# Portfolio Re-balancing strategies

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July 2024

## 1 Introduction

In this project, we investigate the impact of different portfolio re-balancing strategies and frequencies in the overall portfolio performance. We look at absolute and risk-adjusted returns as well as the maximum drawdowns generated by each strategy, comparing the results against a benchmark.

## 2 Scope of the project

The objective of this project is to compare 3 different portfolio re-balancing strategies, under different re-balancing frequencies.

The 3 strategies we will be testing are as follow:

- Minimum Variance Portfolio
- Maximum Sharpe Ratio Portfolio
- 'Sell Winners, buy Losers' Portfolio

We will be constructing a portfolio of S& P 500 sector-tracking ETF, onto which we will be backtesting these 3 different strategies under different re-balancing frequencies.

We will be comparing different strategies by their annualized return, volatility, Sharpe ratio, and the maximum drawdown of the portfolio during the back-testing period.

## 3 Choice of securities

As mentioned above, the re-balancing strategies will be tested on a portfolio of sector-tracking ETFs.

| Sector Index | ETF Ticker |
|---|---|
| S&P 500 Energy | IUES.L |
| S&P 500 Materials | IUMS.L |
| S&P 500 Industrials | IUIS.L |
| S&P 500 Consumer Discretionary | IUCD.L |
| S&P 500 Consumer Staples | IUCS.L |

| Sector Index | ETF Ticker |
|---|---|
| S&P 500 Financials | IUFS.L |
| S&P 500 Healthcare | IUHC.L |
| S&P 500 Information Technology | IUIT.L |
| S&P 500 Communications | IUCM.L |
| S&P 500 Utilities Sector | IUUS.L |

Figure 1: Securities chosen for the backtesting

# 4 Choice of strategies

As mentioned in the scope of the project, we will be testing 3 strategies.

## 4.1 Minimum Variance Portfolio

We want to select a vector of weights at time t

$$\overrightarrow{x}_t$$

With this portfolio construction strategy, we want our vector of weights at time t to be the vector that minimizes the portfolio variance, notably:

$$min \sigma_p^2 = \overrightarrow{x} \cdot Cov_{t-1} \cdot \overrightarrow{x}^T$$

Such program can be solved either as algebraic operation or via a simulation in python with the Dirichlet distribution. The second approach is chosen in this case as we can reuse the code used to calculate the max Sharpe portfolio.

## 4.2 Maximum Sharpe Portfolio

With this portfolio construction strategy, we want our vector of weights at time t to be the vector that maximizes the Sharpe ratio during the period t-1, which is defined as the portfolio's excess return over the risk-free rate per unit of risk. Specifically, we aim to maximize:

$$Sharpe = \frac{\overrightarrow{x} \cdot \overrightarrow{R}_{t-1} - R_f}{\sqrt{\overrightarrow{x} \cdot Cov_{t-1} \cdot \overrightarrow{x}^T}}$$

Such program is solved using the Dirichlet distribution to generate random weights, and then choosing the portfolio that maxes the above equation.

## 4.3 Selling Winners, Buying Losers Portfolio

With this portfolio construction strategy, we want our vector of weights at time t to be the vector that corrects the portfolio drift generated in the previous period.

In a portfolio, if we study the weights of the constituents from the start to the end of a given period, we can notice that the constituents that overperform the portfolio average end up having a higher weight than the constituents that underperformed the average.

As such, the "selling winners, buying losers" strategy basically consists of correcting your portfolio weights to the original weights at the start of the period. This translates into selling the stocks that overperformed the average and buying the ones that underperformed.

# 5 Backtesting

## 5.1 Methodology

The backtesting methodology consists of comparing the result of 4 different frequencies of re-balancing on a same strategy (Monthly, Quarterly, Semi-Annually, and Annually) against a benchmark. Benchmark is defined as a equally weighted portfolio of the same securities, which is never rebalanced.

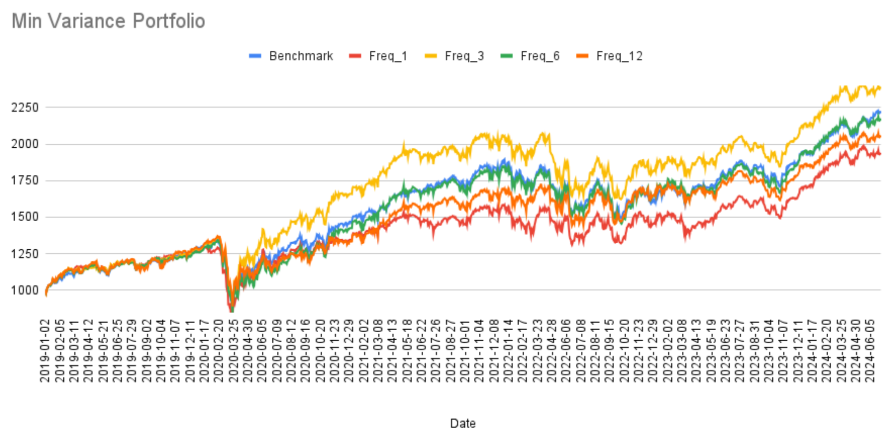
We use yfinance to download data from 2019-01-01 to 2024-07-01.

In order to compare the performance of each strategy and each re-balancing frequency, we will look at the annualized return, volatility, Sharpe Ratio, and Maximum Drawdown.

A maximum drawdown (MDD) is the maximum observed loss from a peak to a trough of a portfolio, before a new peak is attained.

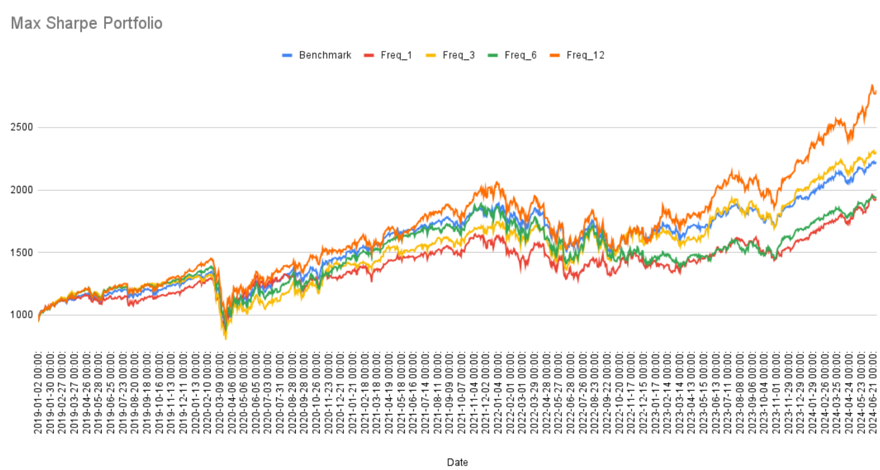
## 5.2 Minimum Variance Portfolio

With the Minimum Variance Portfolio we get the following results:




## 5.3 Max Sharpe Portfolio

With the Max Sharpe Portfolio we get the following results:




## 5.4 Selling Winners, Buying Losers Portfolio

With the Selling Winners Buying Losers Portfolio we get the following results:


## 5.5 Result analysis

We recompile the results in the following summary:

| | Benchmark | Min Variance Portfolio | | | |
|---|---|---|---|---|---|
| **Rebalance Frequency** | - | 1 month | 3 months | 6 months | 12 months |
| **Annualized Return** | 23.91% | 19.58% | 26.39% | 23.19% | 21.50% |
| **Annualized Volatility** | 17.94% | 18.52% | 18.35% | 18.69% | 18.36% |
| **Sharpe Ratio** | 1.10 | 0.83 | 1.21 | 1.02 | 0.94 |
| **Max Drawdown** | 34.80% | 38.00% | 35.18% | 37.51% | 35.14% |

| | Benchmark | Max Sharpe Portfolio | | | |
|---|---|---|---|---|---|
| **Rebalance Frequency** | - | 1 month | 3 months | 6 months | 12 months |
| **Annualized Return** | 23.91% | 19.85% | 25.66% | 19.94% | **32.01%** |
| **Annualized Volatility** | 17.94% | 18.77% | 19.80% | 19.80% | 20.71% |
| **Sharpe Ratio** | 1.10 | 0.83 | 1.08 | 0.80 | **1.34** |
| **Max Drawdown** | 34.80% | **34.30%** | 39.48% | 36.83% | 35.47% |

| | Benchmark | Sell winners buy losers | | | |
|---|---|---|---|---|---|
| **Rebalance Frequency** | - | 1 month | 3 months | 6 months | 12 months |
| **Annualized Return** | 23.91% | 21.87% | 25.52% | 23.32% | 24.12% |
| **Annualized Volatility** | 17.94% | **17.46%** | 17.75% | 17.92% | 17.93% |
| **Sharpe Ratio** | 1.10 | 1.01 | 1.20 | 1.07 | 1.11 |
| **Max Drawdown** | 34.80% | 36.96% | 34.80% | 34.80% | 34.80% |

We notice that in all three strategies, re-balancing very often (1-month frequency) generally performs worse compared to other frequencies.

Quarterly re-balancing consistently yields returns above the benchmark, both in terms of absolute returns and risk-adjusted returns. However, in some scenarios, it returns a lower return compared to other strategies.

In terms of strategies, we see that across all frequencies, the "Selling winners, buying losers" strategies generally yield the best Sharpe ratios.

No strategy consistently beats the benchmark across all frequencies.

Maximum drawdowns generally stay within the same bounds and are generally worse than the benchmark.

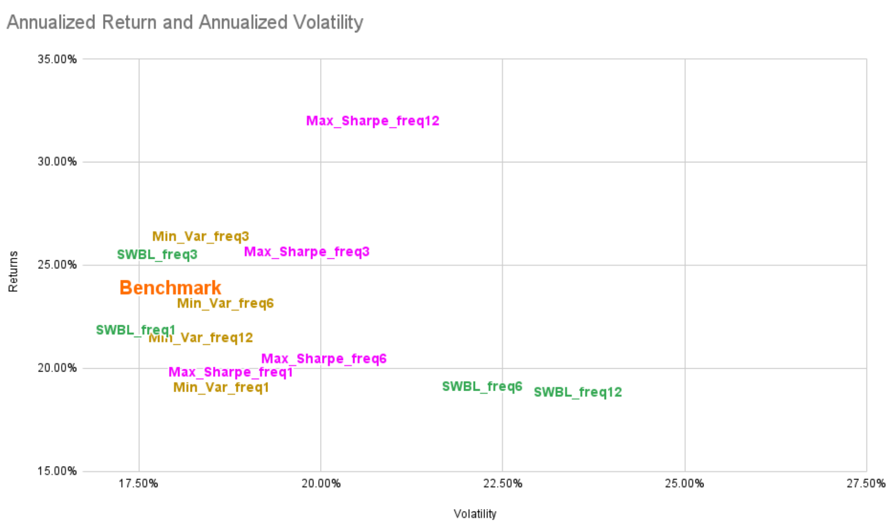



Figure 2: Scatterplot of Return vs Vol