Portfolio Construction based on put-call ratio

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Portfolio Construction:

Background:

In this project we aim to create profitable Long and Short Equity portfolios which can generate alpha. We utilized Put Call Option Ratio as the short-term signal for stock selection. We created two trading strategies and back tested them from 04-01-2016 to 07-30-2021 across different holding periods and investment lags.

Put Call Ratio: Put Call ratio is a short-term signal which can be used to gauge market sentiment. Put Call ratio in our context is defined as percentage of OTM Put buys in total OTM options buys.

$$\text{Put Call Ratio} = \frac{OTM\ PUT\ BUYS}{OTM\ PUT\ BUYS + OTM\ CALL\ BUYS}$$

A high ratio indicates higher Put buying, thus suggesting a downward trend in the security price. A low ratio indicates higher Call buying, thus suggesting a bullish trend for the security price.

Portfolio strategies:

Strategy 1: We use OTM Put ratio, prior day's return, and average Put Call Ratio to select Long and Short Portfolios from S&P 500 constituents.

Long Strategy: Sort the S&P 500 constituents based on yesterday's return and pick the bottom 100. This list is then sorted on Put Call Ratio to 50 stocks with the lowest PC ratio. The intuition here is to identify stocks with low returns and a bullish low PC ratio. Later we perform a double sort on the Average Put ratio pick top 25 and then sort by the current day's PC ratio to 10 stocks with the lowest values. We aim to profit from the new information signaled by the change in PC ratios.

Short Strategy: Using a similar strategy we pick the top 100 performers from S&P 500 based on yesterday's return. We sort them based on the PC ratio and pick the ones with the highest values. This indicates high Put option buying when compared to call, thus indicating a downturn. We further sort them by the average Put ratio to pick the bottom 25 and then sort by the current day's PC ratio to pick the highest values. We want to identify the stocks which historically had low Put buying, but a recent sudden increase suggests a reversal.

Back testing results and discussion:

In our testing, the long strategy was profitable across the holding periods (2-5) and investment lags (2-5). The best performing portfolio had a two-day investment lag and a two-day holding period. The short strategy was not profitable in all our tests. We believe the positive correlation of the short portfolio with SPX makes it difficult to generate positive returns in a bullish market. We also utilize this section to share some portfolio metrics and analyze any discernable patterns.

Figure 1 below figure visualizes the cumulative returns and maximum drawdown for long and short portfolios from Strategy 1 for investment lag 2. The portfolio withholding period of 2 days has outperformed the benchmark SPX returns by ~400% over 4.5 years. We achieve a Sharpe Ratio of 1.2 which is higher than SPX (0.562778). But the one-month maximum drawdown for our portfolios is around 50% during the March 2020 crash, which is higher when compared to ~35% drawdown of SPX. Results for all the portfolios can be found in the appendix.

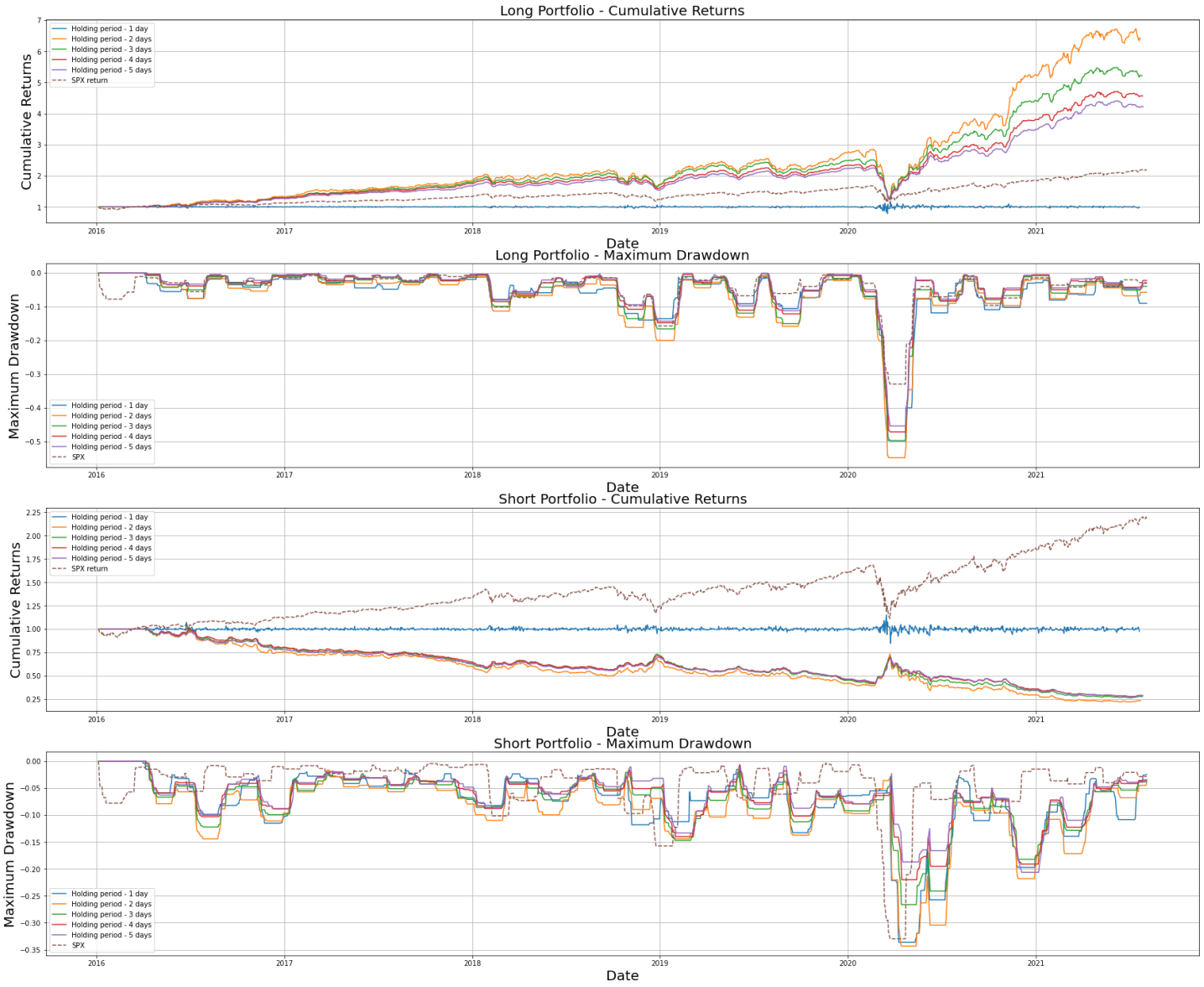

Figure 1 : Strategy 1 returns and maximum drawdown for Holding period 2 and Investment lag 2

Metrics Comparison: This section compares Sharpe Ratios, Volatility, CAPM Beta and Alpha and correlation with benchmark SPX for the Long Portfolios.

- **Sharpe Ratio:** We observe that the ratio decreases as we increase the holding period over 2 days. The Sharpe ratio for portfolio with 1 day holding period are lower due to the high volatility in returns. The effect of investment lag is not very significant when compared holding period. We observe this phenomenon in the remaining metrics as well. Figure 2 is a heatmap visualization of the Sharpe ratio of different portfolios.

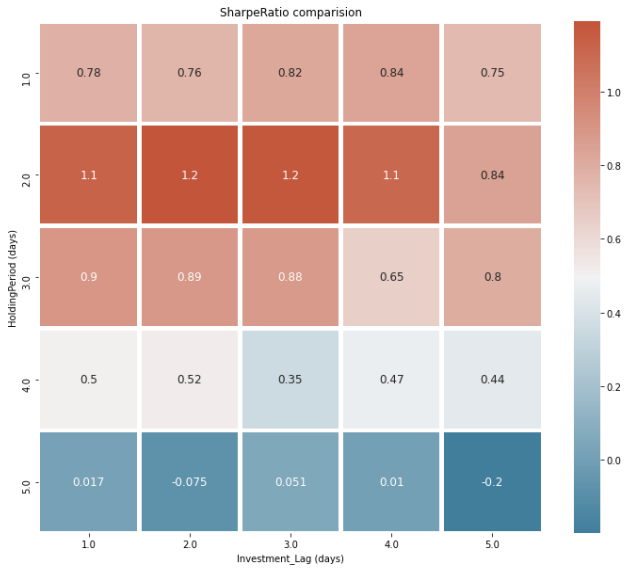

Figure 2: Sharpe ratio comparison for Long Strategy, Benchmark (SPY) Sharpe ratio: 0.562778

- **Volatility:** We see that portfolio with one day holding period is highly volatile. The volatility decreaseswith increased holding period. Investment lag doesn't have a significant effect on the variation of portfolio returns. Figure 3 below is a heatmap visualization of the Volatility of different portfolios.

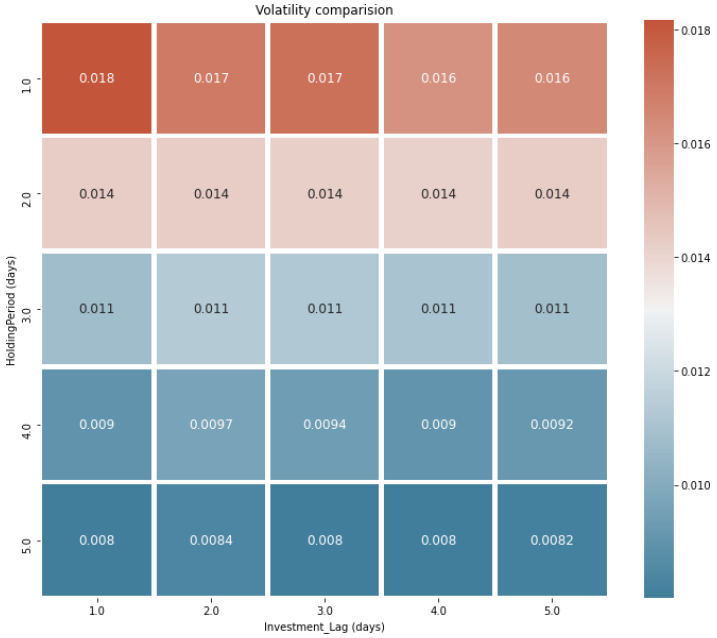

Figure 8: Volatility comparison for Long Strategy, Benchmark SPX Volatility: 0.011826

- **Beta:** Using Capital Asset Pricing model we calculated the Beta and Alpha of our portfolios. As expected, Beta decreases with increasing holding period. Our portfolio with 1 day holding period has high Beta values (>1). Figure 4 below is a heatmap visualization of the Betas of different portfolios.

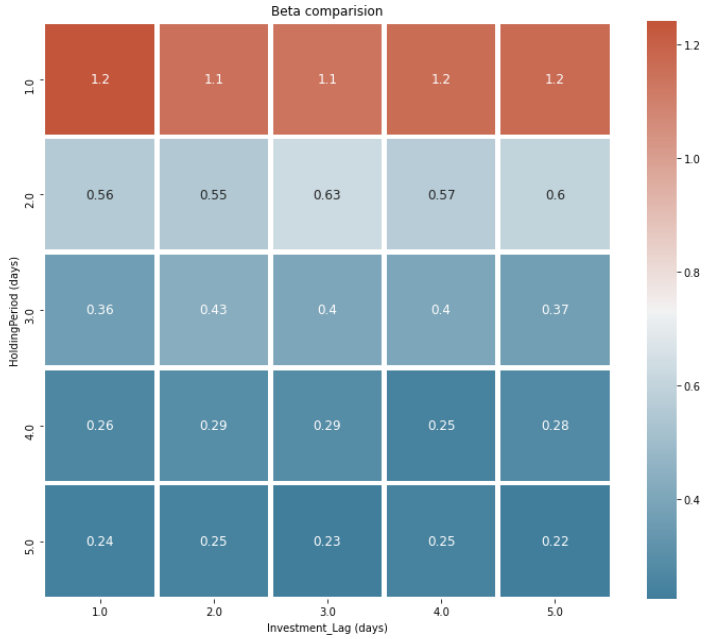

Figure 9: Beta comparison for Long Strategy

- **Correlation with SPX returns:** As expected from the Betas, the correlation with SPX drops with increasing holding periods. Figure 4 below is a heatmap visualization of the correlation with SPX for different portfolios.

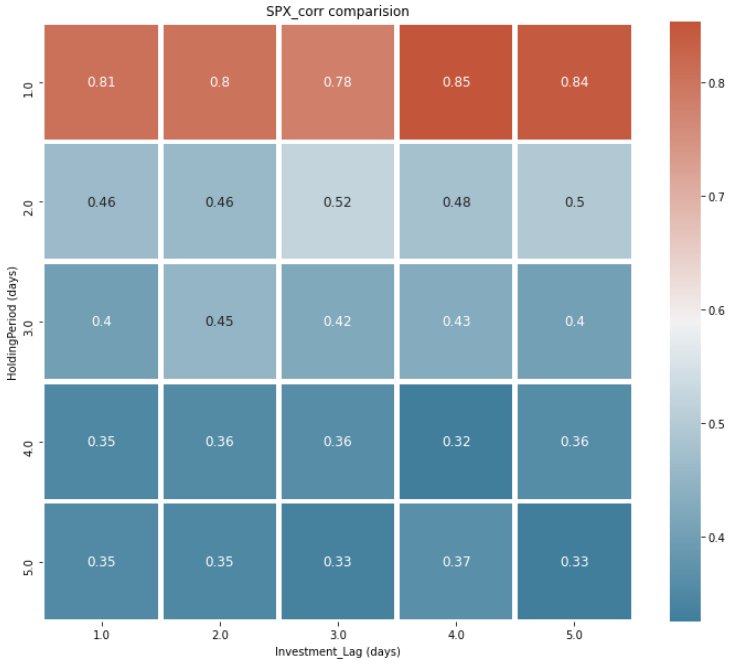

Figure 10: SPX correlation comparison for the Long strategy

- **Alpha:** The Alphas reported in the below figure are annualized. All our long portfolios generate positive alpha against benchmark SPX, except for the ones with holding period 5. This suggests that the signal strength decreases with holding periods as expected from a short-term indicator.

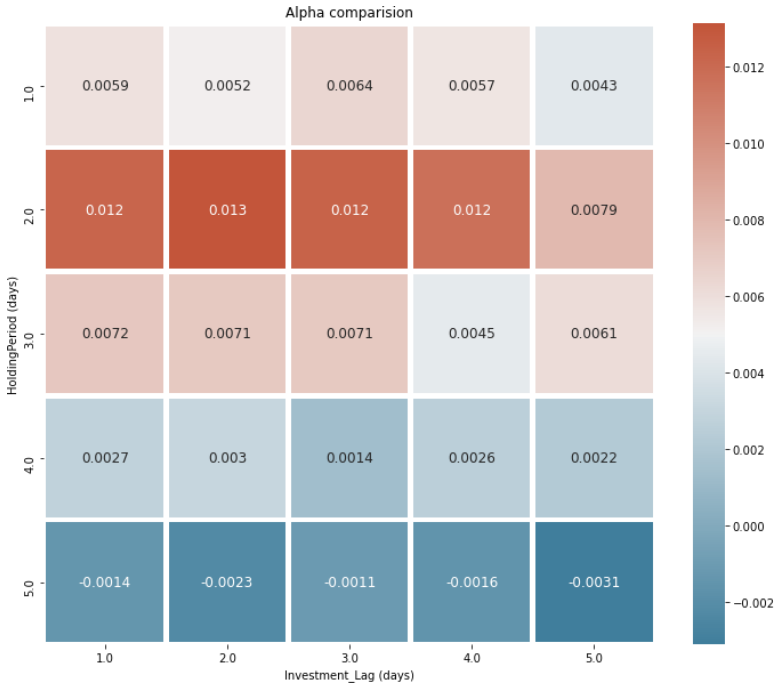

Figure 11: Alpha comparison for the Long strategy

Strategy 2:

This strategy uses same sorting and filtering from Strategy 1, but the scope has been increased to all US equities to decrease our short portfolio's correlation with SPX. It also implements additional restrictions based on technical indicators like 50 day moving average and 5 day moving average slope. In our back test we were able to create a profitable short portfolio which had negative correlation with SPX

Long Strategy: After the initial sorting and filtering like Strategy 1, we enforce a condition that the stock price line is below the moving average and the moving average is trending upwards (MA slope > 1).

Short Strategy: For the short portfolio we enforce a similar condition that the price line is above the moving average and the moving average is trending downwards (MA slope < 1).

Back testing results and discussion:

We used a shorter back test window from 01-01-2020 to 07-30-2020 for this portfolio. In our testing short portfolios based on this strategy with a holding period of 1 or 2 days and an investment lag of 3 days were able to achieve positive returns. Portfolio with 1 day holding period slightly outperforms SPX in terms of Sharpe Ratio. Portfolio with 2 day holding period has the highest cumulative returns almost comparable to SPX. Figure7 below visualizes the cumulative returns and maximum draw down of our best performing short portfolio in this strategy.

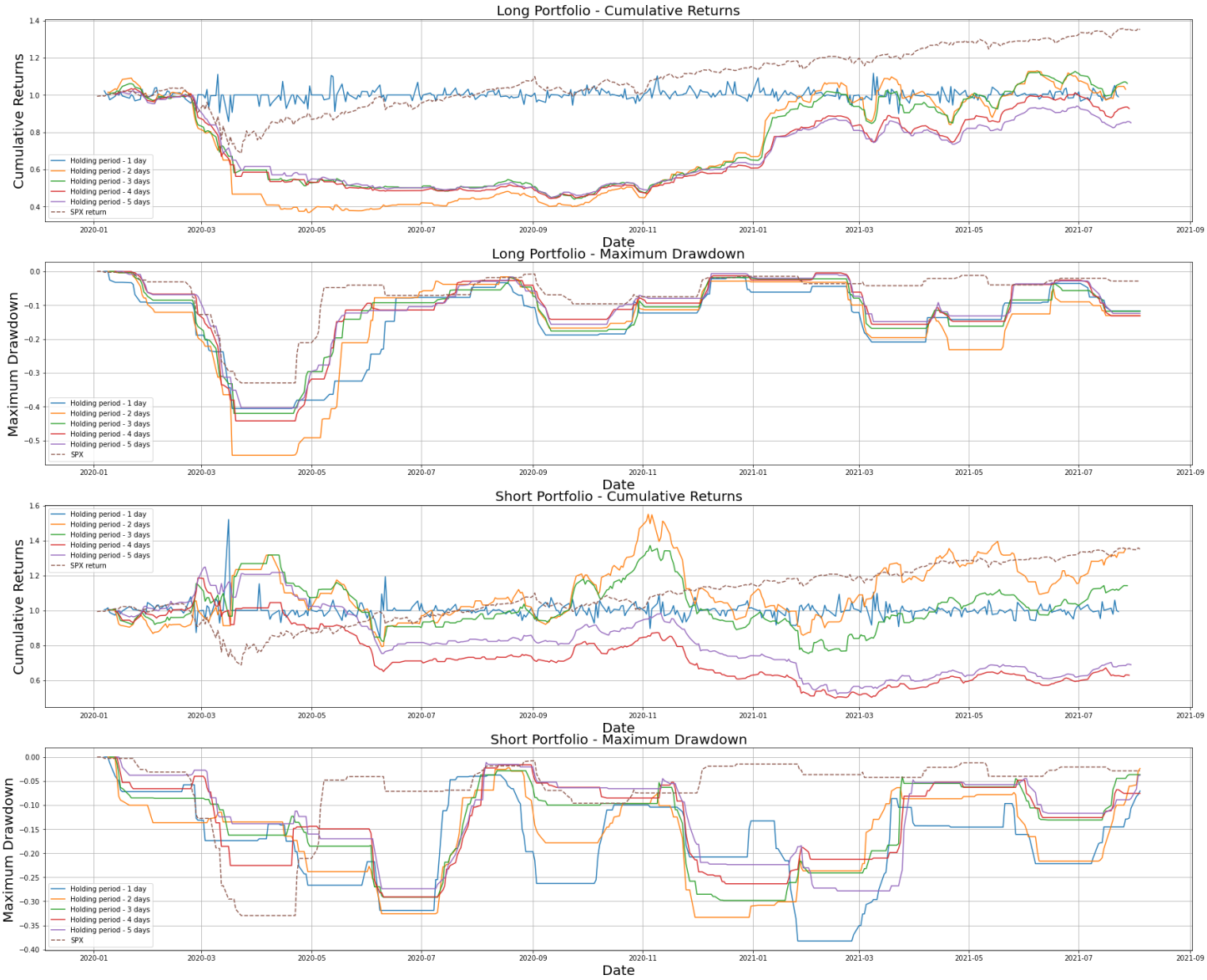

Figure 12: Cumulative returns and maximum drawdown for Long and Short Portfolios from Strategy 2 with investment lag 3

Conclusion and next steps:

From our analysis we identified that holding period of a portfolio is significant factor while using OTM Put Call Ratio as a short-term signal. The impact of investment lag is unclear on our strategies and requires further testing. Next steps for this project would be tune the parameters used for momentum and technical indicators calculation. We also would need to validate our results with economic intuition which requires research into macro-economic factors.

References:

1. Patrick Houlihan & Germán G. Creamer (2019) Leveraging a call-put ratio as a trading signal, Quantitative Finance
2. Pedro Manuel Nogueira Reis & Carlos Pinho (2020): A Reappraisal of the Causal Relationship between SentimentProxies and Stock Returns, Journal of Behavioral Finance