

MIE1622 Assignment 1

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*Note: in this report, strategies 1, 2, 3, and 4 correspond to Buy and Hold, Equal Weights, Min Variance, and Max Sharpe Ratio respectively.

1. Brief Description of Implementation Part

[1.1 Rounding Procedure](#)

The weights of the stocks in the portfolio are firstly computed with CPLEX. The new position (in terms of number of shares) is computed with this set of weights by adopting simple integer type cast as rounding without considering transaction cost. Then the transaction cost is estimated by treating this new position as the actual position and comparing it with the position of last period. This transaction cost is indeed an upper bound of the actual transaction cost. The actual transaction cost can be potentially lower but would be close, since the actual position would not differ much (transaction cost 0.5% is small). The estimated transaction cost is deducted from the portfolio value and the position is recomputed with the same set of weights but new portfolio value, with simple integer type cast again. This rounding process makes sure the transaction cost can be covered and the budget is enough with the rounding process.

[1.2 Validation Process](#)

As mentioned previously the rounding procedure would ensure the transaction cost can be covered and the rebalancing is feasible. In addition, a verifying section of code is executed for each strategy at each period checking if the cash account remains nonnegative and the rebalancing is feasible. A message would be thrown if the issue occurs. In fact, such feasibility issue never occurs in my code.

2. Analysis of Results

[2.1 Output of strategies for 12 periods](#)

See *Figure 1.1* and *Figure 1.2* in Appendix for the output.

[2.2 Daily Portfolio Value Chart](#)

See *Figure 2* in Appendix for the chart.

[2.3 Dynamic Change in Portfolio Allocation for Strategy 3 and Strategy 4 Charts](#)

See *Figure 3.1* and *Figure 3.2* in Appendix for the charts.

[2.4 Strategy Comparison and Discussion](#)

In this assignment, variation of portfolio values of strategies 2 and 3 can, in some degree, indicate the general trend of the market. From this point of view, from portfolio value of strategy in *Figure 2*, it can be found that the market has an uptrend from January 2019 to around February 2020, following by a downtrend until end of March 2020, then following by an uptrend until end of 2020.

All four strategies Strategy have similar performance when the market is in downtrend, although strategy 2 has portfolio value decreased the least 1 has overall worst performance throughout the whole 2 years because its portfolio value can hardly grow when the market is in uptrend. Strategies 2 and 4 have better performance in terms of portfolio value growing than strategy 3 when the market is in uptrend. Strategy 4 has similar performance as strategy 2 until end of March 2020, then has a better growth in portfolio value than strategy 2. Overall, strategy 4 has the best performance.

In addition, from *Figure 3.1* and *Figure 3.2*, it can be found that strategy 3 always has portfolio of multiple stocks with non-zero number of shares, while strategy 4 has portfolio consist of only one stock with non-zero number of shares at some periods. This can potentially be problematic (especially, when the company of that single stock encounter big issue) for strategy 4 because it does not follow diversification.

I would choose strategy 4 for managing my own portfolio. Strategy 4 is the only strategy that has expected return considered (expected return and variance are both considered in Sharpe ratio), and it has the best performance in terms of portfolio value. Although strategy 4 can result in portfolio including only one stock, which violates diversification, I would not be afraid of taking risk when buying stock.

3. Discussion of Possible Improvements to Trading Strategies

3.1 Variation of Strategies

Variation has been tested for strategies 2, 3, and 4. The variation is for the purpose of reducing transaction cost by lessening the frequency of rebalancing. Variation of adopting the strategy and then holding until the end of 12 periods and variation of rebalancing every 2 periods have been attempted. The comparison of variations against original strategies are plotted and showed as in *Figure 4.1*, *Figure 4.2*, and *Figure 4.3* in Appendix.

Holding for 2 years has the best performance for strategy 2, because of the transaction cost reduced. However, rebalancing every two periods works the best for strategy 3 and the original one works the best for strategy 4. This mean the earning created by rebalancing portfolio with updated Q (and μ for strategy 4) can be more than the reduced transaction cost (this is much more obvious in *Figure 4.3* for strategy 4). For strategy 3, it is demonstrated that some level of lessening rebalancing frequency can be beneficia, but rebalancing with updated Q is also important.

In conclusion, the variations have obtained better results for strategies 1, 2, and 3, but not 4.

3.2 Suggestion of Improvements

1) Only strategy 4 takes the expected returns into account in optimization process. The strategy of mean-variance portfolio optimization with appropriate selection of

weighting between mean and variance might produce a better result.

2) Including transaction cost as part of the objective function with appropriate weighting.

3) As mentioned in the analysis section, the market (for the 20 stocks) experiences a downtrend that last for months. An option can be added to the optimization process that choosing to sell all stocks and put all money into cash account (since there is no risk free asset within the 20 stocks) when the market appears to be in a significant downtrend (e.g. the expected returns are mostly negative).

(Appendix starts on next page)

4. Appendix

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Initial portfolio value = $ 1000070.06

Period 1: start date 01/02/2019, end date 02/28/2019
  Strategy "Buy and Hold", value begin = $ 1000070.06, value end = $ 1121179.83
  Strategy "Equally Weighted Portfolio", value begin = $ 991110.53, value end = $ 1097139.05
  Strategy "Minimum Variance Portfolio", value begin = $ 991694.14, value end = $ 1057727.91
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 990119.39, value end = $ 1016524.41

Period 2: start date 03/01/2019, end date 04/30/2019
  Strategy "Buy and Hold", value begin = $ 1126131.27, value end = $ 1075001.89
  Strategy "Equally Weighted Portfolio", value begin = $ 1103425.44, value end = $ 1188889.41
  Strategy "Minimum Variance Portfolio", value begin = $ 1055676.99, value end = $ 1108275.36
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1007117.74, value end = $ 1076765.61

Period 3: start date 05/01/2019, end date 06/28/2019
  Strategy "Buy and Hold", value begin = $ 1070867.54, value end = $ 969057.81
  Strategy "Equally Weighted Portfolio", value begin = $ 1181393.74, value end = $ 1169301.49
  Strategy "Minimum Variance Portfolio", value begin = $ 1092186.69, value end = $ 1099667.41
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1060451.78, value end = $ 1073388.89

Period 4: start date 07/01/2019, end date 08/30/2019
  Strategy "Buy and Hold", value begin = $ 976973.31, value end = $ 933721.61
  Strategy "Equally Weighted Portfolio", value begin = $ 1179796.34, value end = $ 1150032.09
  Strategy "Minimum Variance Portfolio", value begin = $ 1097489.35, value end = $ 1129717.70
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1071209.32, value end = $ 1140264.81

Period 5: start date 09/03/2019, end date 10/31/2019
  Strategy "Buy and Hold", value begin = $ 922211.42, value end = $ 1028337.74
  Strategy "Equally Weighted Portfolio", value begin = $ 1138328.41, value end = $ 1252905.01
  Strategy "Minimum Variance Portfolio", value begin = $ 1115970.40, value end = $ 1182721.76
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1139080.87, value end = $ 1246475.50

Period 6: start date 11/01/2019, end date 12/31/2019
  Strategy "Buy and Hold", value begin = $ 1037933.42, value end = $ 1099403.03
  Strategy "Equally Weighted Portfolio", value begin = $ 1270616.92, value end = $ 1373610.07
  Strategy "Minimum Variance Portfolio", value begin = $ 1184766.42, value end = $ 1256239.28
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1248551.92, value end = $ 1369849.65
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Figure 1.1: Part 2 Output of Strategies

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Period 7: start date 01/02/2020, end date 02/28/2020
  Strategy "Buy and Hold", value begin = $ 1112112.69, value end = $ 900207.54
  Strategy "Equally Weighted Portfolio", value begin = $ 1396421.26, value end = $ 1258473.94
  Strategy "Minimum Variance Portfolio", value begin = $ 1256601.66, value end = $ 1159796.35
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1379227.69, value end = $ 1284635.75

Period 8: start date 03/02/2020, end date 04/30/2020
  Strategy "Buy and Hold", value begin = $ 924774.25, value end = $ 856285.51
  Strategy "Equally Weighted Portfolio", value begin = $ 1312359.86, value end = $ 1215382.27
  Strategy "Minimum Variance Portfolio", value begin = $ 1210165.17, value end = $ 1077038.70
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1340311.96, value end = $ 1417151.32

Period 9: start date 05/01/2020, end date 06/30/2020
  Strategy "Buy and Hold", value begin = $ 822532.65, value end = $ 875128.45
  Strategy "Equally Weighted Portfolio", value begin = $ 1171231.67, value end = $ 1316235.02
  Strategy "Minimum Variance Portfolio", value begin = $ 1046251.05, value end = $ 1081224.98
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1357463.54, value end = $ 1637822.10

Period 10: start date 07/01/2020, end date 08/31/2020
  Strategy "Buy and Hold", value begin = $ 852159.31, value end = $ 852474.32
  Strategy "Equally Weighted Portfolio", value begin = $ 1307180.39, value end = $ 1494126.76
  Strategy "Minimum Variance Portfolio", value begin = $ 1084360.85, value end = $ 1242832.79
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 1698911.14, value end = $ 2238261.54

Period 11: start date 09/01/2020, end date 10/30/2020
  Strategy "Buy and Hold", value begin = $ 857122.42, value end = $ 795062.75
  Strategy "Equally Weighted Portfolio", value begin = $ 1504821.99, value end = $ 1407551.72
  Strategy "Minimum Variance Portfolio", value begin = $ 1245046.56, value end = $ 1193651.51
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 2285546.99, value end = $ 2164732.78

Period 12: start date 11/02/2020, end date 12/31/2020
  Strategy "Buy and Hold", value begin = $ 811070.20, value end = $ 972162.37
  Strategy "Equally Weighted Portfolio", value begin = $ 1419986.79, value end = $ 1682327.39
  Strategy "Minimum Variance Portfolio", value begin = $ 1204298.45, value end = $ 1273645.25
  Strategy "Maximum Sharpe Ratio Portfolio", value begin = $ 2162771.27, value end = $ 2493427.99

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Figure 1.2: Part 2 Output of Strategies (Continue)

Portfolio Value for Different Strategies from 2019 to 2020

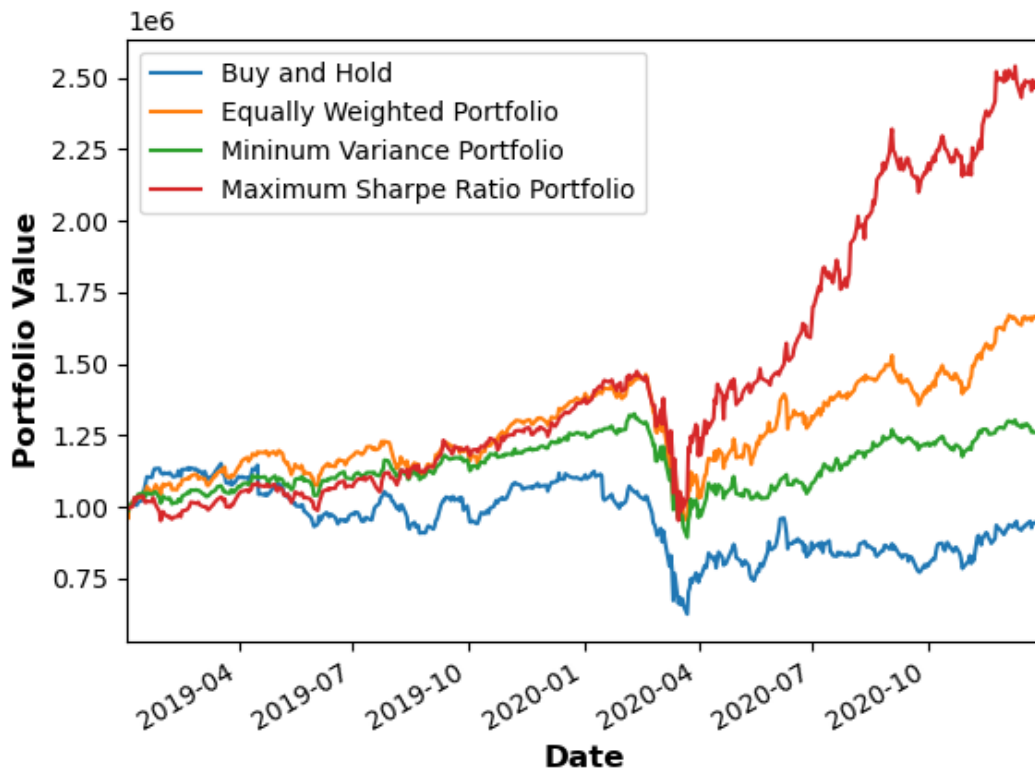


Figure 2: Daily Portfolio Value Chart

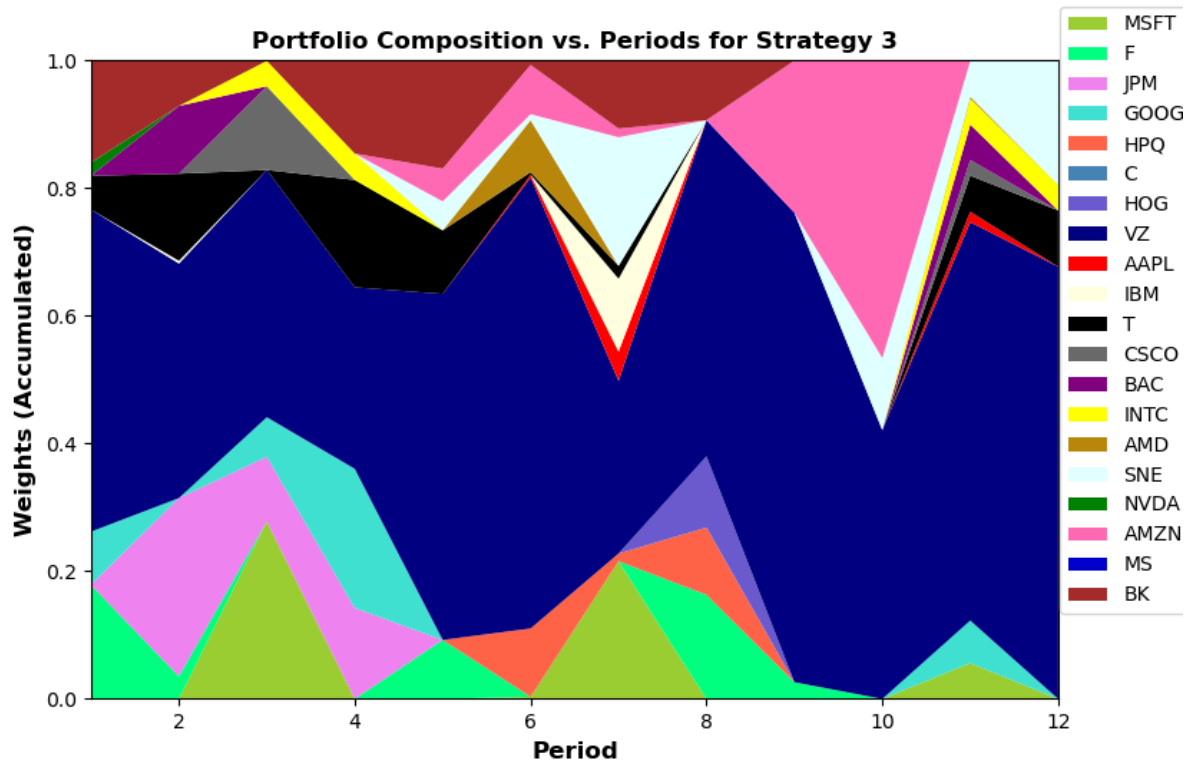


Figure 3.1: Portfolio Dynamic Change for Strategy 3

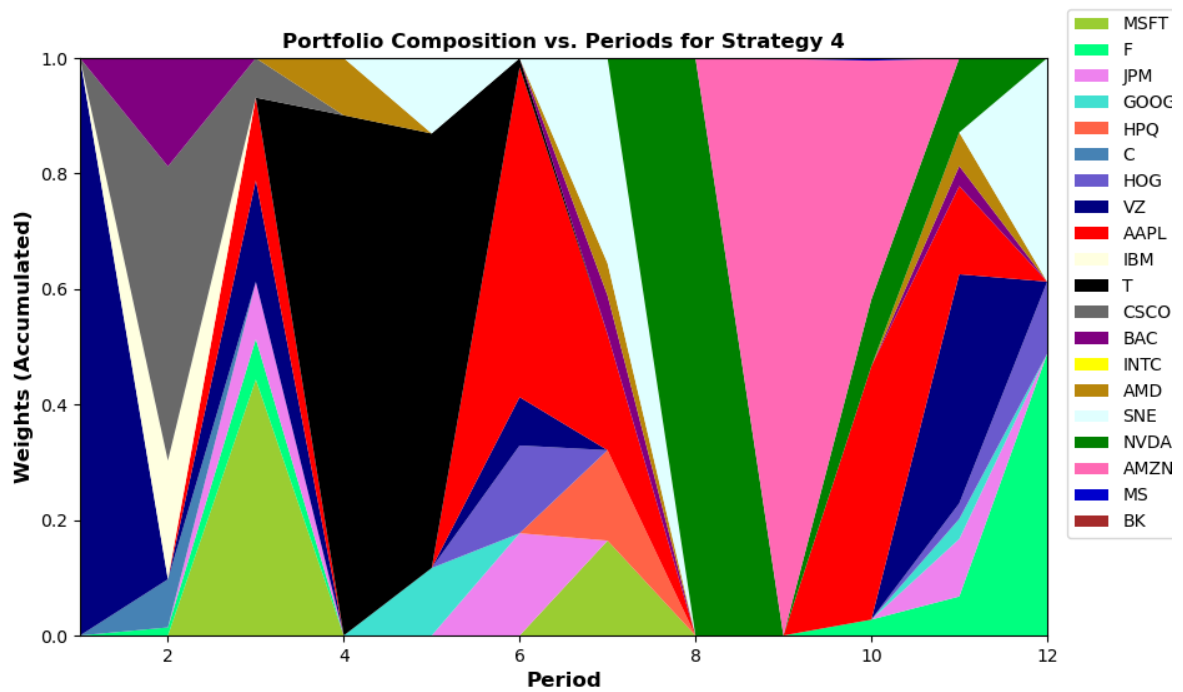


Figure 3.2: Portfolio Dynamic Change for Strategy 4

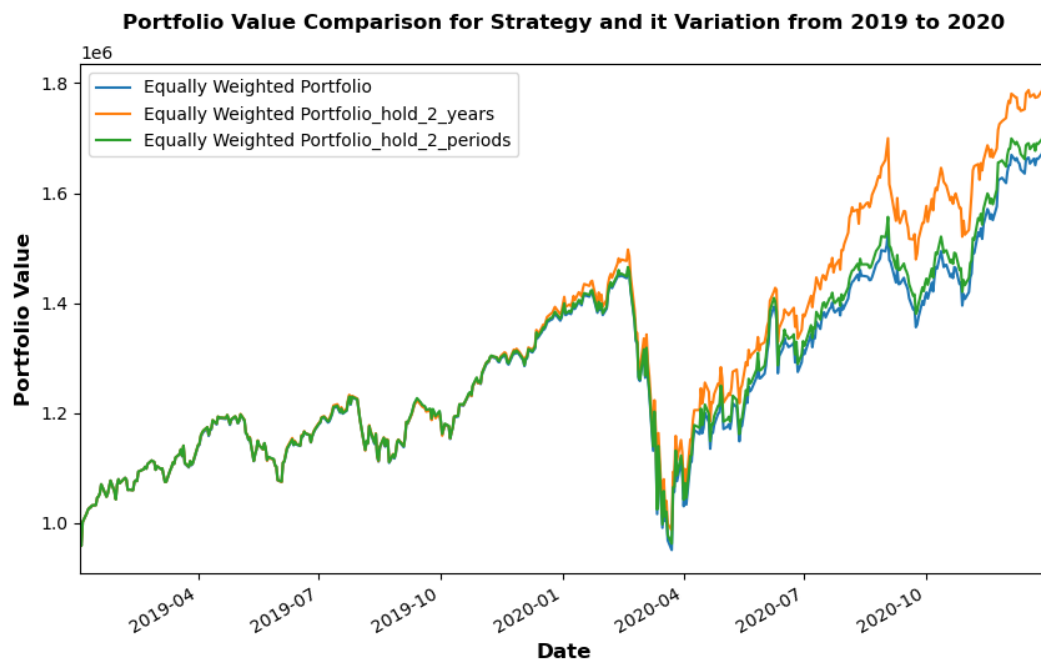


Figure 4.1: Variation Comparison for Strategy 2

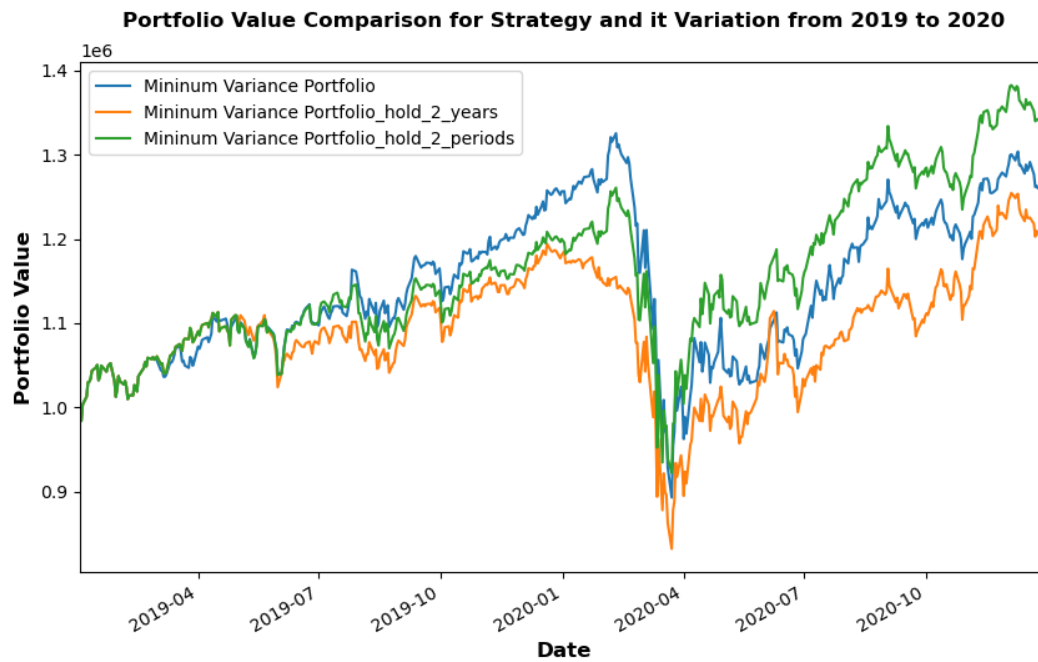


Figure 4.2: Variation Comparison for Strategy 3

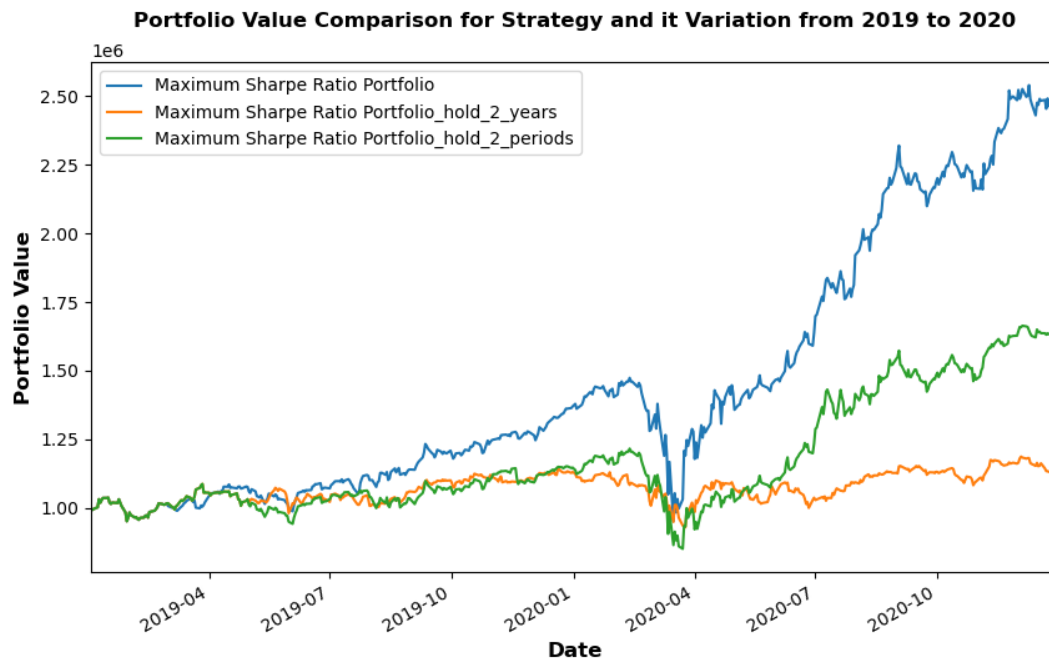


Figure 4.3: Variation Comparison for Strategy 4