Introduction

The objective of this report is to find various portfolios using quadratic programming methods discussed in class. My portfolio is composed of 27 stocks: Apple, ABB, AMD, Blackrock, Caterpillar, Churchill Downs, Comstock Resources, Crispr Therapeutics, EOG Resources, First Solar, Home Depot, Jpmorgan Chase, KKR, Malibu Boats, Mcdonalds, Medtronic, Microsoft, Nvidia, Omega Healthcare, Procter & Gamble, Ptc, Regeneron Pharmaceuticals, Charles Schwab, Sempra, Thermo Fisher Scientific, UnitedHealth Group, and Union Pacific. These are the 27 stocks that compose the Leeds Investment and Trading Group, which is a student-run long only equity fund at CU Boulder. Our holdings expanded to 30 stocks this semester, but I did not include these newer additions. In this project, the stocks were used to build portfolio strategies including: long only, long short, and 130/30. For each portfolio, return was maximized and variance was minimized to find the portfolio weights by a quadratic programming method, and each portfolio's performance was compared to the S&P 500.

Discussion of Methodologies

Before the optimizations can be conducted, collection of data and calculation of expected returns, alpha, and betas is necessary. The data is the last five years of monthly stock history for the 27 stocks and S&P 500: the first three years will be used for calibration of the model and the last two years will be used for testing. The returns were calculated using a simple average of the last six months of the calibration data for every stock and the index. The betas were calculated through a linear regression of each stock against the S&P 500. The alpha is calculated by taking the difference between the expected return and the beta multiplied by the return of the index. This data is unchanged for the non-rebalancing portfolios, but it is modified in the rebalancing

portfolios (add the 3 newest data points and remove the 3 oldest data points).

Long Only Portfolio Performance

The long only portfolio was the simplest of the quadratic optimizations created. The constraints used for optimization were a beta equal to one, a monthly alpha of 0.5%, and all portfolio weights greater than or equal to zero. For the quarterly rebalancing: expected returns, betas, alphas, and the covariance matrix were recomputed and the optimization was recalculated.

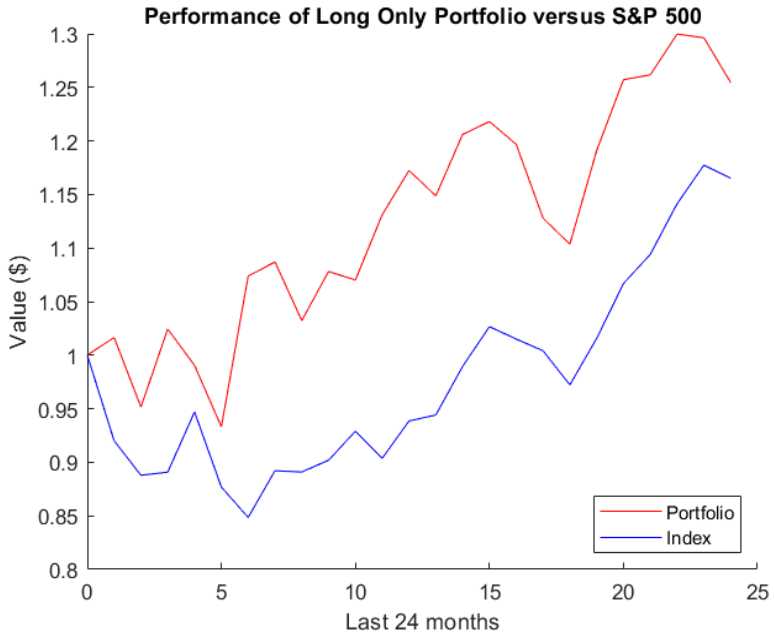

Figure 1: This shows the performance of the long only portfolio compared to the S&P 500 over the two years of testing data. The long only portfolio and index return 25.44% and 16.51% respectively over the 24 month period. As is the case with all of these optimizations, portfolio variance was minimized and return was maximized.

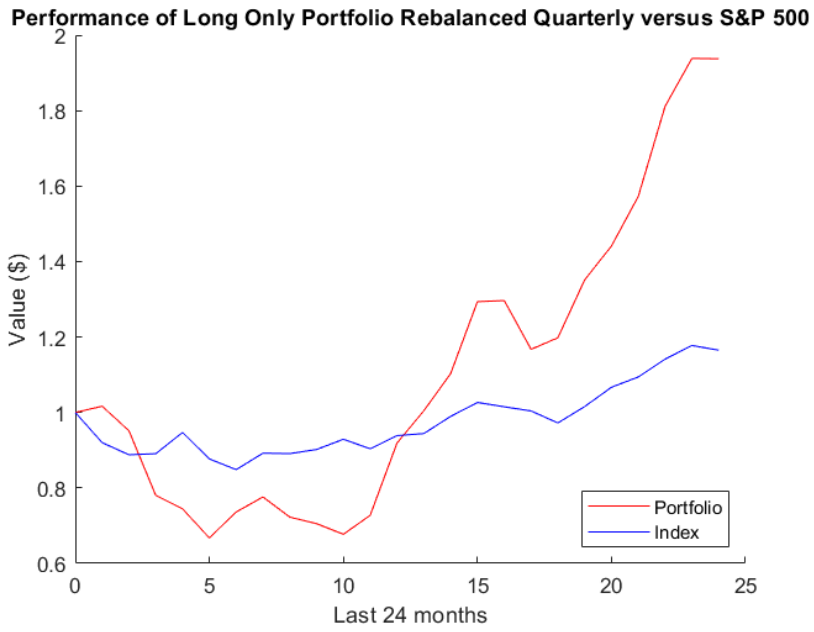

Figure 2: This shows the performance of the long only quarterly rebalanced portfolio compared to the S&P 500 over the two years of testing data. The long only portfolio and index returned 93.74% and 16.51% respectively over the 24 month period.

Long Short Portfolio Performance

The long only portfolio was the second of the quadratic optimizations created. The constraints used for optimization were a beta equal to one, a monthly alpha of 0.5%, and all portfolio weights were unbounded. For the quarterly rebalancing: expected returns, betas, alphas, and the covariance matrix were recomputed and the optimization was recalculated. As is the case with all of these optimizations, portfolio variance was minimized and return was maximized.

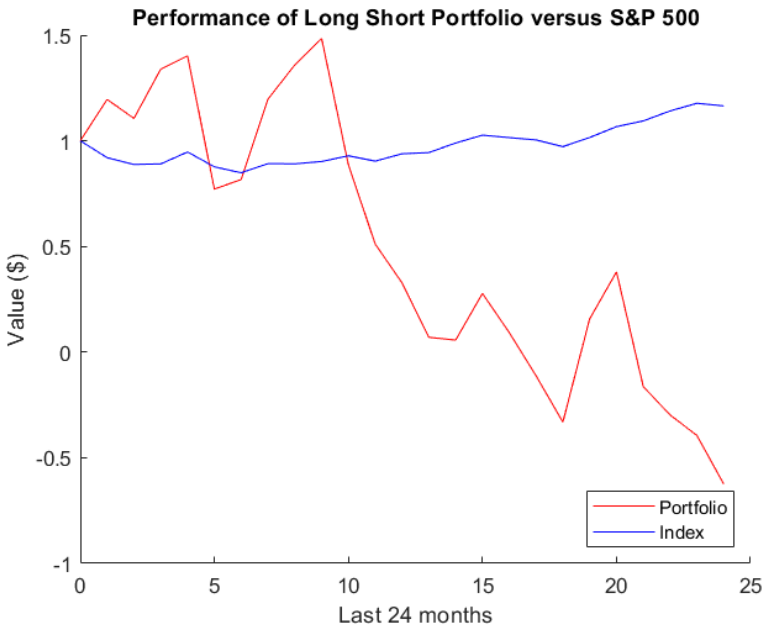

Figure 3: This shows the performance of the long short portfolio compared to the S&P 500 over the two years of testing data. The long short portfolio and index returned 62.43% and 16.51% respectively over the 24 month period.

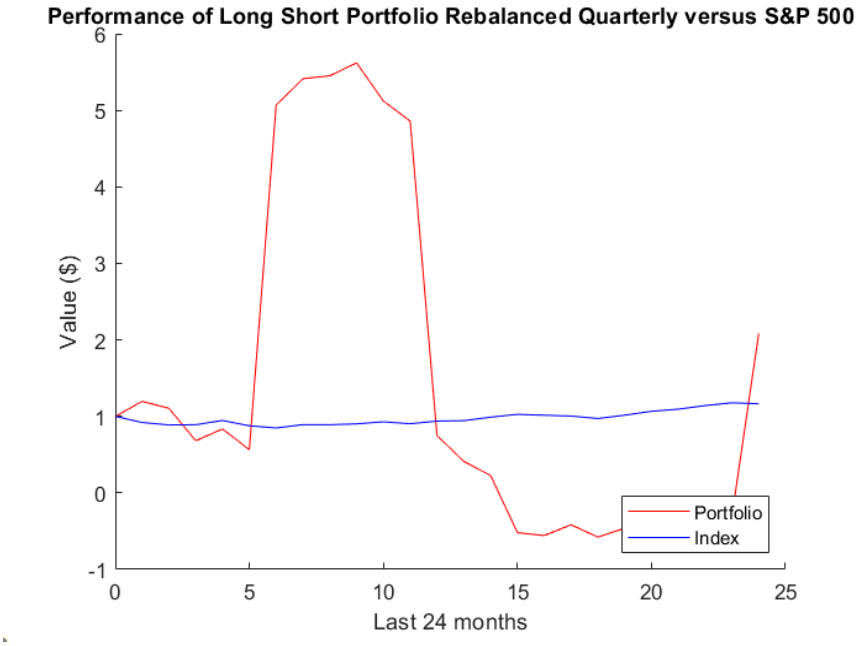

Figure 4: This shows the performance of the long short quarterly rebalancing portfolio compared

to the S&P 500 over the two years of testing data. The long short portfolio and index returned 108.21% and 16.51% respectively over the 24 month period.

130/30 Portfolio Performance

The 130/30 portfolio was the last of the quadratic optimizations created. The constraints used for optimization were a beta equal to one, a monthly alpha of 0.5%, and the portfolio short positions were bounded at 30%. For the quarterly rebalancing: expected returns, betas, alphas, and the covariance matrix were recomputed and the optimization was recalculated. As is the case with all of these optimizations, portfolio variance was minimized and return was maximized.

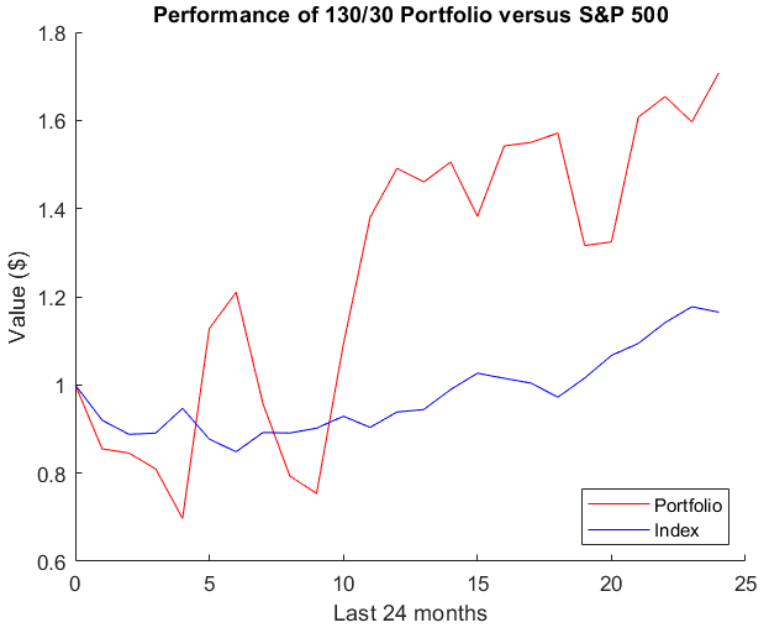

Figure 5: This shows the performance of the 130/30 portfolio compared to the S&P 500 over the two years of testing data. The 130/30 portfolio and index returned 70.76% and 16.51% respectively over the 24 month period.

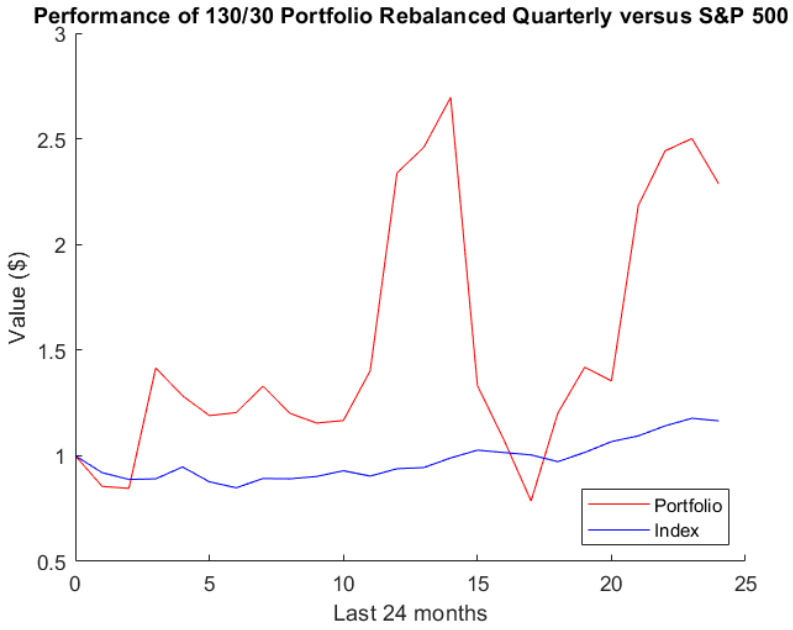

Figure 6: This shows the performance of the 130/30 portfolio compared to the S&P 500 over the two years of testing data. The 130/30 portfolio and index returned 128.65% and 16.51% respectively over the 24 month period.

Conclusion

From these initial results, I have become interested in further examining the portfolio at Leeds Investing and Trading group. According to these results, a long only portfolio found from this optimization algorithm did outperform the index by a significant amount even after constraining the beta to be equal to one and minimizing the variance. As a portfolio manager for the fund next year, I am excited to delve into our portfolio and to see how to improve portfolio construction. Understandably, this project would be only a starting point, but it does make me wonder how these results can be applied to the portfolio for the future.