Report

Project: 0261 Project 4

2024

Contents

Important Note

This project is for educational purposes only.
This is not a financial guide and should not be seen as such.
The authors are not and will not be responsible for any damage done by using
this information.

0.1 Project Information

This project consists of scraping and gathering financial information. The information was used for defining, creating and comparing backtesting strategies. Some of those strategies were used on a forward testing analysis.

Web Scraping

Sources used to gather information.

- Wikipedia.

    (DJI) Dow Jones Industrial Average.

- Yahoo Finance.
    Closing Prices.

The Following Process was done:

- Gathering information for the DJI Average and constituents.

- Normalizing unicode strings and getting ticker symbols.

- Getting and selecting constituent prices.

- Saving desired information.

    Used a CSV Format.

0.2 EDA

Closing Stock Price with return.
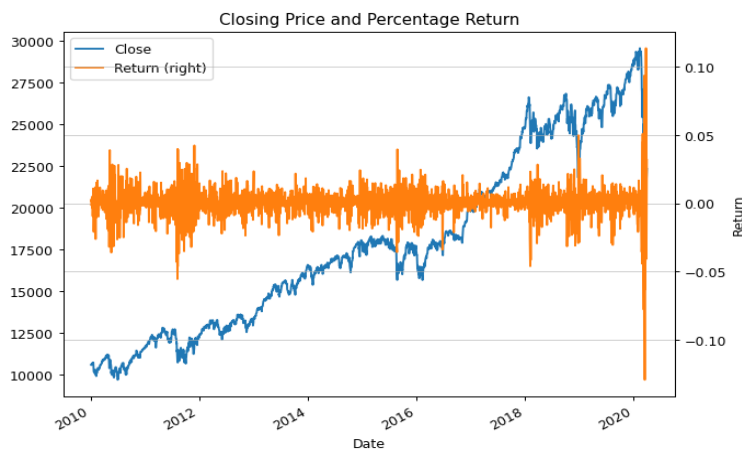
0.3 Backtesting Strategies

Backtesting

Several backtesting strategies were defined and created. Performance was measured using annualized risk and return.

0.3.1 Backtesting Strategies

- Fitting Period: 2017-2018

- Forward Testing Period: 2019

| Strategy	Position	Description
Buy_and_Hold		Initially investing into DJI and doing nothing
Simple_Momentum	Long	+1 If today's return is +
	Short	-1 If today's return is -
Simple_Contrarian	Long	-1 If today's return is +
	Short	+1 If today's return is -
Short_Neutral	Long	+1 If today's return is -
	Short	0 If today's return is +
Simple_1_percent	Long	+1 If today's return is $<=$ to 1%
	Short	-1 If today's return is $>=$ to 1%
SMA_Crossover_Momentum	Long	+1 If Today's SMA50 $>$ SMA200
	Short	-1 If Today's SMA50 $<$ SMA200
SMA_Crossover_Contrarian	Long	+1 If Today's SMA50 $<$ SMA200
	Short	-1 If Today's SMA50 $>$ SMA200

Backtesting Results

For most of the strategies, the risk was almost the same, around 16.7 %.
Neutral Short Selling had the lowest risk with around 12.53 %.
The lowest return was negative for strategy SMA50_sub_SMA200_df08 (-2.28%). The
highest return was for strategy Buy_or_Short_1Percent_df05 (18.42 %).

Backtesting Strategies Risk and Return

|	Return	Risk
Buy_and_Hold	0.087212	0.167896
Simple_Contrarian_df03	0.057966	0.167946
Neutral_Short_Selling_df04	0.072152	0.125301
Buy_or_Short_1Percent_df05	0.174262	0.167659
SMA50_sub_SMA200_df08	-0.022887	0.167655
SMA50_sub_SMA200_contr_df09	0.022887	0.167655

5
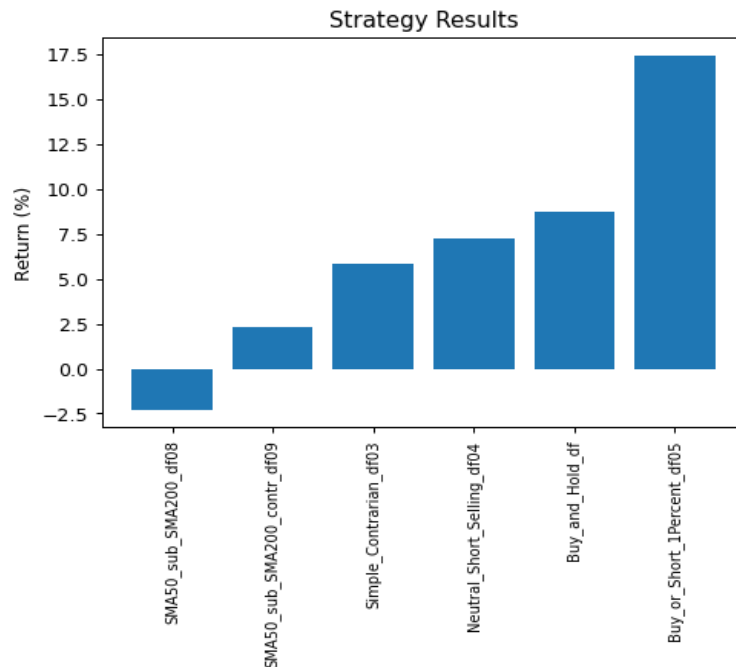
0.4   Index Tracking

0.4.1   EDA

Using previous information along with the tracking indices to compare stocks.

Notes: Normalization was performed to be able to compare stocks. The common value used was 100. Apple (AAPL) was the highest performing stock and was dropped to compare the other stocks. Visa (V) Was the second stock with highest return with a risk similar to Apple.
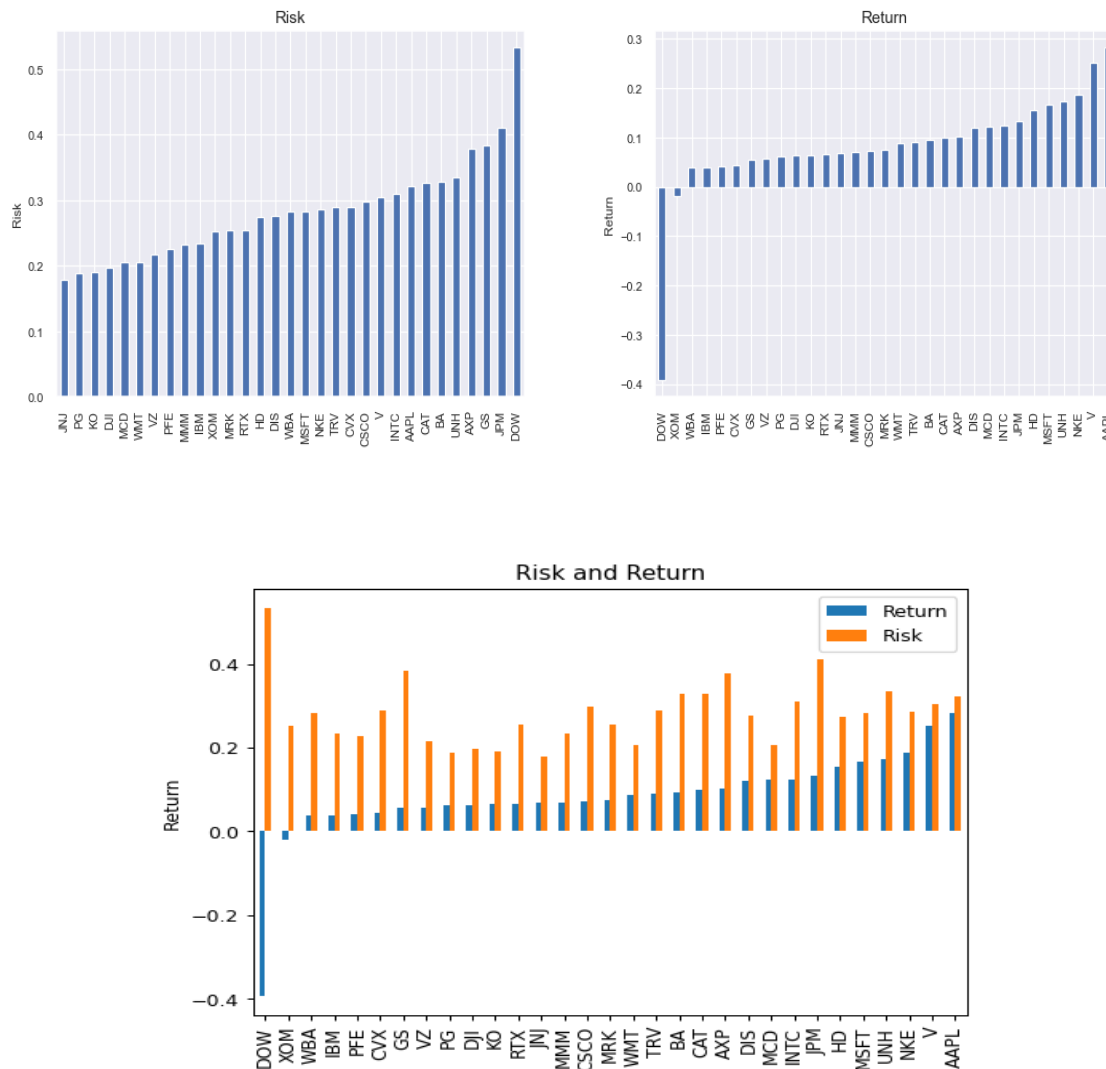
0.5 Stock Information with Ticker Symbols

| ticker	Company
AAPL	Apple Inc.
AXP	American Express
BA	Boeing
CAT	Caterpillar Inc.
CSCO	Cisco Systems
CVX	Chevron Corporation
DIS	The Walt Disney Company
GS	Goldman Sachs
HD	The Home Depot
IBM	IBM
INTC	Intel
JNJ	Johnson Johnson
JPM	JPMorgan Chase
KO	The Coca-Cola Company
MCD	McDonald's
MMM	3M
MRK	Merck Co.
MSFT	Microsoft
NKE	Nike
PFE	Pfizer
PG	Procter Gamble
RTX	Raytheon Technologies
TRV	The Travelers Companies
UNH	UnitedHealth Group
V	Visa Inc.
VZ	Verizon
WBA	Walgreens Boots Alliance
WMT	Walmart
XOM	ExxonMobil
DJI	Down Jones

## 0.5.1 Tracking Stock Selection

Selection of the 10 tracking stocks with the lowest Tracking Error.

- 'DJI'
- 'MMM'
- 'JPM'
- 'PFE'
- 'V'
- 'AXP'
- 'RTX'
- 'KO'
- 'HD'
- 'XOM'
- 'TRV'

0.5.2 Tracking Portfolios

Creation of portfolio of 10 stocks with the lowest Tracking Error. This portfolio showed that it tries to track the Dow Jones Index. It is not perfect, but it is close and can be improved by weight optimization.
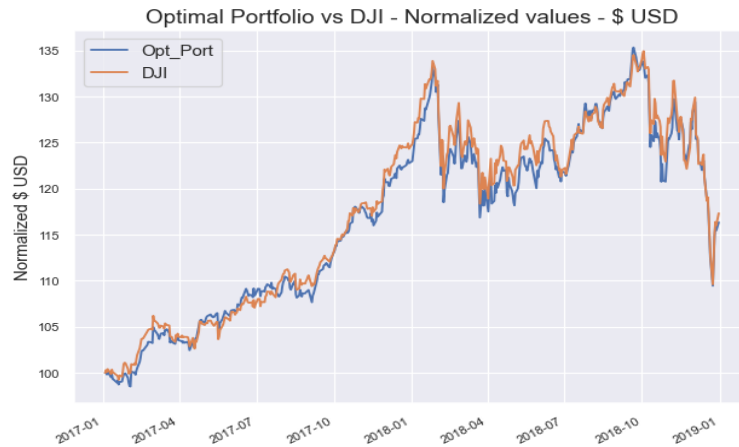
Equal Weighted Portfolio
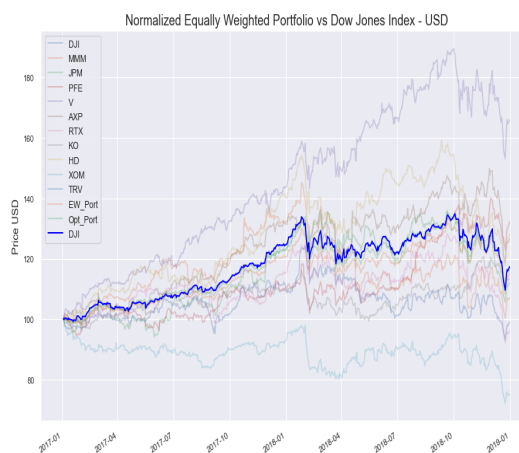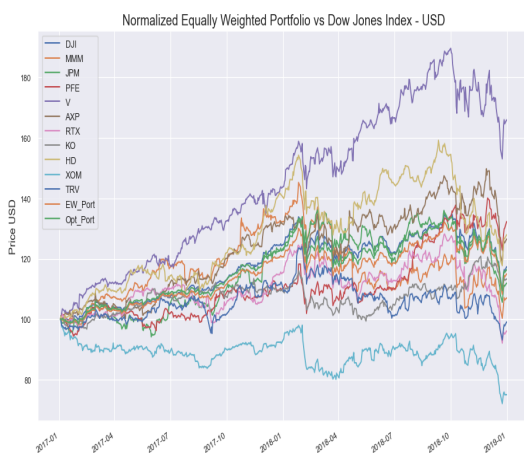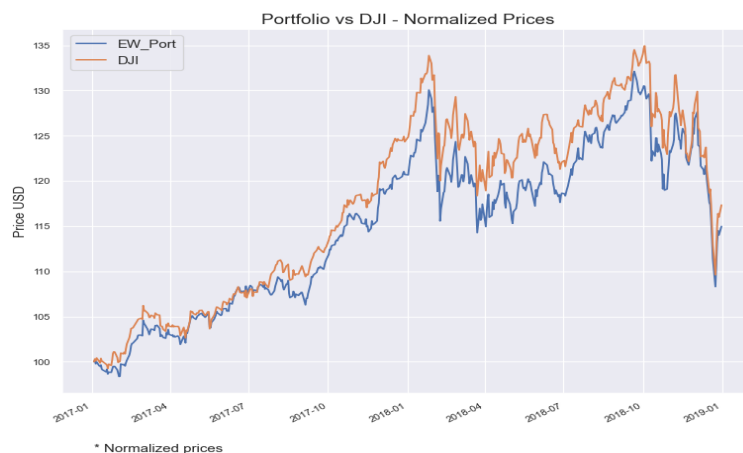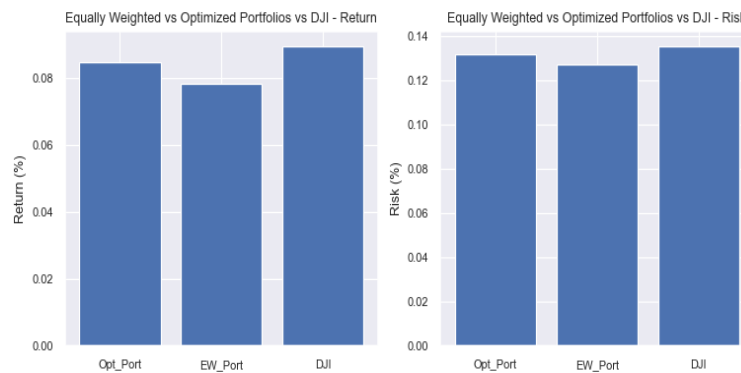
0.5.3 Portfolio Optimization

Performed optimization techniques to minimize the Tracking Error of this portfolio. Using SciPy "SLSQP" optimizer method to minimize the tracking error.

Equally Weighted Portfolio (Optimized)

Optimal Portfolio vs DJI - Normalized values - $ USD

0.5.4 Strategy Comparison

|	Return	Risk
Opt_Port	0.084879	0.131867
EW_Port	0.078256	0.127138
DJI	0.089562	0.135206

0.6   Forward Testing

Forward testing process.

- Fitting the optimized portfolio on the training set.

- Testing the trained portfolio on unseen data using the test set.

For verification purposes the (Annualized) Tracking Error was calculated during the training period, to see if the code was working correctly.

The (Annualized) Tracking Error for the training set was 3.79% The Annualized Tracking Error for Forward Testing was 4.78%

Note: A higher T.E. is frequent on forward testing for data that the model has not seen before.

Portfolio vs DJI - Normalized Prices

* Normalized prices
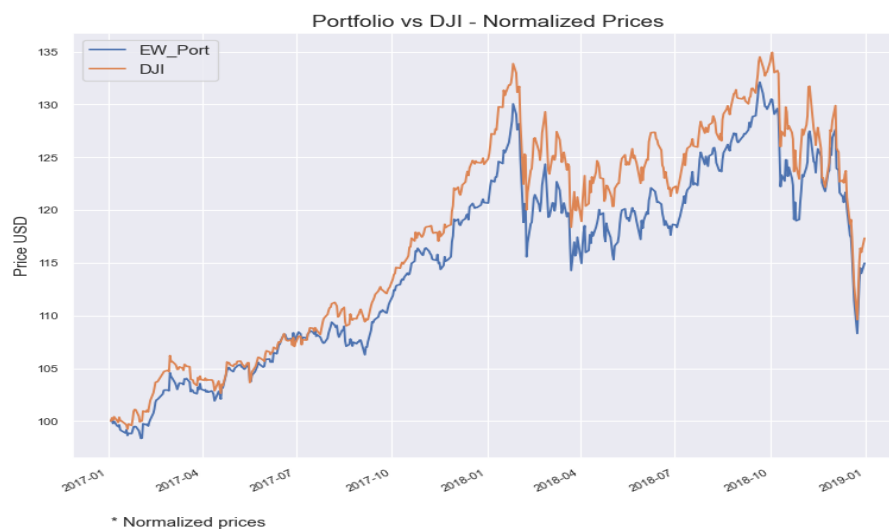
Both charts still move closely together. The Tracking Error is slightly higher.

To see if the optimized portfolio works and performs well with new unseen data. For this the following process will be done. Randomly generated portfolios with randomly generated weights will be created and compared against the optimized portfolio using Tracking Error as the metric. If the portfolio tracks the index better than the vast majority of random portfolios will indicate that the method to create the tracking portfolios works with new data as well.

Random Portfolio Creation Process and Comparison:

- Create several portfolios by choosing 10 random stocks and generating random weights to them.

    The amount of randomly generated portfolios was 10,000.

- Calculate the Tracking Error for each Portfolio generated.

- Verify whether the Tracking Error of each of the randomly generated portfolios is lower than the forward tracking error.

- Calculate the mean of the tracking errors of the randomly generated portfolios.

0.7   Forward Testing Result

6.55% of the random portfolios performed better than the tracking portfolio by having a lower tracking error.
This is a strong indication that the tracking portfolio has superior abilities to track the index. This is not random 6.5% is not too bad for the small sample.
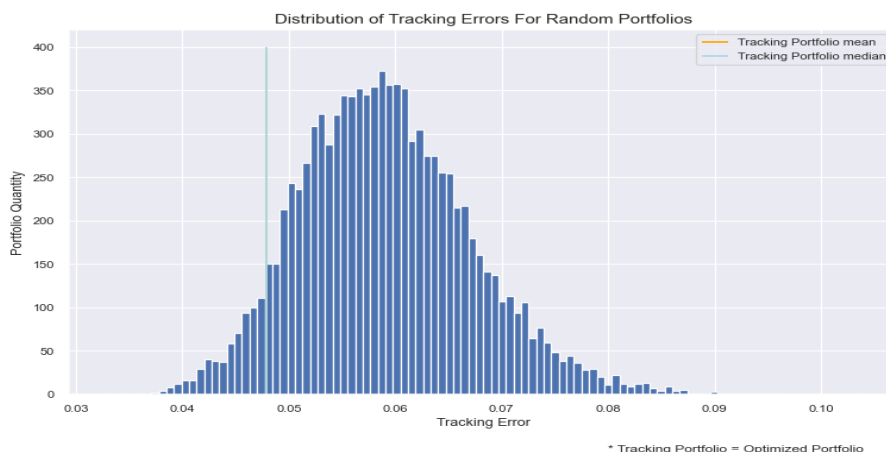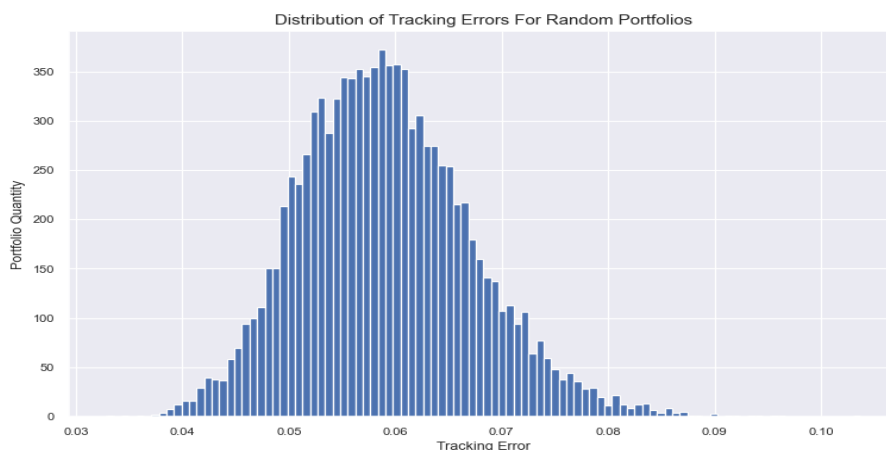
0.8   Conclusion

6.55% of the 1000 random portfolios created were better than the tracking portfolio using the optimization to minimize the Tracking Error, meaning that the resulting 93.45% of the random portfolios have a worse tracking error than the tracking portfolio The Optimized

portfolio performed better than 93% of the randomly generated portfolios with random indexes and random weights.

	Return	Risk
Buy_and_Hold	0.087212	0.167896
Simple_Contrarian_df03	0.057966	0.167946
Neutral_Short_Selling_df04	0.072152	0.125301
Buy_or_Short_1Percent_df05	0.174262	0.167659
SMA50_sub_SMA200_df08	-0.022887	0.167655
SMA50_sub_SMA200_contr_df09	0.022887	0.167655

0.8.1 Backtesting Strategies Risk and Return

The best result obtained was by using the following strategy:

- Using the an equal weight portfolio of 10 of the lowest Tracking Error stocks.

- Performing optimization by minimizing the Tracking Error using the Quadratic Optimization "SLSQP" on equally distributed weights and setting the respective boundaries.

Only a small sample of 6.5% of the 10,000 portfolios had superior (a lower Tracking Error) than the optimized portfolio.

Conclusion: The tracking portfolio has superior abilities to track the index on 93% of the cases out of 10,000 randomly generated portfolios.