion Strategy 400 (1)



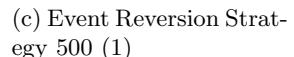
(h) Event Reversion Strategy 400 (2)



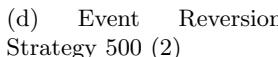
(a) Event Reversion Strategy 400 (3)



(b) Event Reversion Strategy 400 (4)



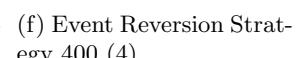
(c) Event Reversion Strategy 500 (1)



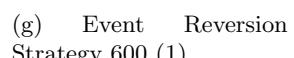
(d) Event Reversion Strategy 500 (2)



(e) Event Reversion Strategy 500 (3)



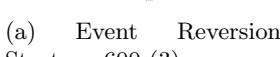
(f) Event Reversion Strategy 400 (4)



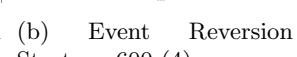
(g) Event Reversion Strategy 600 (1)



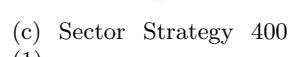
(h) Event Reversion Strategy 600 (2)



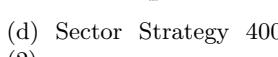
(a) Event Reversion Strategy 600 (3)



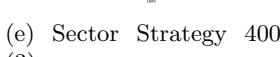
(b) Event Reversion Strategy 600 (4)



(c) Sector Hedge Strategy 400 (1)



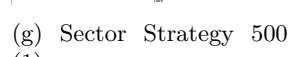
(d) Sector Hedge Strategy 400 (2)



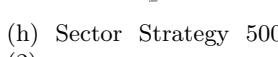
(e) Sector Hedge Strategy 400 (3)



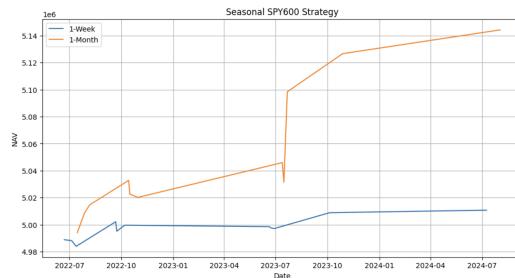
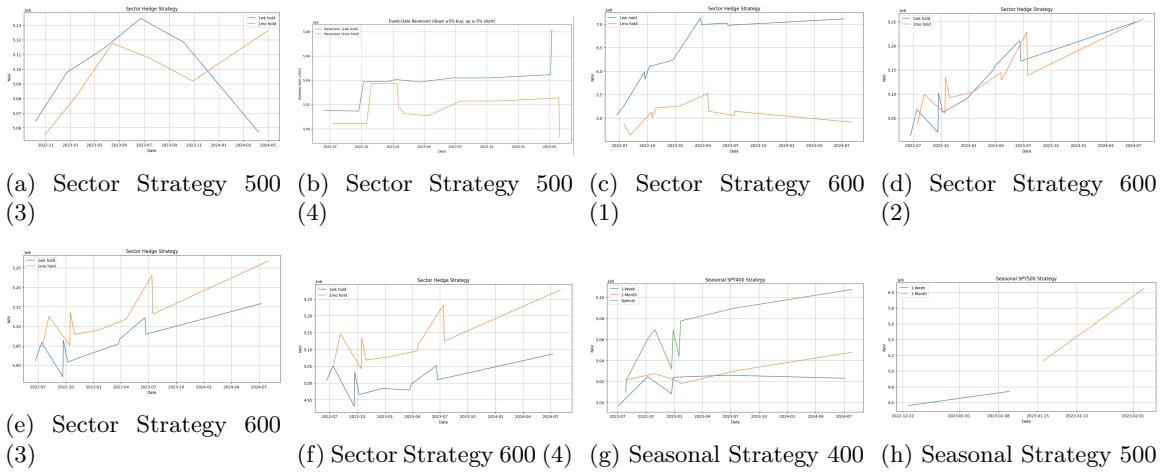
(f) Sector Hedge Strategy 400 (4)



(g) Sector Hedge Strategy 500 (1)



(h) Sector Hedge Strategy 500 (2)



(a) Seasonal Strategy 600