

## Portfolio Optimization

Using QuantMod/PerformanceAnalytics/PortfolioAnalytics in R

### Summary:

This project illustrates the benefits of portfolio management & reweighting to navigate the market. An initial portfolio of assets was selected & the data was pulled from Yahoo Finance. We then calculated the unadjusted annualized returns for the portfolio under the assumption each asset had an equal weight in the portfolio. We then established two market benchmarks using the S&P500 & the DJI. Financial ratios were calculated for comparisons.

We then structured the optimization methods by applying constraints & objectives.

### Constraints

- Full Investment
  - o All supplied funds are to be invested. (No holding cash)
- Weight Sum
  - o Distribute the weights with a cumulative sum of 100%
- Transaction Costs
  - o Accounts for transaction costs at each rebalance (Once a month)
- Long Only
  - o
- Box
  - o The minimum & maximum portfolio percentage an asset can have
  - o This helps with risk. But also constrains profitability
    - Each asset must make up at least 2% of the portfolio
    - Each asset must not exceed 50% of the portfolio

### Objectives - 2 objectives

- Returns
  - o Objective is to maximize returns
- Risk
  - o Objective mitigate risk - minimize volatility.

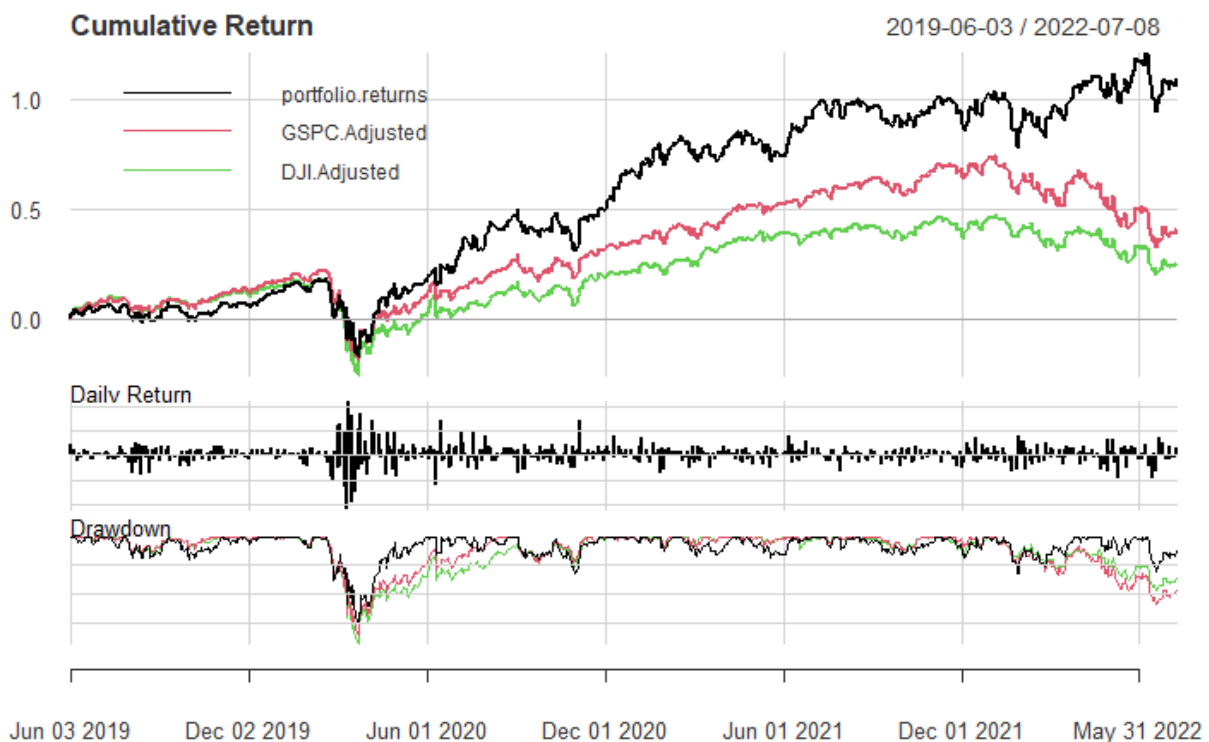
For the optimization, we did something similar to that of a “random search” in machine learning tuning. Given the goal of maximizing returns & minimizing risk (aka volatility/STDev), we searched X instances of randomly generated weight settings & select the most optimal parameters (set of weights).

There are better approaches to portfolio optimization, but for this project, we used a random search.

Once the optimal rebalancing weights were found, we visualized the optimal settings & applied the parameters.

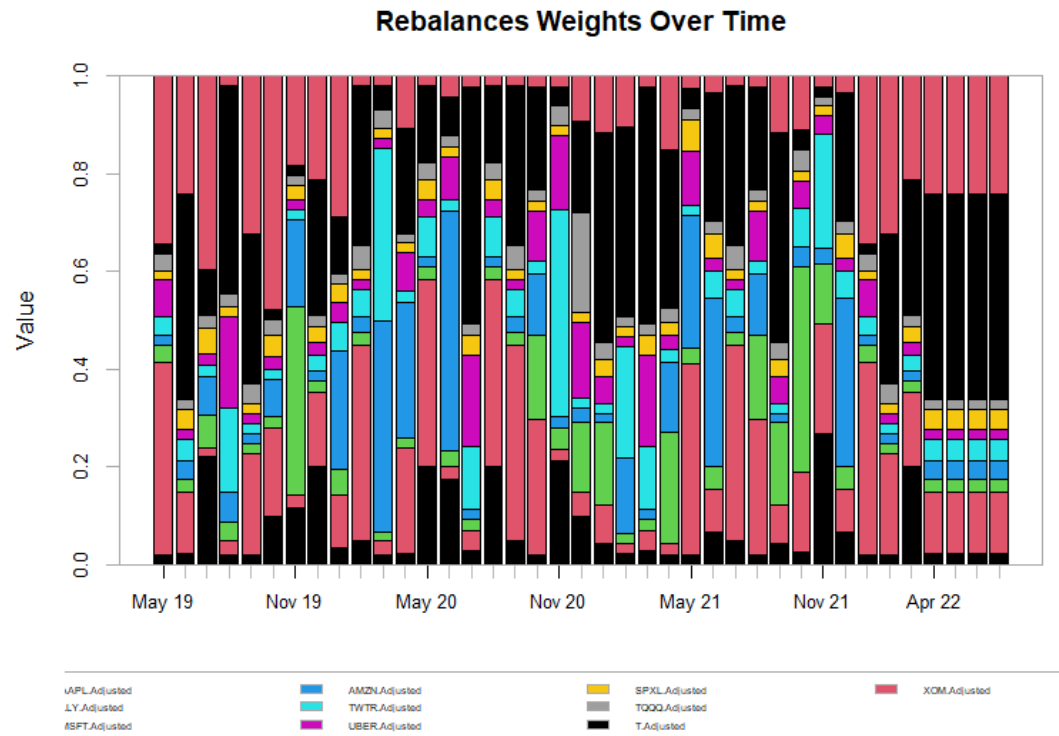
For the final results, our optimal rebalanced portfolio averaged 26.81% annualized returns. For the same timeframe, the S&P had 14.19% annualized returns & the DJI had 9.65% annualized returns. So, we can conclude that our rebalancing strategy beat the market.

## P/L Overtime



Applying the optimization.

The annualized returns mentioned above were the result of back testing. The rebalancing took place once a month. So, to apply this strategy - one would need to build out their portfolio, set the desired constraints (Minimums/Maximums, etc.), run the optimization and then extract the final weights for the most recent month. After a month, the user would run the optimization again & set this month accordingly. Since the weights are rebalanced each month, the selected weights will remain in place for 30 days.



For our example above, we can see that the optimal weights for the month of July are

Asset	Weight % of Portfolio
AAPL (Apple)	2.4%
LLY (Eli Lilly)	12.4%
MSFT (Microsoft)	2.8%
AMZN (Amazon)	3.6%
TWTR (Twitter)	4.4%
UBER (Uber)	2%
SPXL (SP500 3x Leveraged ETF)	4.2%
TQQQ (NASDAQ 3x Leveraged ETF)	2%
T (AT&T)	42%
XOM (Exxon Mobil)	24.2%

\*3x ETFS were included in the portfolio to be used as short-term investment tools. We can see this in the optimization. For the most part, both 3x ETFS never exceed 5% of the portfolio. But for ONE month, TQQQ was raised to 20.4%. (Short-term)

In conclusion, this project intended to demonstrate the importance of portfolio rebalancing & optimization. If we were to follow the model from May 2019 to July 2022, we would have an annualized return of 26.81% whereas the overall market benchmarks produced 9.65% & 14.19% annually.