Asset Allocation Strategy Project

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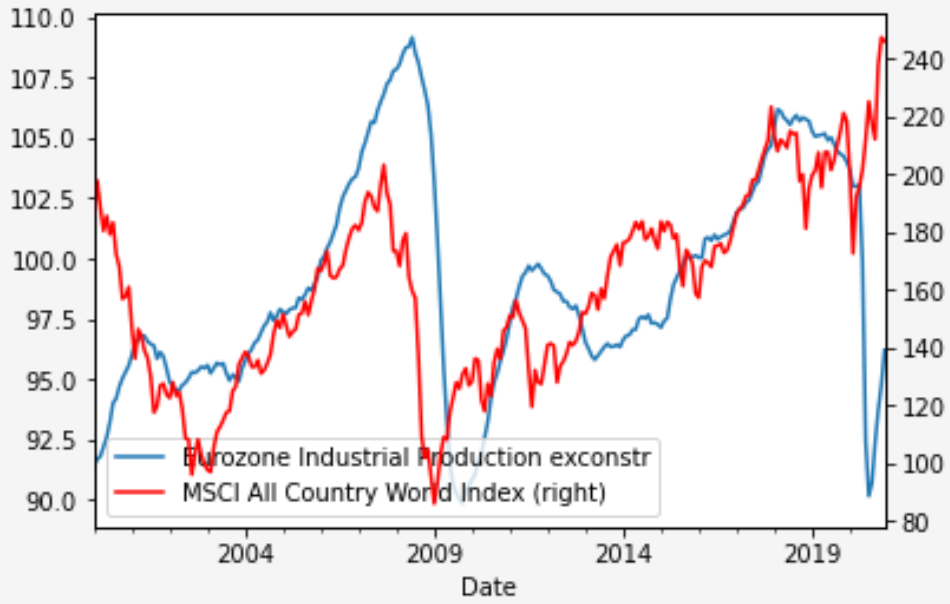
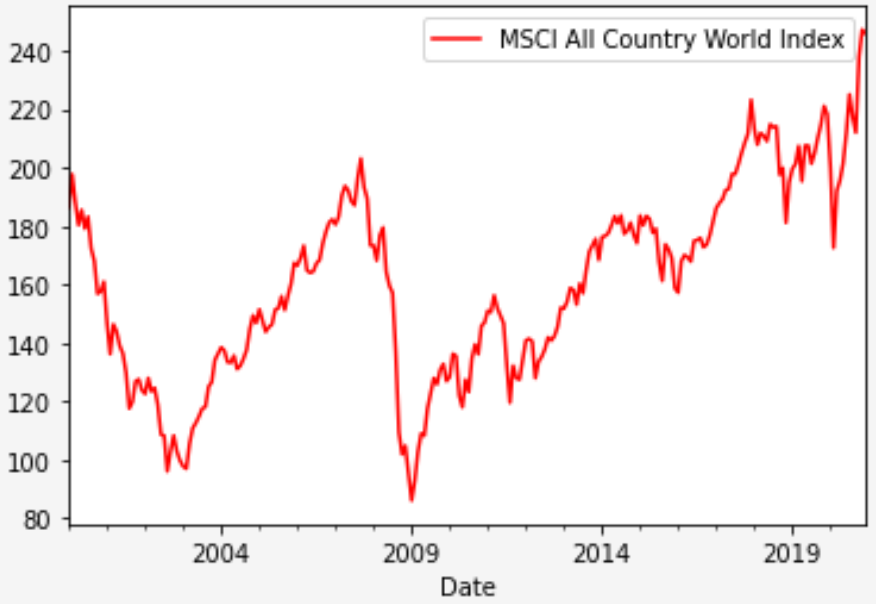
Outline

- Project Goal
- Steps
- Strategy Backtesting and portfolio performance evaluation
- Conclusions
- Further Steps

Project Goal

- Optimal asset allocation is a common problem within asset management
- The goal of the asset allocation strategy is to decide whether we should be long(buy), neutral(no position) or short(sell) on equity markets over the next month.





Steps

- Exploratory data
- Feature Selection
- Feature Engineering
- Machine Learning Index Forecasting Asset Allocation Strategy
- Strategy Backtesting and Portfolio Performance evaluation
- Conclusions
- Further steps

Data set

Monthly multivariate feature set (Jan 2000 – Dec 2020) , including various indicators (economic, technical, sentiment etc.) that are considered drivers of global equity market.

MSCI All Country World Index (widely used index of global equity markets).

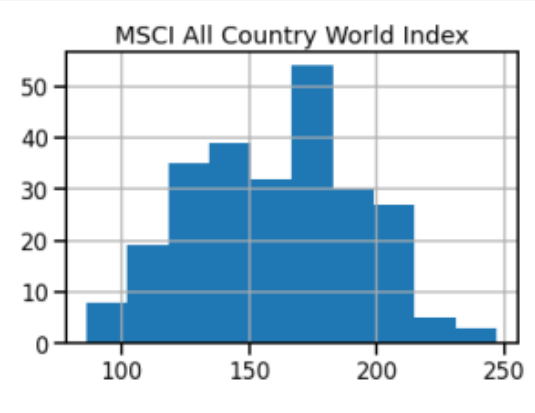
Date	Cycle Indicator Global	Eurozone Retail Sales	Eurozone Industrial Production exconstr	Eurozone Industrial Production manuf	US Privately Owned Housing Starts	US HomeBuilders Market Index	US Real Personal Income	US Real Personal Income exTrans	US Indus Prod Index	Adv Retail Sales US exFood Services	...	Sentiment Consumer Sentiment Global News Social	Sentimer Economi Growt Globa New Soci
2000-01-31	0.798597	89.828825	91.393553	89.570414	-1.528411	71.025769	9198.923425	8025.951006	90.558830	243994.941514	...	0.897155	1.35951
2000-02-29	0.809702	90.020590	91.681109	89.778867	-2.920293	70.446978	9260.602446	8085.365005	90.911650	245984.386795	...	0.804153	1.49054
2000-03-31	0.851096	90.300421	91.800792	89.842048	-0.943067	69.747841	9310.316033	8133.660718	91.258950	248540.847711	...	0.597958	1.40121
2000-04-30	0.879508	90.500301	92.200566	90.258606	-2.445048	68.105601	9358.568595	8177.786227	91.605907	251236.034079	...	0.746670	1.02711
2000-05-31	0.867909	90.843072	92.600404	90.699004	-0.403605	66.646858	9401.148996	8209.447305	92.021905	252200.595771	...	0.535569	0.64508
...	...	...	...	...	...	...	...	...	...	...	...	...	.
2020-08-31	-0.623177	106.079433	90.708823	90.776251	6.476332	59.745073	17734.181766	13836.212114	93.137959	457509.381284	...	0.162074	-0.51052
2020-09-30	-0.464127	108.171024	92.363302	92.497322	4.740237	64.960766	17733.874404	13743.151510	93.924942	464758.700917	...	0.169350	-0.45644
2020-10-31	-0.349857	109.265017	93.716845	93.840945	7.014455	70.114833	17713.399146	13878.593936	94.404073	473016.500655	...	0.218693	-0.30788
2020-11-30	-0.296449	110.417869	94.769032	94.943532	9.267468	74.367738	17638.382533	13946.995668	95.044452	480067.500468	...	0.255090	-0.15038
2020-12-31	-0.227275	109.669907	96.206451	96.388237	10.876763	78.834099	17583.283809	13978.311192	95.649151	483848.214620	...	0.187261	-0.16438

252 rows × 60 columns

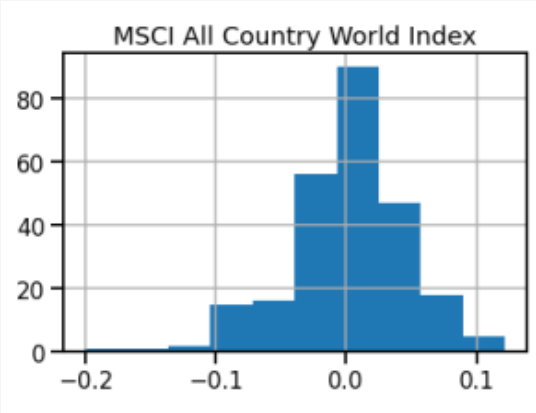
Exploratory Data Analysis

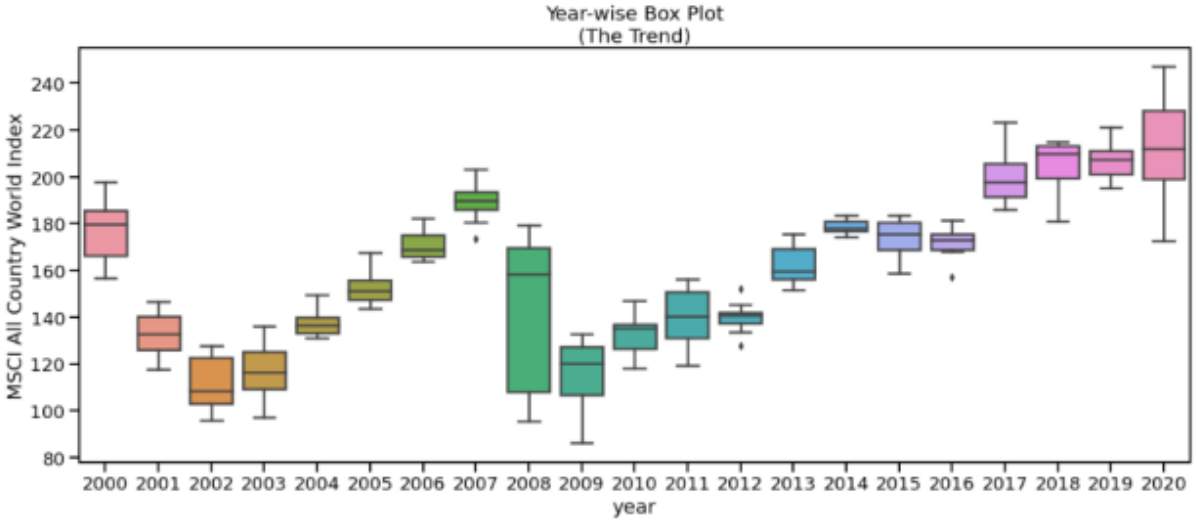
Insight	Significance test	Transformation
Skewed data		Feature Engineering
Structural breaks	Chow Test	Data Split
Seasonality		

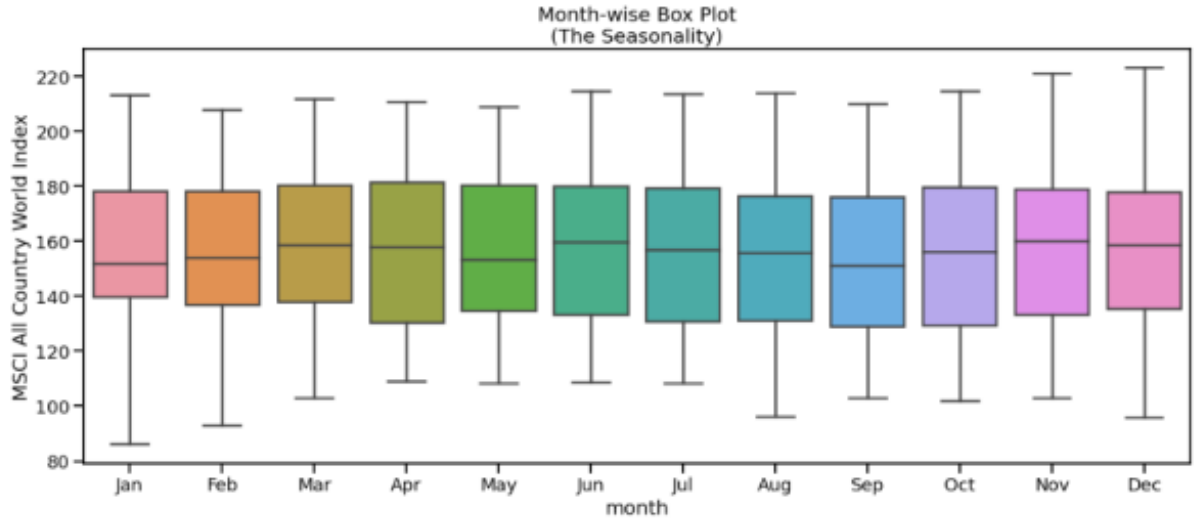
Index Value



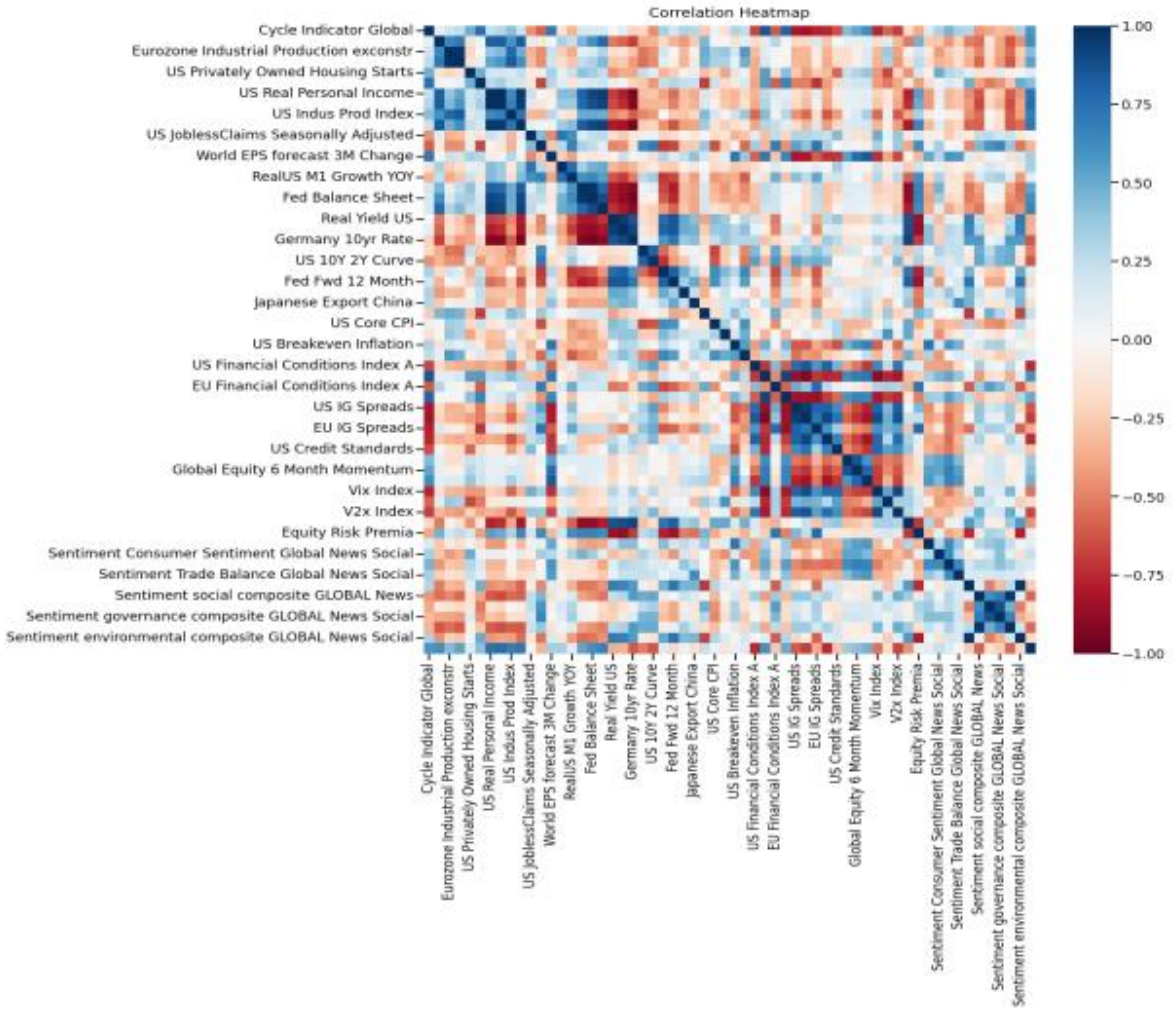
Index percent change, %







Feature Selection



Feature 1	Feature 2	Correlation Coefficient
US Real Personal Income	US Real Personal Income exTrans	0.993794
Eurozone Industrial Production manuf	Eurozone Industrial Production exconstr	0.984108
Sentiment environmental composite GLOBAL News	Sentiment environmental composite GLOBAL News Social	0.972994
Fed Balance Sheet	FED Excess Reserves	0.971247

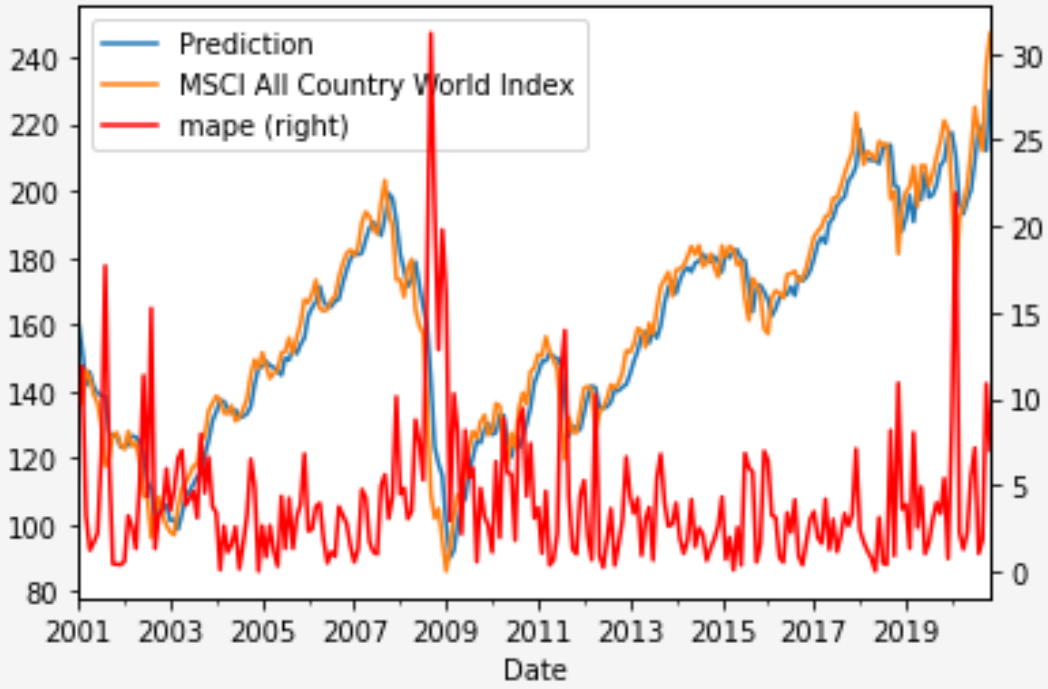
Feature Importance

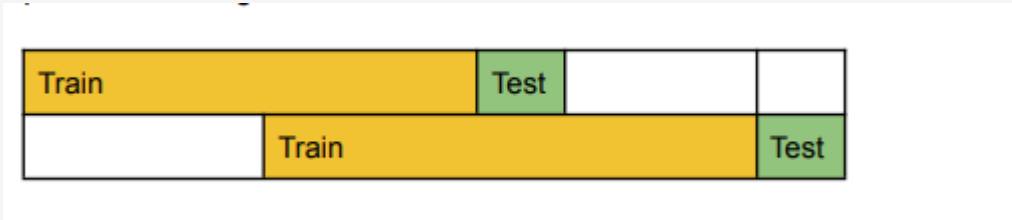
- Boruta Algorithm Feature Importance

period 2000 - 2003	period 2003-2009	period 2009-2020
US Financial Conditions Index A	EU 10Y 2Y Curve	US Financial Conditions Index A
EU IG Spreads	EU HY Spreads	Cycle Indicator Global
Equity Risk Premia	Fed Fwd 6 Month	ECB Balance Sheet
Eurozone Retail Sales	Inflation Surprise Global	EU HY Spreads
Fed Balance Sheet	RealUS M1 Growth YOY	Eonia Spread
Fed Fwd 6 Month	Sentiment Macro Fundamentals Global News Social	Fed Balance Sheet
Global Equity 12 Month Momentum	US 10Y 2Y Curve	Fed Fwd 6 Month
Real Yield US	US JoblessClaims Seasonally Adjusted	Sentiment Macro Fundamentals Global News Social
US 10Y 2Y Curve	US M1 Growth YOY	US HomeBuilders Market Index
US HY Spreads	US U6 Unemp Rate	US IG Spreads
US JoblessClaims Seasonally Adjusted	Vix Index	US Real Personal Income
World EPS forecast 3M Change	World EPS forecast 3M Change	V2x Index

Modeling

- Regression model
- Metrics: MAPE
- Random Forest



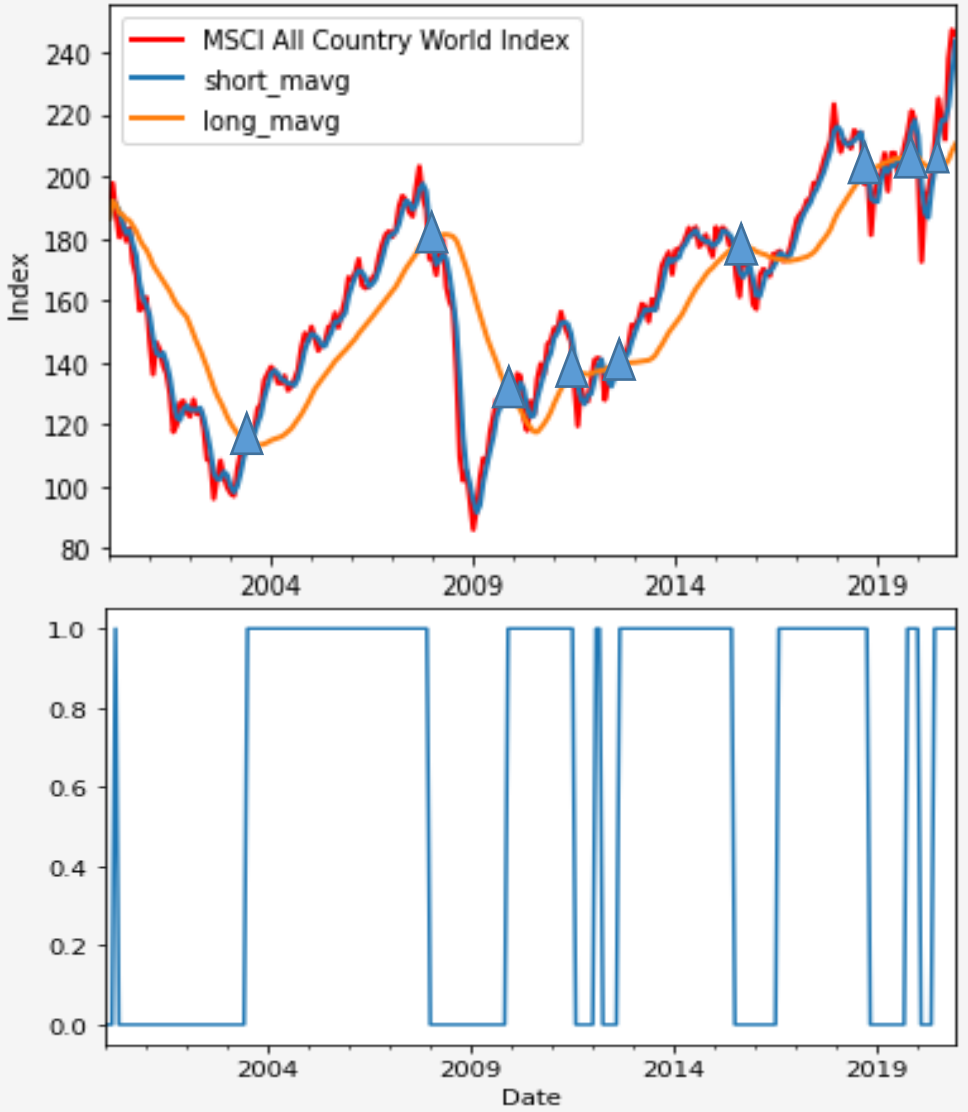


Asset Allocation Strategy

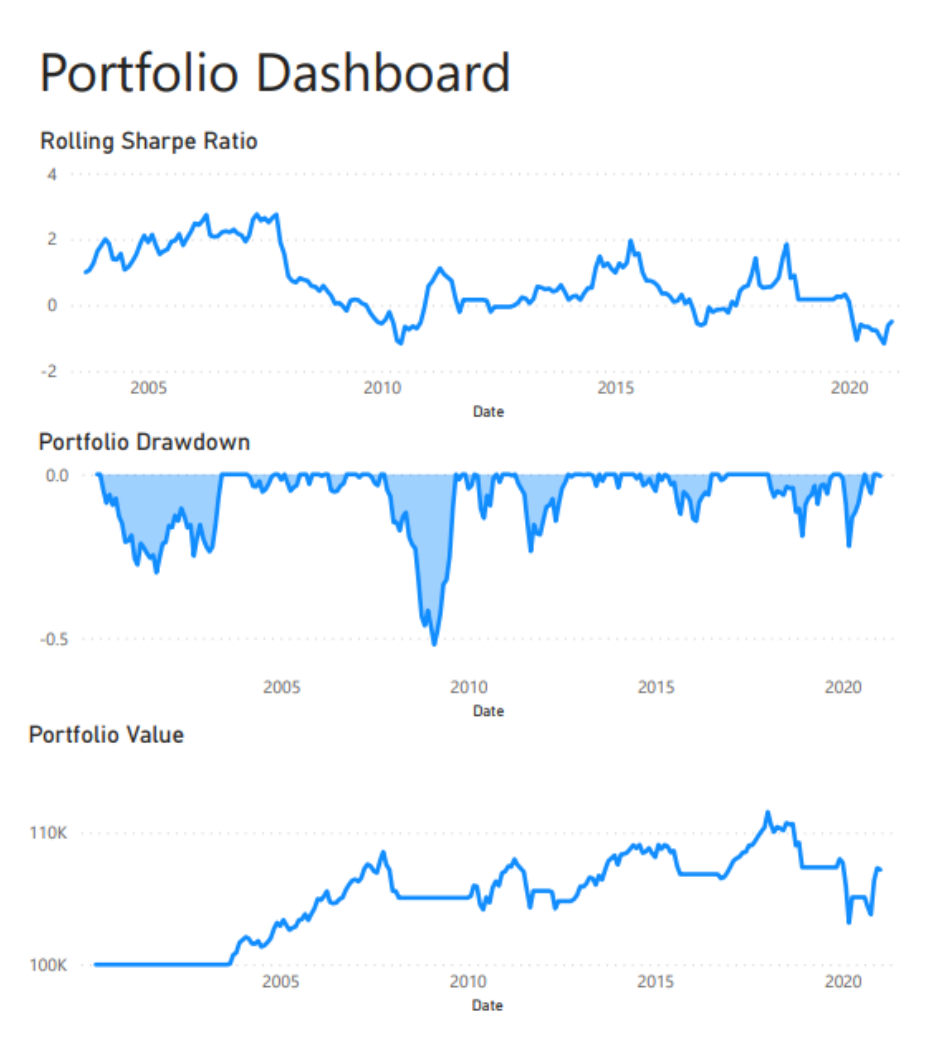
As an asset allocation strategy moving average crossover is implemented.

The predicted index value is used for calculating the moving averages for the next month and create buy/hold/sell signal depending on the moving averages (long moving average < short moving average = sell signal, short < long = buy signal, the rest is hold).

Backtesting of buy/hold/sell signal using historical index value, calculating returns and portfolio metrics are done and reported to Html file.



Strategy Backtesting and portfolio performance evaluation



- Portfolio performance evaluation shows that model based on predicted values outperforms the model based on real historical index values
- Portfolio performance is poor in terms of total return 7.6%
- Sharpe ratio of 0.21 is reasonable
- Maximum Drawdown 52% is acceptable

Performance Metrics	Values
Annualized sharpe_ratio	0.21
Maximum Drawdown, %	-52.04
Largest Monthly Gain, %	2.49
Largest Monthly Loss, %	-2.6
Total Return, %	7.32

Conclusions

- Information in the features can be used for one-month ahead prediction with MAPE = 4.1% for the data timeframe.
- Highly correlated features like Fed Balance Sheet/Fed Excess Reserves can be replaced with one feature
- Features that are important for index prediction are different for different periods (for example, Fed Balance Sheet after 2008 crisis), that is why the sliding training data is used to retrain the model.
- Moving average crossover asset allocation model was implemented using index prediction one month ahead to predict moving averages crossover
- Portfolio performance evaluation shows that model based on predicted values outperforms the model based on real historical index values. Overall the portfolio performance is poor in terms of total return (7.6%), sharpe ratio (0.21), and drawdown (-52%). The benchmarking with buy and hold strategy should be done for more precise evaluation.

Further Steps

- Feature Engineering (lagged data, aggregated and averaged data, difference economic periods/cycles, previous index price information)
- ML model tuning and optimization (historical index data used for training, recent data has higher weights than older data)
- Testing other algorithms like QRF, ANN and in combination with Time Series Algorithms
- Strategy optimization in terms of long and short windows based on portfolio performance metrics
- Testing and benchmarking different buy/sell strategy