PORTFOLIO OPTIMIZATION

NYC DATA SCIENCE ACADEMY

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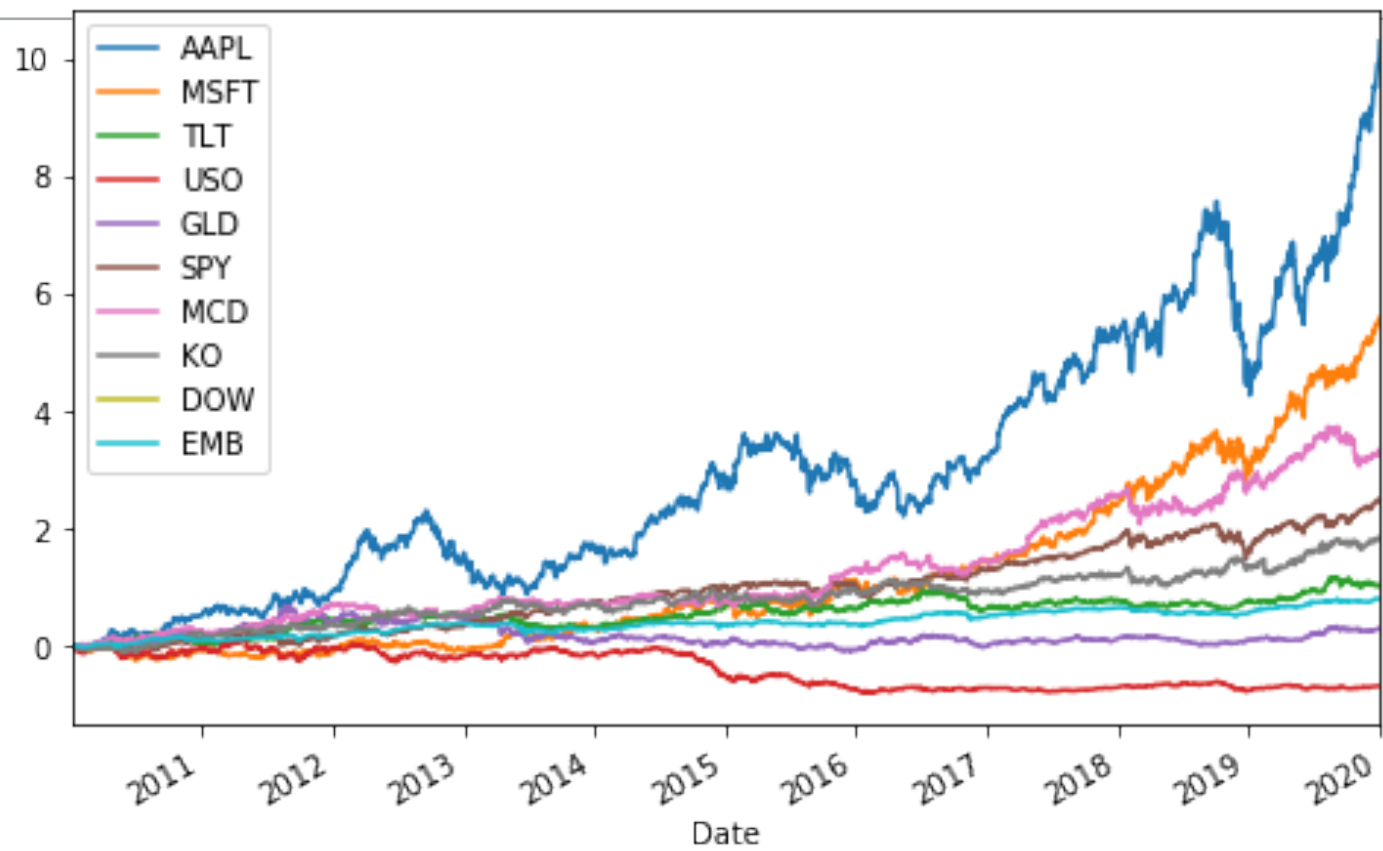
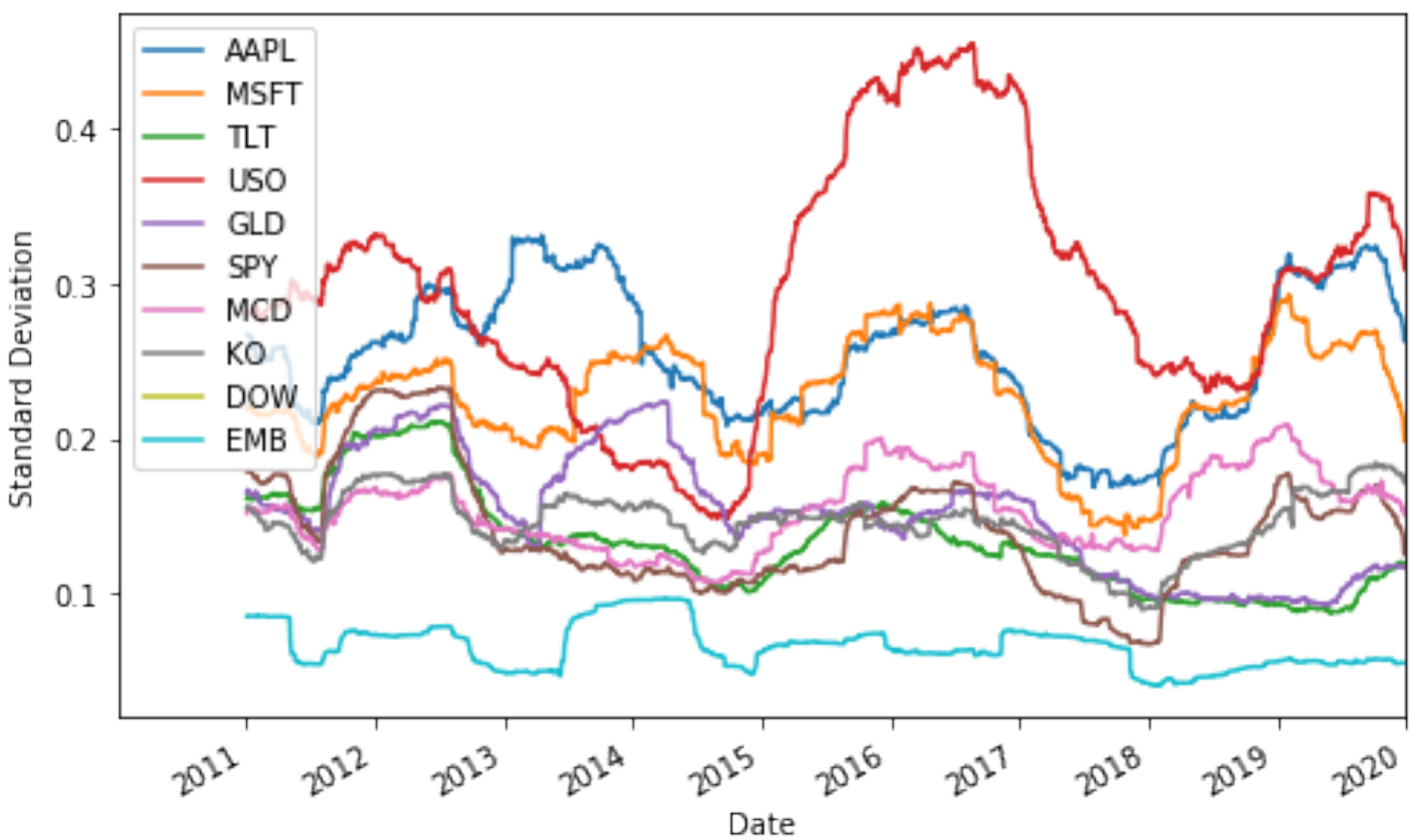
SCRAPING & PROCESSING THE DATA

- Historical price data was scraped from Yahoo Finance for each portfolio component and merged into a pandas DataFrame.

Normalized Returns



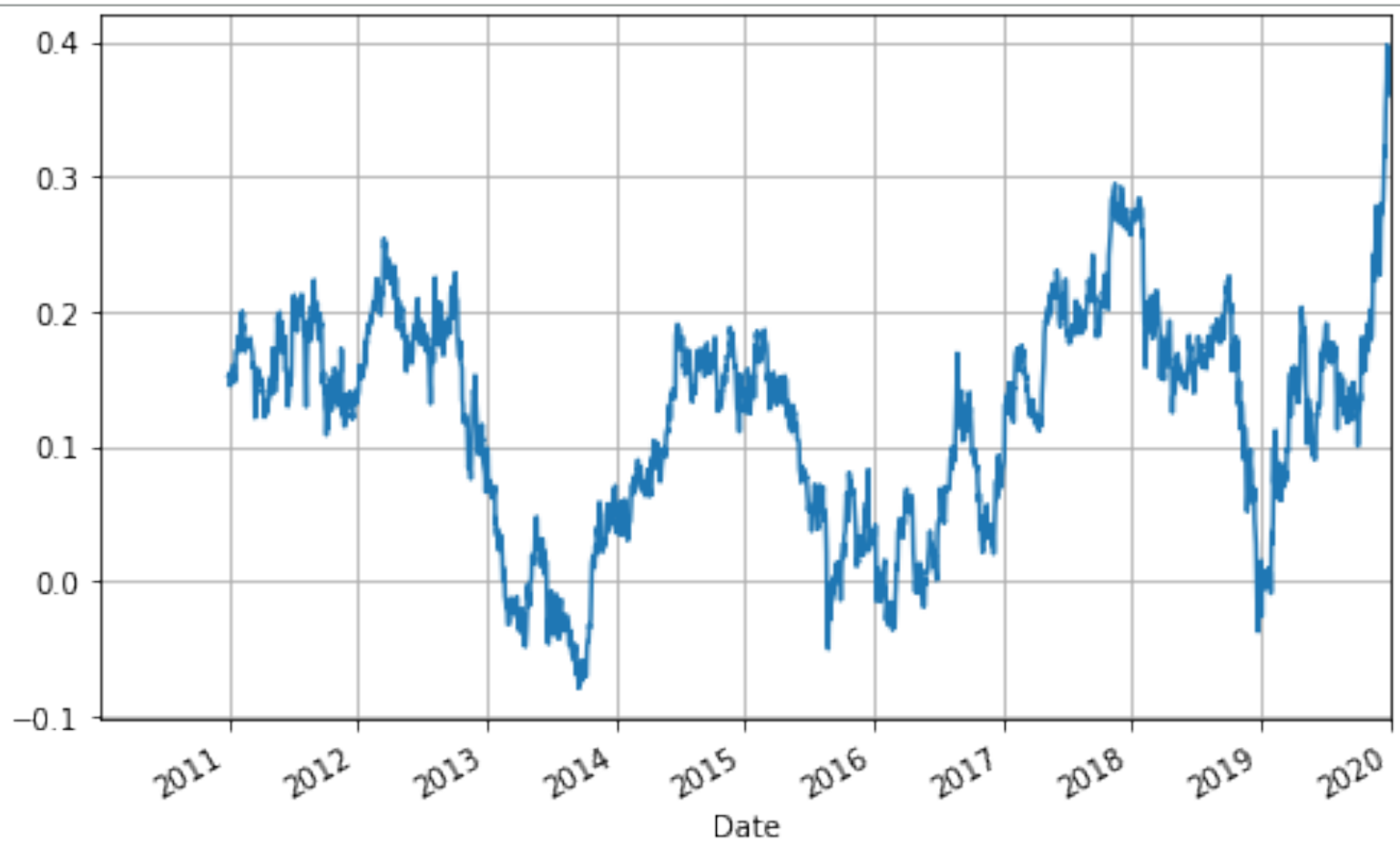
Rolling Annualied Volatility (StDev)



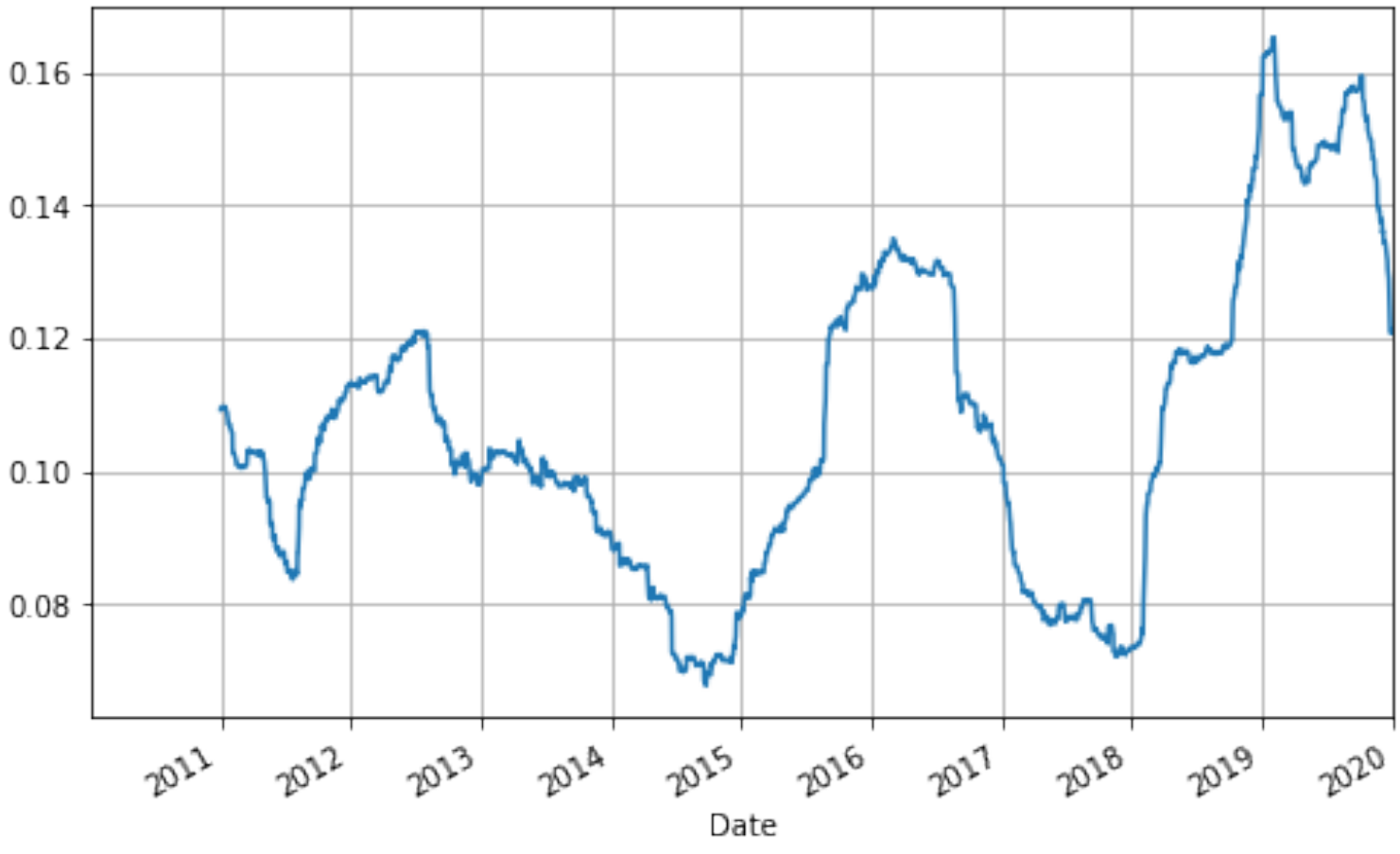
EQUAL-WEIGHT PORTFOLIO

- Each component bears the same weight (10%)
- Weights sum to 100%
- Sharpe Ratio = 0.85x

Rolling 12-month Portfolio Return



Rolling 12-month Portfolio Volatility



MODERN PORTFOLIO THEORY

- Quantitative framework founded by Harry Markowitz in the 1950s
- Replaced the investment world's reliance on judgement with statistical and mathematical models
- Statistical models applied to portfolio theory rest on the assumption returns of securities are normally distributed

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Variance-Covariance Matrix

	AAPL	MSFT	TLT	USO	GLD	SPY	MCD	KO	DOW	EMB
AAPL	0.000264	0.000107	-0.000036	0.000073	1.660224e-06	0.000089	0.000047	3.924482e-05	0.000128	0.000016
MSFT	0.000107	0.000205	-0.000034	0.000069	-3.584175e-06	0.000092	0.000054	4.985927e-05	0.000085	0.000016
TLT	-0.000036	-0.000034	0.000075	-0.000048	1.783659e-05	-0.000039	-0.000018	-1.782238e-05	-0.000074	0.000002
USO	0.000073	0.000069	-0.000048	0.000372	2.842768e-05	0.000075	0.000033	3.480493e-05	0.000153	0.000022
GLD	0.000002	-0.000004	0.000018	0.000028	9.565472e-05	-0.000002	-0.000003	5.623346e-07	-0.000042	0.000008
SPY	0.000089	0.000092	-0.000039	0.000075	-1.529189e-06	0.000086	0.000048	4.854540e-05	0.000086	0.000015
MCD	0.000047	0.000054	-0.000018	0.000033	-2.926633e-06	0.000048	0.000097	3.964714e-05	-0.000005	0.000010
KO	0.000039	0.000050	-0.000018	0.000035	5.623346e-07	0.000049	0.000040	8.748232e-05	0.000030	0.000011
DOW	0.000128	0.000085	-0.000074	0.000153	-4.184026e-05	0.000086	-0.000005	3.008251e-05	0.000436	0.000009
EMB	0.000016	0.000016	0.000002	0.000022	8.067670e-06	0.000015	0.000010	1.106848e-05	0.000009	0.000018

Correlation Matrix

	AAPL	MSFT	TLT	USO	GLD	SPY	MCD	KO	DOW	EMB
AAPL	1.000000	0.345757	-0.289745	0.271615	0.102485	0.533544	0.326052	0.277079	0.399375	0.217038
MSFT	0.345757	1.000000	-0.349523	0.315310	0.048433	0.645896	0.394895	0.397323	0.498756	0.208150
TLT	-0.289745	-0.349523	1.000000	-0.351570	0.105755	-0.573996	-0.321182	-0.364761	-0.471714	-0.044919
USO	0.271615	0.315310	-0.351570	1.000000	0.292684	0.526174	0.309505	0.327834	0.471904	0.256251
GLD	0.102485	0.048433	0.105755	0.292684	1.000000	0.071320	0.031175	0.019606	0.107591	0.181706
SPY	0.533544	0.645896	-0.573996	0.526174	0.071320	1.000000	0.594823	0.618375	0.784864	0.358728
MCD	0.326052	0.394895	-0.321182	0.309505	0.031175	0.594823	1.000000	0.487397	0.422448	0.255594
KO	0.277079	0.397323	-0.364761	0.327834	0.019606	0.618375	0.487397	1.000000	0.437023	0.253736
DOW	0.399375	0.498756	-0.471714	0.471904	0.107591	0.784864	0.422448	0.437023	1.000000	0.299960
EMB	0.217038	0.208150	-0.044919	0.256251	0.181706	0.358728	0.255594	0.253736	0.299960	1.000000

MONTE CARLO SIMULATION

- Generate vectors of random portfolio weights on a larger scale.
- Record return and variance for all portfolio simulations
- Analyze the simulations that generated an optimal risk-reward relationship

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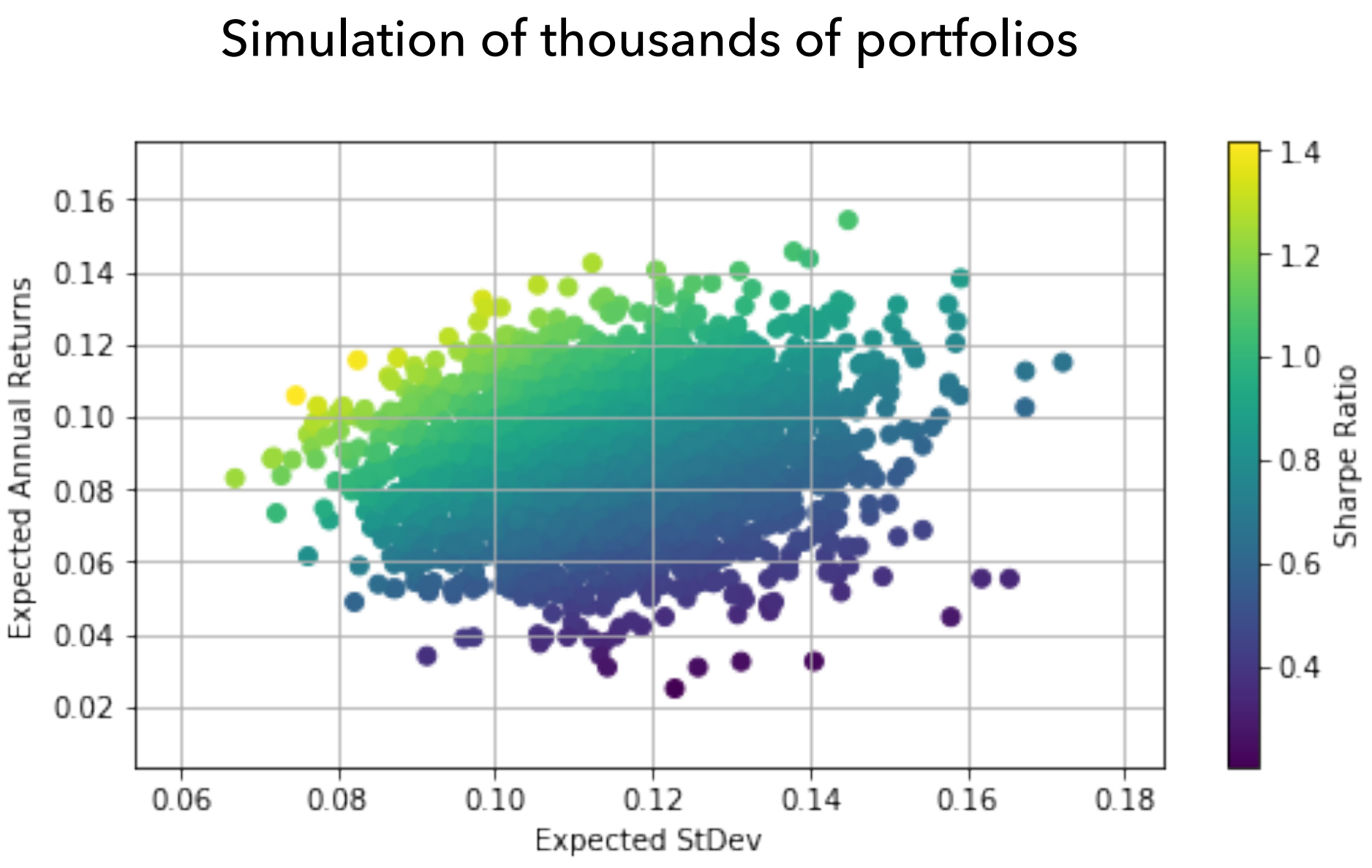
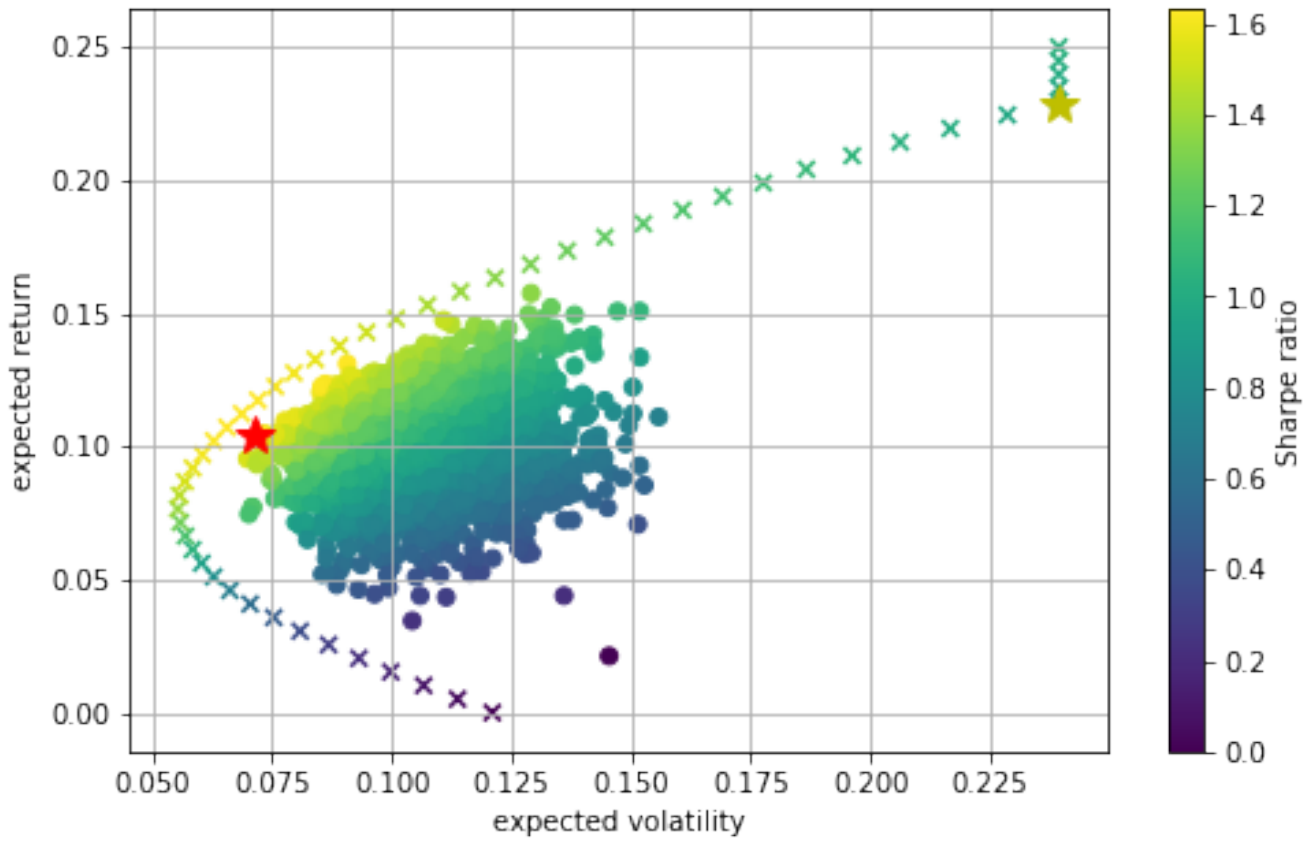


EFFICIENT FRONTIER

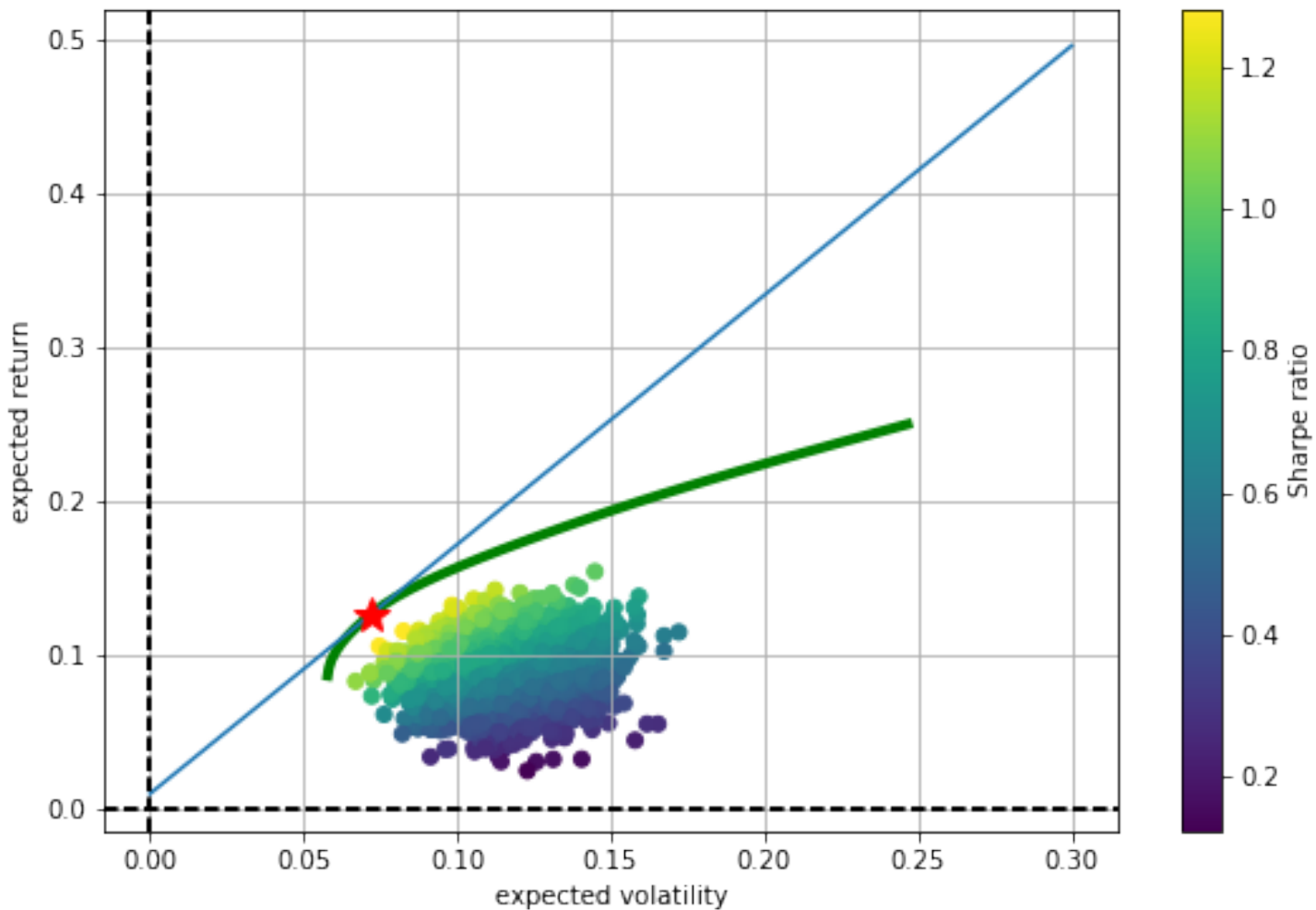
- Fix a target return level and derive for each such level those portfolio weights that lead to the minimum volatility value.

- For the optimization, this leads to two conditions: 1.) target return level 2.) sum of portfolio weights.

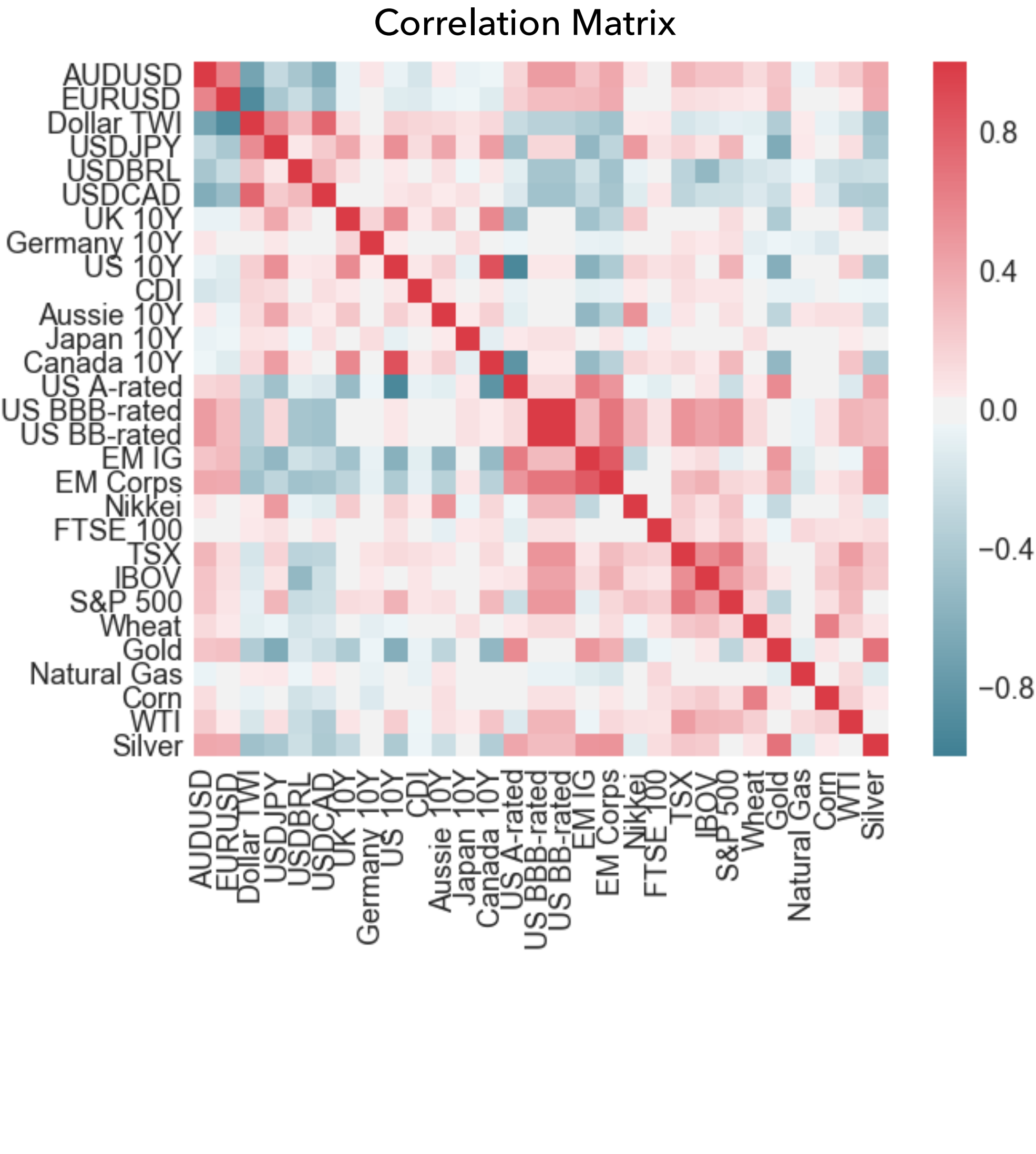
Method 1 - Maximize Sharpe



Method 2 - Minimize Variance

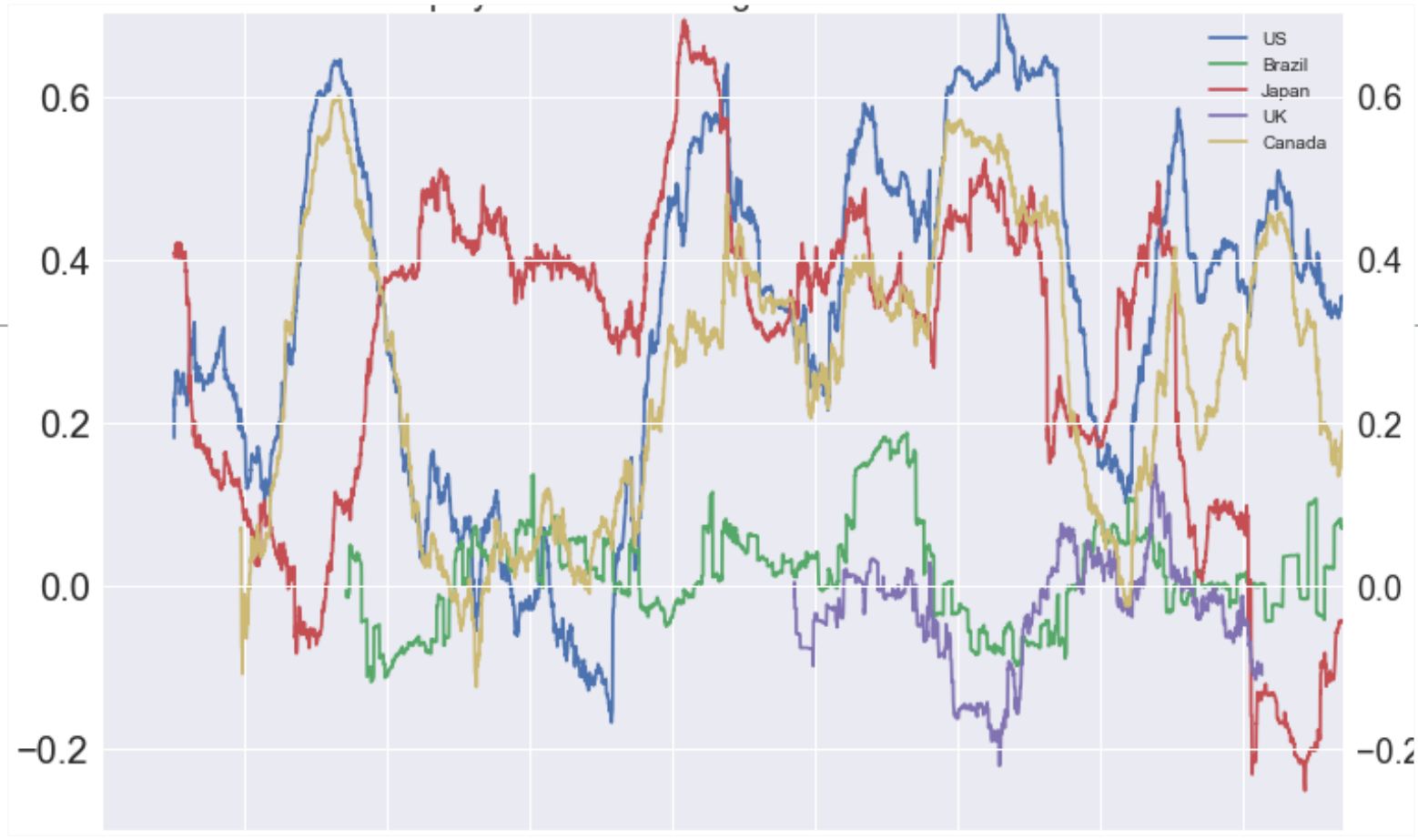


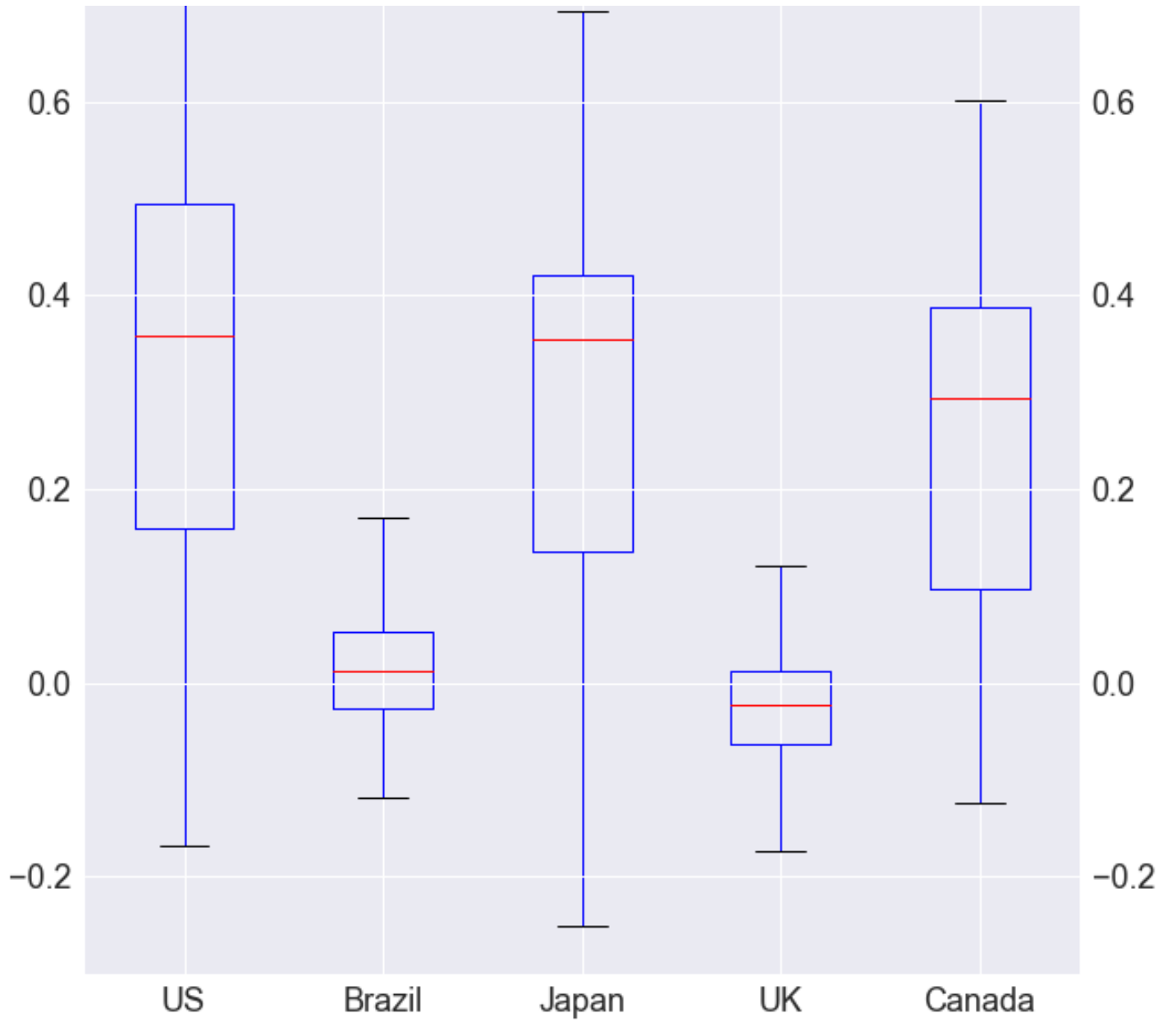
CROSS-ASSET MONITORS



CROSS-ASSET MONITORS

Rolling 12M Correlations: Equity vs. 10Y Rates

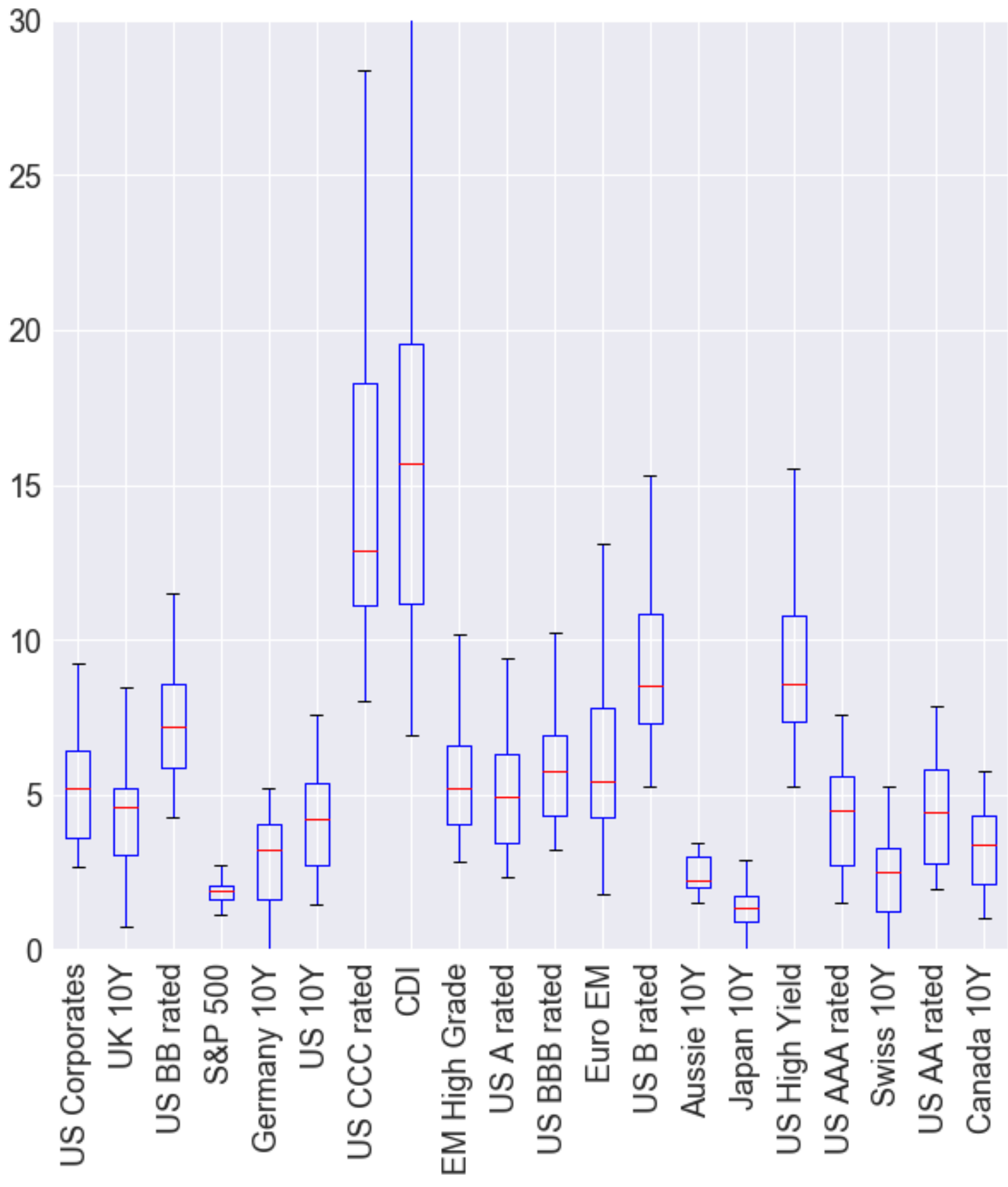




CROSS-ASSET MONITORS

Cross-Asset Yields

	US Corporates	UK 10Y	US BB rated	S&P 500	Germany 10Y	US 10Y	US CCC rated	CDI	EM High Grade	US A rated	US BBB rated	Euro EM	US B rated	Aussie 10Y	Japan 10Y	US High Yield	US AAA rated	Swiss 10Y	US AA rated
Yields																			
Metric	3.39	1.28	4.72	2.03	0.19	2.45	11.49	13.63	3.51	3.11	3.8	1.77	6.09	2.24	0.04	6.19	3.05	-0.08	2.76
Average	5.17	4.4	7.34	1.87	2.82	4.14	15.19	18.05	5.48	4.94	5.73	6.25	9.18	2.48	1.42	9.27	4.38	2.29	4.47
Percentiles																			
Current %	19.1	1.9	7.7	68	4.9	19.3	29.5	39.4	12	22.8	14.5	0.5	7.3	48.9	3.8	8.7	32.6	7.2	24.9
95th %ile	7.81	7.95	10.46	2.6	4.55	6.64	26.25	39.4	8.5	7.6	8.24	12.01	13.89	3.41	3.09	13.67	6.98	4.3	7.22
5th %ile	2.91	1.63	4.65	1.21	0.21	1.75	9.23	8.34	3.24	2.53	3.42	2.9	5.8	1.62	0.29	5.93	2	-0.2	2.14



DATA TAKEAWAYS & FURTHER EXPLORATION

- Statistical models applied to portfolio theory rest on the assumption returns of securities are normally distributed
- Construct an algorithmic position sizing tool based on volatility and correlation of each individual component from a portfolio perspective