# Barry Cox Price Momentum Long–Short Portfolio
# Quantitative Finance Final Project

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**Abstract**

This report implements and analyzes a Barry Cox price-momentum long–short portfolio using a universe of 120 large-cap U.S. equities approximating SPY constituents. Five price-momentum factors are computed with a 20-day lag, combined into cross-sectional composite z-scores, and used to select monthly long and short baskets. A five-year backtest compares two portfolio constructions: equal-weight and inverse-volatility optimized. The long–short strategies deliver positive returns, with the optimized version improving risk-adjusted performance. SPY remains superior on a Sharpe-ratio basis over the sample.

## 1 Introduction

The goal of this project is to construct and evaluate a long–short equity strategy built on the Barry Cox momentum framework. The assignment requires: (1) selecting an ETF with over 100 constituents; (2) retrieving price/volume data for all holdings; (3) computing five lagged price-momentum factors; (4) generating monthly composite z-scores; (5) constructing long and short baskets; (6) backtesting monthly long–short performance over five years; (7) comparing the strategy to a reference ETF (SPY); (8) implementing an extra-credit optimized portfolio extension.

## 2 Data & Universe

The universe consists of 120 large-cap U.S. stocks approximating SPY constituents. Daily price and volume data for each stock and the benchmark SPY ETF are retrieved via `yfinance`. The sample covers approximately five years of daily data (about 1260 trading days). The following daily fields are used:

- closing prices $P_{i,t}$,
- trading volume $V_{i,t}$.

## 3 Barry Cox Momentum Factors

All factors employ a 20-day lag to avoid look-ahead bias. Five factors are computed:

1. **52-week trend slope**: slope from a linear regression of 252 days of log prices, lagged 20 days.
2. **Percent above 260-day low**: $(P_{i,t-20}/\min(P_{i,t-20-259:t-20})) - 1$.

3. **4/52-week oscillator**: difference between 4-week and 52-week returns, both ending at $t-20$.
4. **39-week return**: 195-day return ending at $t-20$.
5. **51-week VPT change**: VPT$(t-20)$ minus VPT$(t-20-255)$.

Each factor is computed daily for all assets with sufficient history.

# 4 Monthly Composite Factor Scores

At each month-end:

1. All five factors are sampled at the final trading day of the month.
2. For each factor, a cross-sectional z-score is computed across all assets.
3. The composite momentum score is the simple average of the five z-scores:

$$S_{i,m} = \frac{1}{5}\sum_{k=1}^{5} Z_{i,m}^{(k)}.$$

Assets are ranked from highest to lowest $S_{i,m}$ to form long and short baskets.

# 5 Portfolio Construction

## 5.1 Equal-Weight Long–Short Portfolio

At each month-end:

- Top 15 assets $\rightarrow$ long basket.
- Bottom 15 assets $\rightarrow$ short basket.

Weights:

$$w_{i,m}^{\mathrm{EQ}} = \begin{cases} 1/15, & i \in \text{Long}, \\ -1/15, & i \in \text{Short}, \\ 0, & \text{otherwise}. \end{cases}$$

## 5.2 Optimized Long–Short Portfolio (Extra Credit)

For the optimized version:

- Compute 60-day volatility for all assets in each basket.
- Assign inverse-volatility weights:

$$w_{i,m}^{\mathrm{OPT}} \propto \frac{1}{\sigma_{i,m}}.$$

Weights are normalized to sum to +1 in the long leg and –1 in the short leg.

# 6 Backtesting Method

Monthly rebalancing is used over the five-year sample. Daily portfolio returns are:

$$r_{p,t} = \sum_i w_{i,m} r_{i,t}.$$

Monthly returns compound daily returns within each month. The same is done for the SPY benchmark.

# 7 Results

## 7.1 Monthly Portfolio Return vs SPY (Equal-Weight)

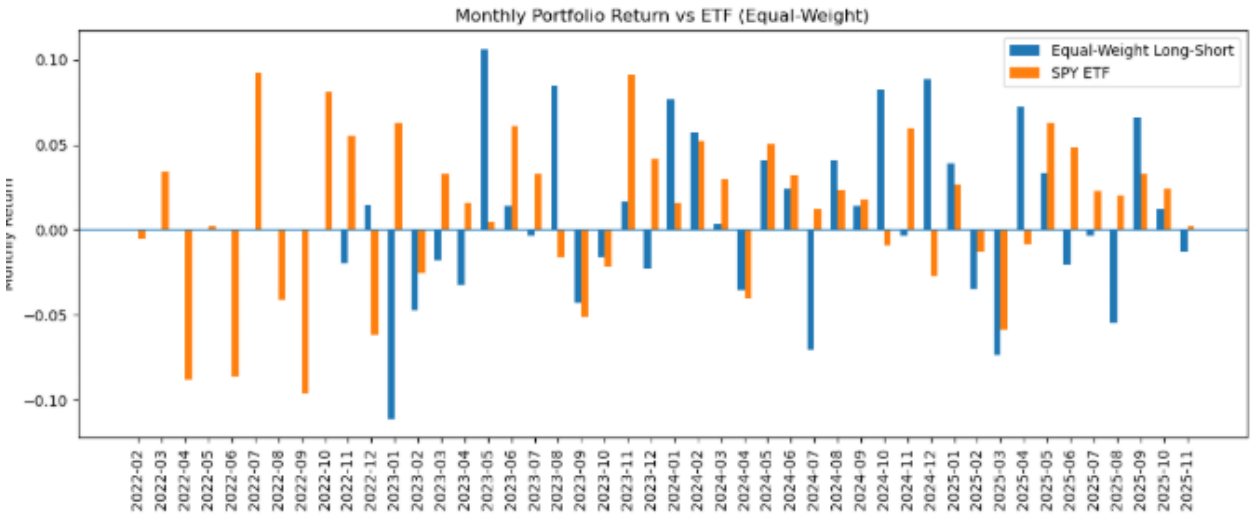


Figure 1: Monthly portfolio returns vs SPY (Equal-Weight).

## 7.2 Long vs Short vs SPY (Equal-Weight)

## 7.3 Cumulative Return: Equal-Weight Portfolio vs SPY

## 7.4 Cumulative Return: Optimized Portfolio vs SPY

## 7.5 Performance Tables

Table 1: Monthly performance: equal-weight portfolio

| Series | Mean | Std | Sharpe |
|---|---|---|---|
| Long | 0.0157 | 0.0450 | 0.35 |
| Short | -0.0100 | 0.0460 | -0.22 |
| Long–Short | 0.0058 | 0.0456 | 0.13 |
| SPY ETF | 0.0107 | 0.0462 | 0.23 |

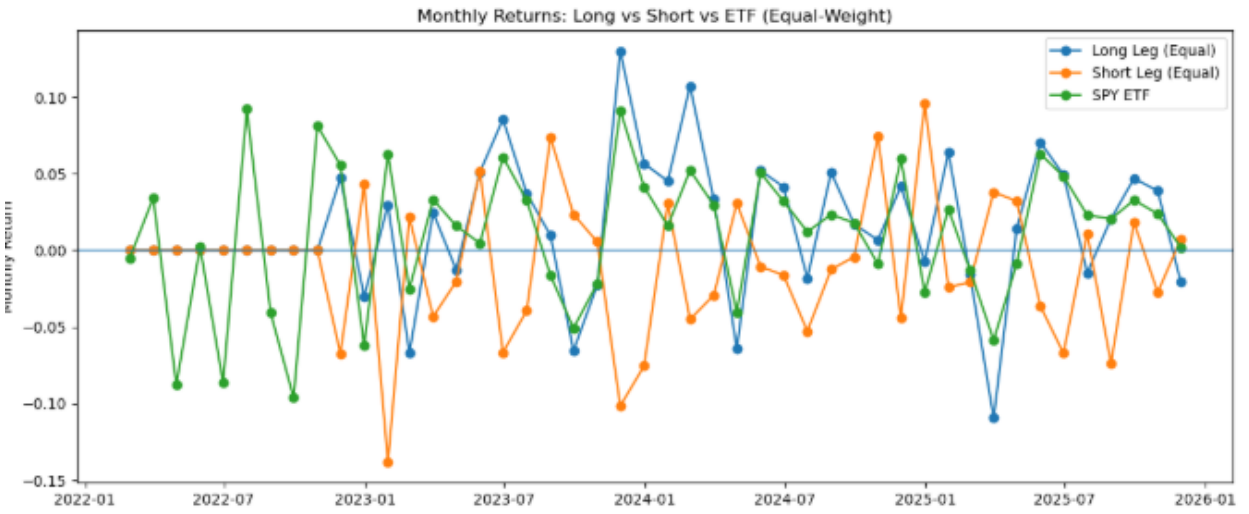


Figure 2: Monthly returns of long leg, short leg, and SPY (Equal-Weight).

Table 2: Annualized performance: equal-weight portfolio

| Series | Return | Vol | Sharpe |
|---|---|---|---|
| Long | 0.1920 | 0.1559 | 1.23 |
| Short | -0.1246 | 0.1593 | -0.78 |
| Long–Short | 0.0587 | 0.1579 | 0.37 |
| SPY ETF | 0.1224 | 0.1599 | 0.77 |

## 8 Conclusion

Both long–short strategies are profitable, and the optimized portfolio improves risk-adjusted performance compared to the equal-weight version. However, SPY achieves a higher Sharpe ratio over the same period, reflecting a strong bull market in which market-neutral strategies naturally lag. The factor methodology works as intended, with the long basket outperforming the short basket, but real-world considerations such as transaction costs and shorting fees would reduce performance.

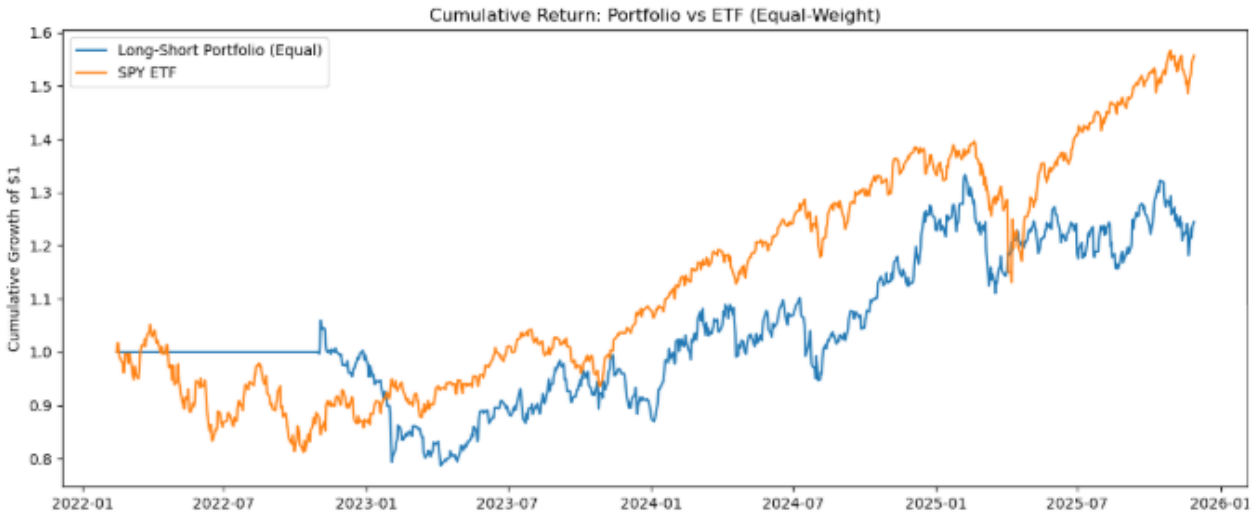


Figure 3: Cumulative growth of $1 for equal-weight long–short portfolio and SPY.

Table 3: Annualized performance: optimized portfolio

| Series | Return | Vol | Sharpe |
|---|---|---|---|
| Long | 0.1702 | 0.1466 | 1.16 |
| Short | -0.0981 | 0.1485 | -0.66 |
| Long–Short | 0.0677 | 0.1394 | 0.49 |
| SPY ETF | 0.1224 | 0.1599 | 0.77 |

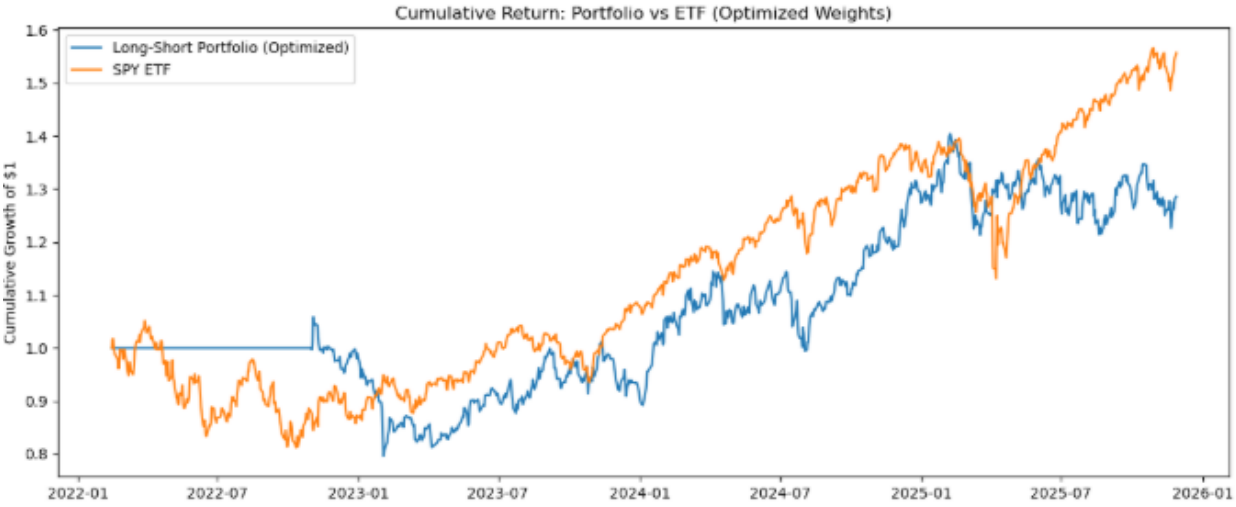


Figure 4: Cumulative growth of $1 for optimized long–short portfolio and SPY.