Computational Finance and Financial Management

Task to do .....

Perform a time series analysis
The characteristics of the time series
Analyze the risk return profile of a portfolio
Tangential Portfolio as well as The Minimum Variance Portfolio
Other suitable metrics to include when choosing the optimal portfolio

Time frame: 06.01.2016-06.29.2021 (daily)
Assets: 1. MSCI EM Small Cap UCITS ETF - IEMS
2. MSCI EM UCITS ETF - IQQE
3. Gold

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Scientific Background

Literature Review

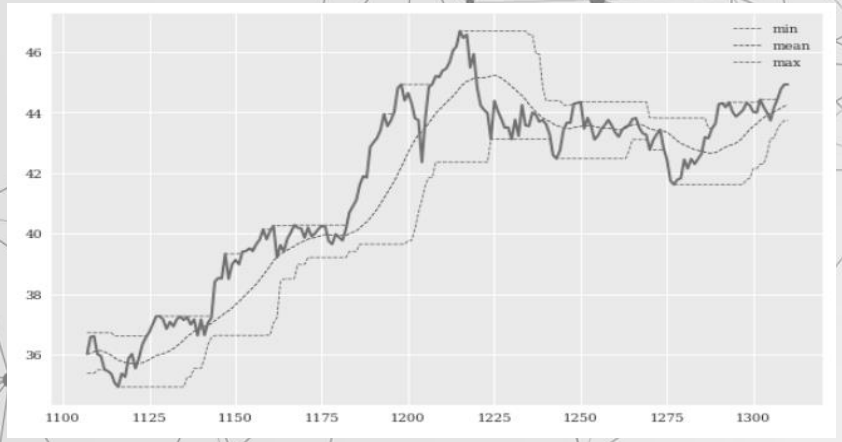
- *Definition of MSCI indexes*
- *Hacibedel and Bommel (2007)*
- *Chakrabarti, Huang, Jayaraman, and Lee (2015)*
- *Jain, Srivastava, and Sharma (2019)*
- *Wang, Fang and Ye (2013)*

02

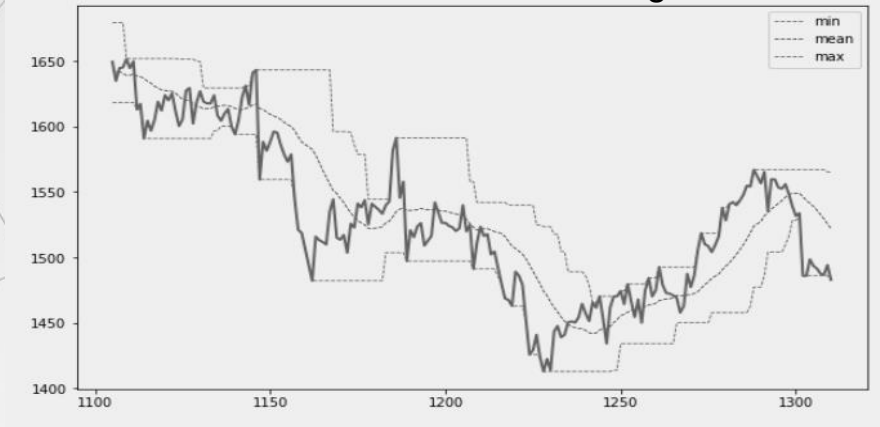
Time Series Analysis

Rolling Statistics

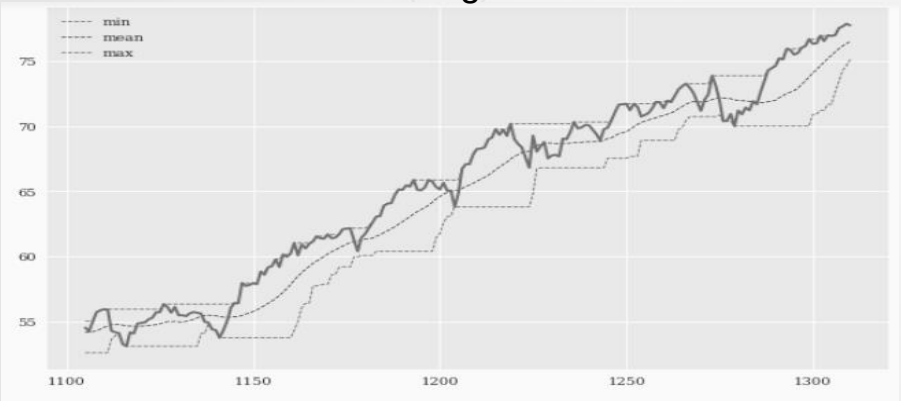
IQQE Rolling Statistics



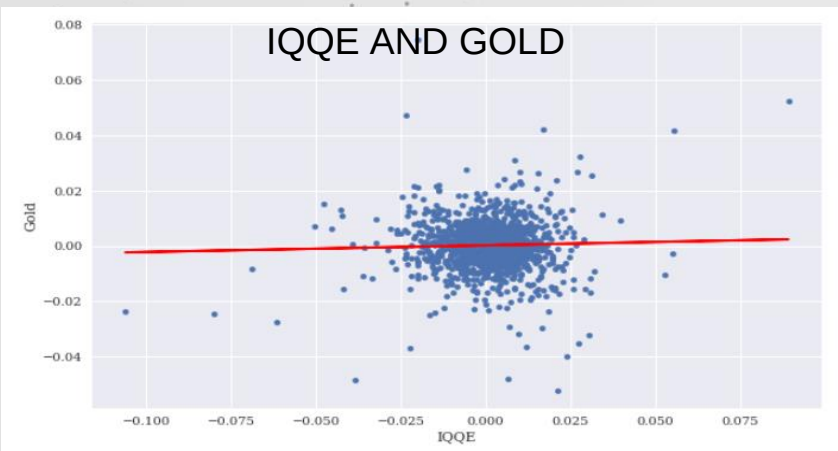
Gold Rolling Statistics

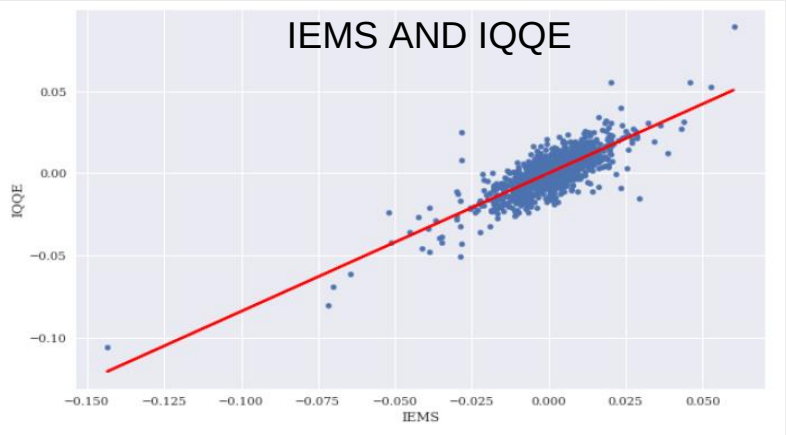


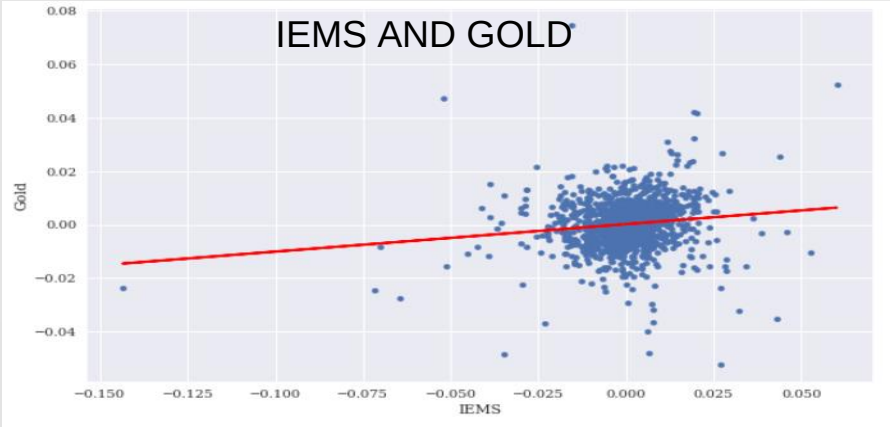
IEMS Rolling Statistics



OLS Regression







Stationarity

H_0: Data is non stationary
H_a: Data is stationary

IEMS ADF test results

Results of dickey fuller test	
Test Statistics	-1.014764
p-value	0.747841

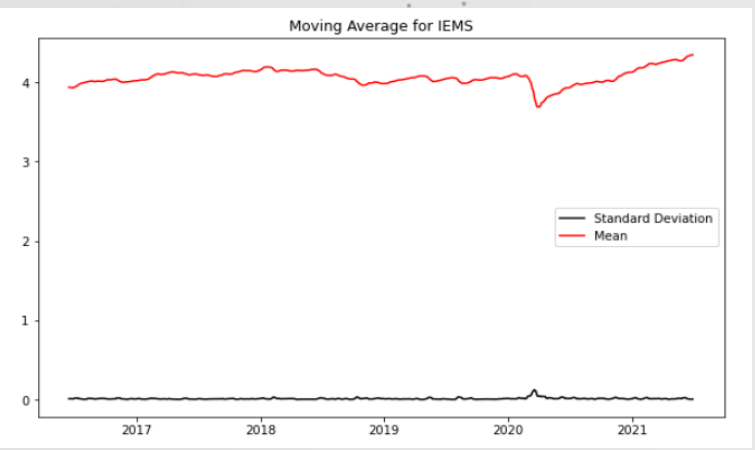
GOLD ADF test results

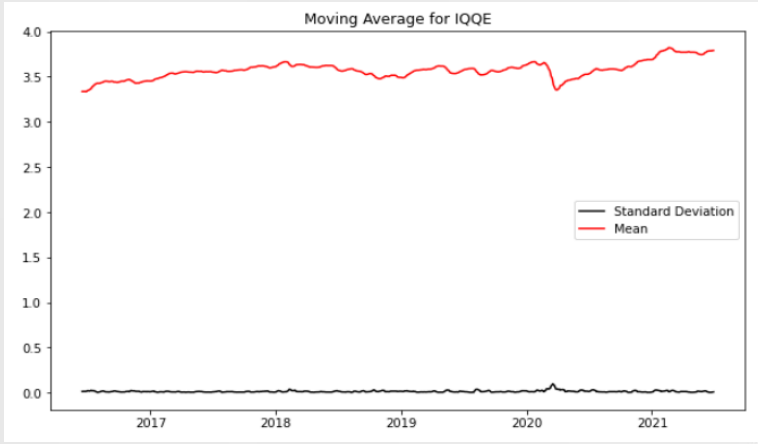
Results of dickey fuller test	
Test Statistics	-0.450342
p-value	0.901348

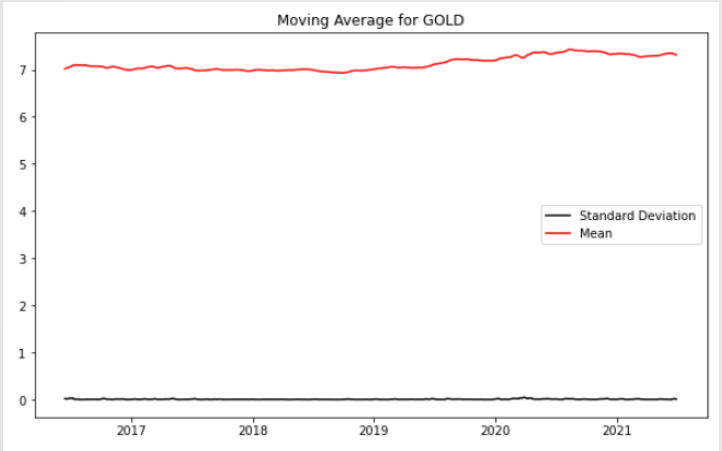
Results of dickey fuller test	
Test Statistics	-1.690324
p-value	0.436105

IQQE ADF test results

MOVING AVERAGE







ARIMA model (IEMS)

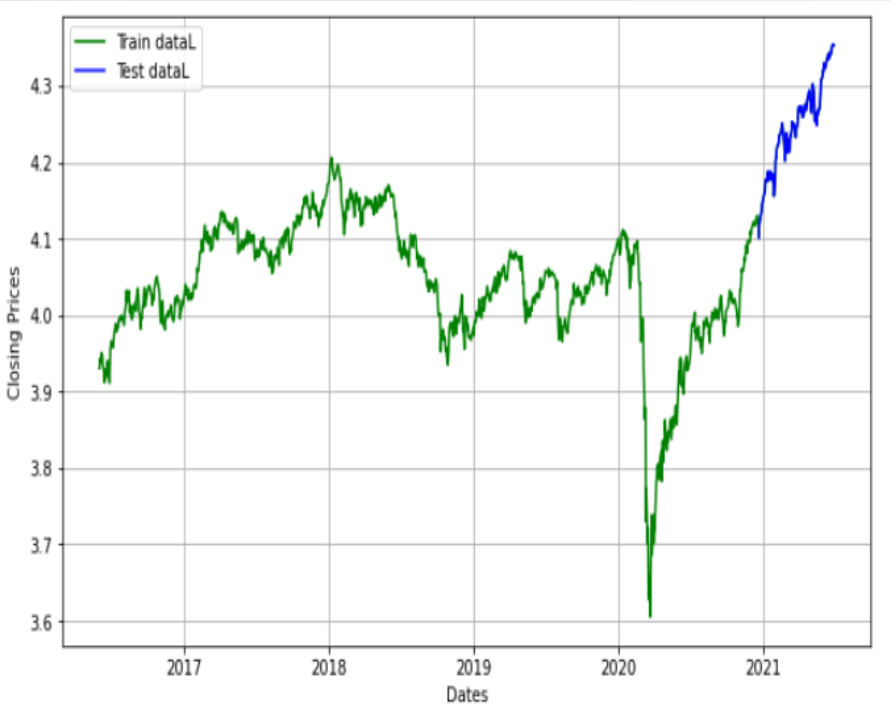
ARIMA Model Results

Dep. Variable:	D.IEMS	No. Observations:	1085
Model:	ARIMA(3, 1, 2)	Log Likelihood	3232.348
Method:	css-mle	S.D. of innovations	0.012
Date:	Mon, 05 Jul 2021	AIC	-6450.696
Time:	12:14:29	BIC	-6415.771
Sample:	1	HQIC	-6437.475

	coef	std err	z	P>|z|	[0.025	0.975]
const	0.0002	0.000	0.362	0.718	-0.001	0.001
ar.L1.D.IEMS	-0.2912	0.105	-2.763	0.006	-0.498	-0.085
ar.L2.D.IEMS	0.6762	0.099	6.800	0.000	0.481	0.871
ar.L3.D.IEMS	0.1925	0.030	6.434	0.000	0.134	0.251
ma.L1.D.IEMS	0.1613	0.105	1.540	0.124	-0.044	0.366
ma.L2.D.IEMS	-0.6605	0.098	-6.727	0.000	-0.853	-0.468

Roots

	Real	Imaginary	Modulus	Frequency
AR.1	1.2196	+0.0000j	1.2196	0.0000
AR.2	-1.2088	+0.0000j	1.2088	0.5000
AR.3	-3.5234	+0.0000j	3.5234	0.5000
MA.1	-1.1144	+0.0000j	1.1144	0.5000
MA.2	1.3585	+0.0000j	1.3585	0.0000



ARIMA MODEL (IQQE)

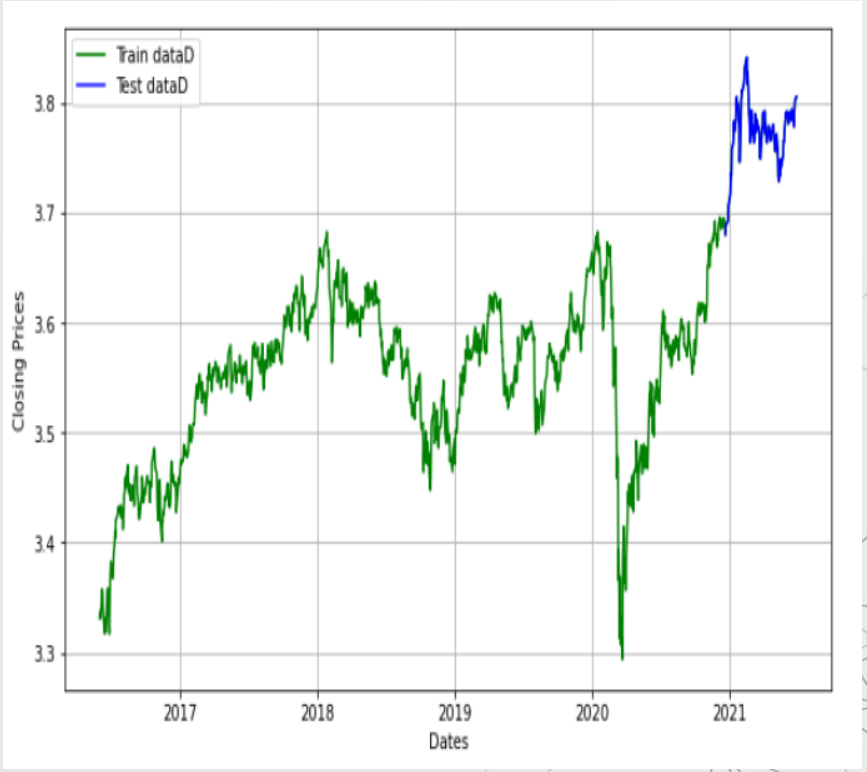
ARIMA Model Results

Dep. Variable:	D.IQQE	No. Observations:	1085
Model:	ARIMA(3, 1, 2)	Log Likelihood	3194.521
Method:	css-mle	S.D. of innovations	0.013
Date:	Mon, 05 Jul 2021	AIC	-6375.041
Time:	12:14:34	BIC	-6340.116
Sample:	1	HQIC	-6361.820

	coef	std err	z	P>|z|	[0.025	0.975]
const	0.0003	0.000	0.869	0.385	-0.000	0.001
ar.L1.D.IQQE	-1.6740	0.069	-24.406	0.000	-1.808	-1.540
ar.L2.D.IQQE	-1.0556	0.099	-10.689	0.000	-1.249	-0.862
ar.L3.D.IQQE	-0.0562	0.041	-1.386	0.166	-0.136	0.023
ma.L1.D.IQQE	1.5752	0.060	26.095	0.000	1.457	1.693
ma.L2.D.IQQE	0.9378	0.056	16.750	0.000	0.828	1.048

Roots

	Real	Imaginary	Modulus	Frequency
AR.1	-0.8404	-0.5780j	1.0200	-0.4041
AR.2	-0.8404	+0.5780j	1.0200	0.4041
AR.3	-17.1143	-0.0000j	17.1143	-0.5000
MA.1	-0.8398	-0.6008j	1.0326	-0.4012
MA.2	-0.8398	+0.6008j	1.0326	0.4012



ARIMA MODEL (Gold)

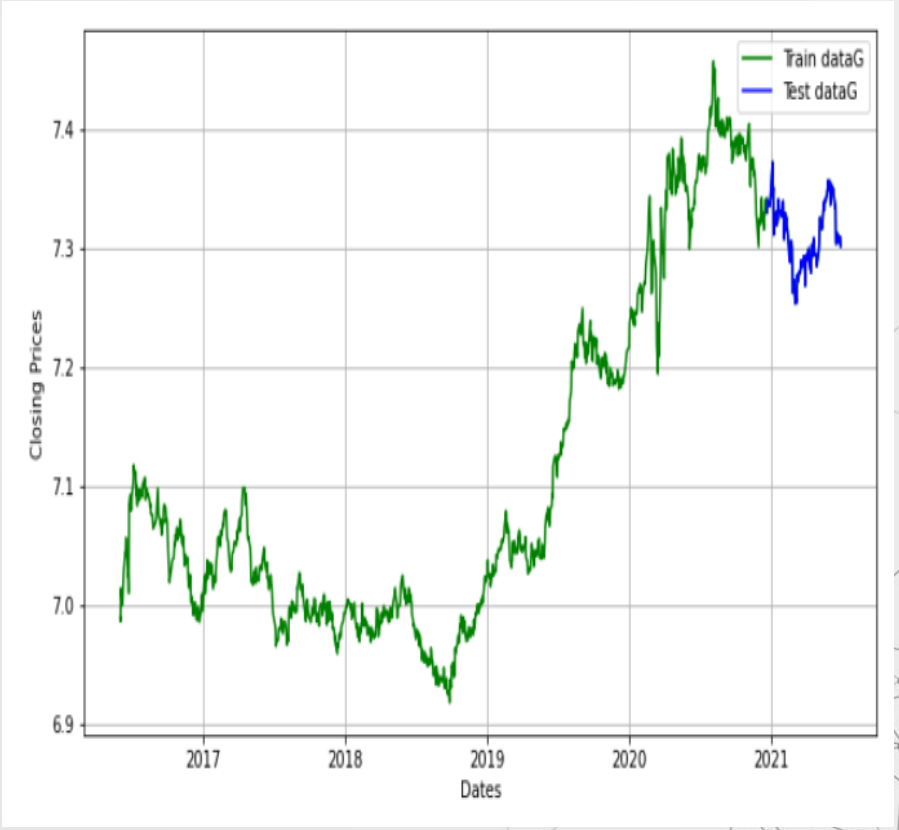
ARIMA Model Results

Dep. Variable:	D.Gold	No. Observations:	1085
Model:	ARIMA(3, 1, 2)	Log Likelihood	3533.398
Method:	css-mle	S.D. of innovations	0.009
Date:	Mon, 05 Jul 2021	AIC	-7052.796
Time:	12:14:37	BIC	-7017.870
Sample:	1	HQIC	-7039.574

	coef	std err	z	P>|z|	[0.025	0.975]
const	0.0003	0.000	1.266	0.205	-0.000	0.001
ar.L1.D.Gold	1.4918	0.054	27.388	0.000	1.385	1.599
ar.L2.D.Gold	-0.7040	0.073	-9.632	0.000	-0.847	-0.561
ar.L3.D.Gold	-0.1390	0.031	-4.480	0.000	-0.200	-0.078
ma.L1.D.Gold	-1.5991	0.047	-34.035	0.000	-1.691	-1.507
ma.L2.D.Gold	0.9012	0.053	17.011	0.000	0.797	1.005

Roots

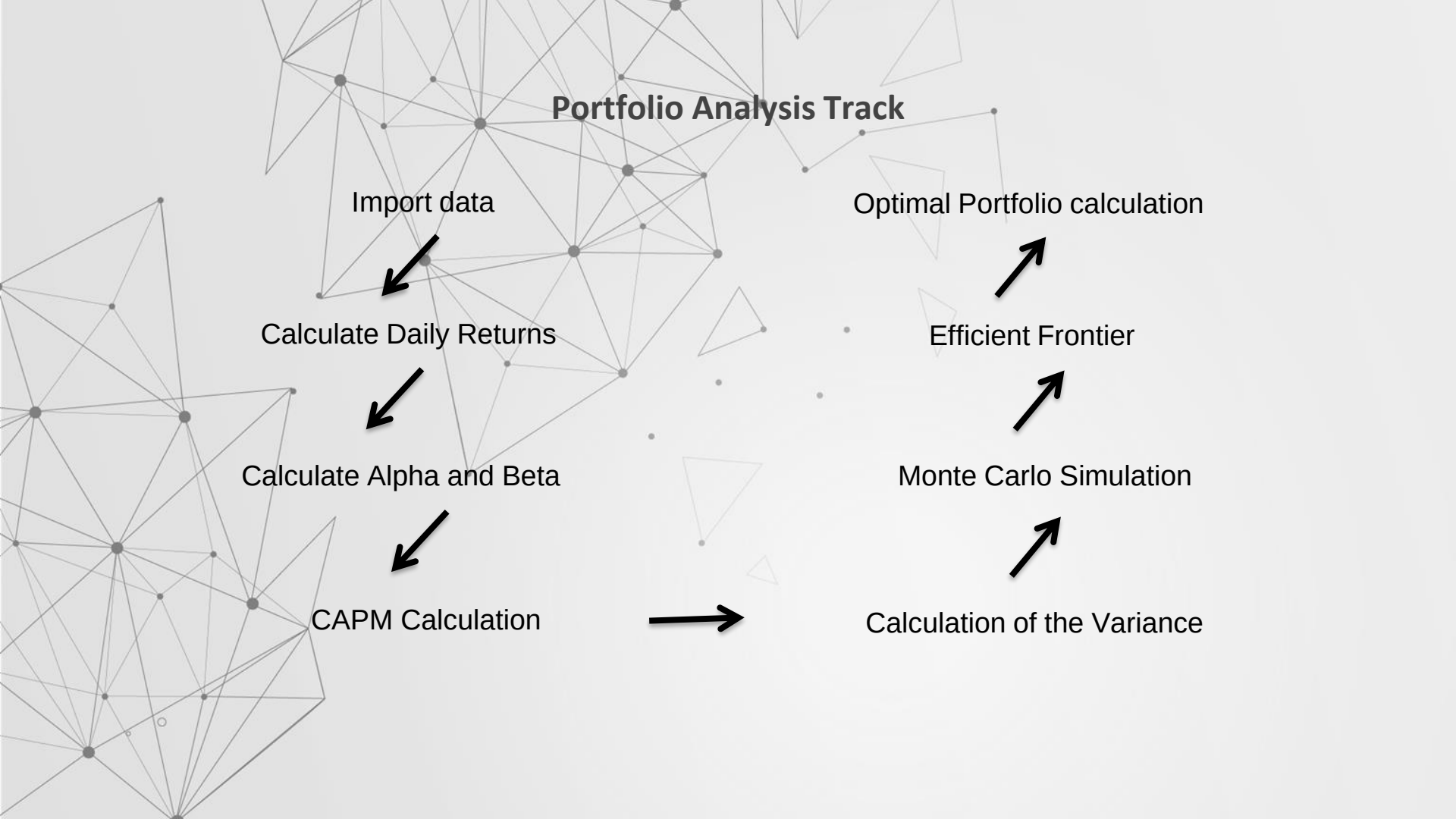
	Real	Imaginary	Modulus	Frequency
AR.1	0.8671	-0.5534j	1.0286	-0.0904
AR.2	0.8671	+0.5534j	1.0286	0.0904
AR.3	-6.7971	-0.0000j	6.7971	-0.5000
MA.1	0.8872	-0.5679j	1.0534	-0.0906
MA.2	0.8872	+0.5679j	1.0534	0.0906



03

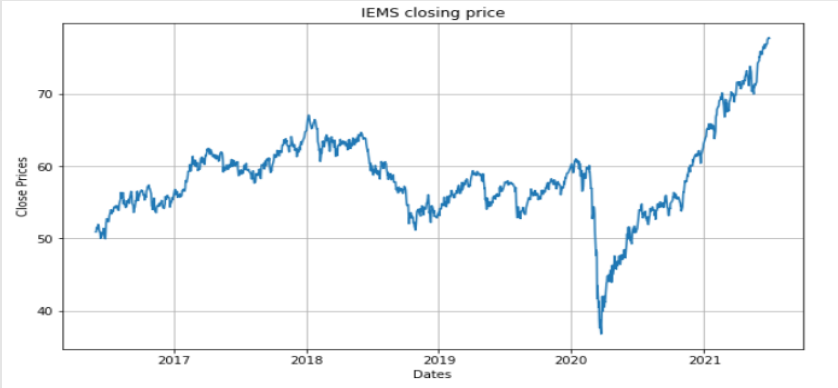
Portfolio Risk Return Analysis

Portfolio Analysis Track



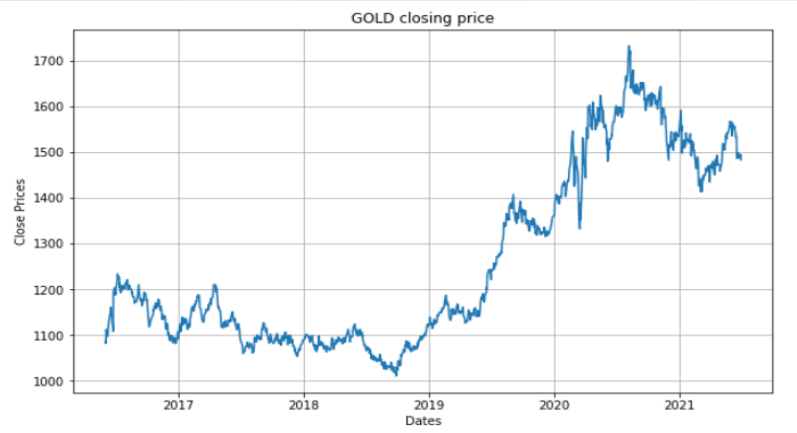
Historical Price Trend

MSCI EM



GOLD

MSCI EM SC



Return Calculation Features

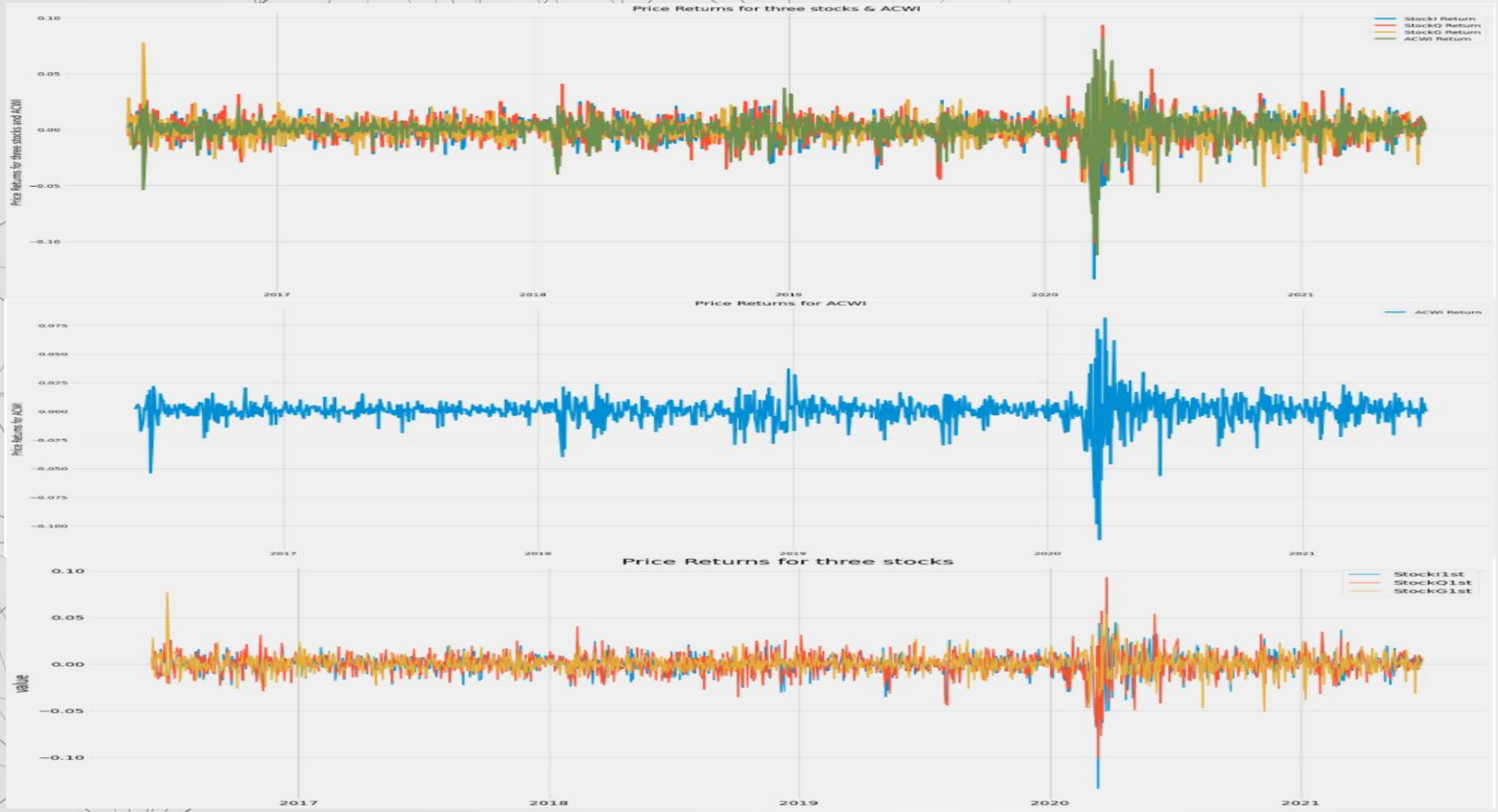
CAPM Equation

r(equity) = r(f) + B(equity)(r(m) - r(f))

Market Return – ACWI World Index

Risk Free Rate = 0.0025
source of TB <https://www.bloomberg.com/markets/rates-bonds/government-bonds/us>

Stocks Return & Market Return Comparison



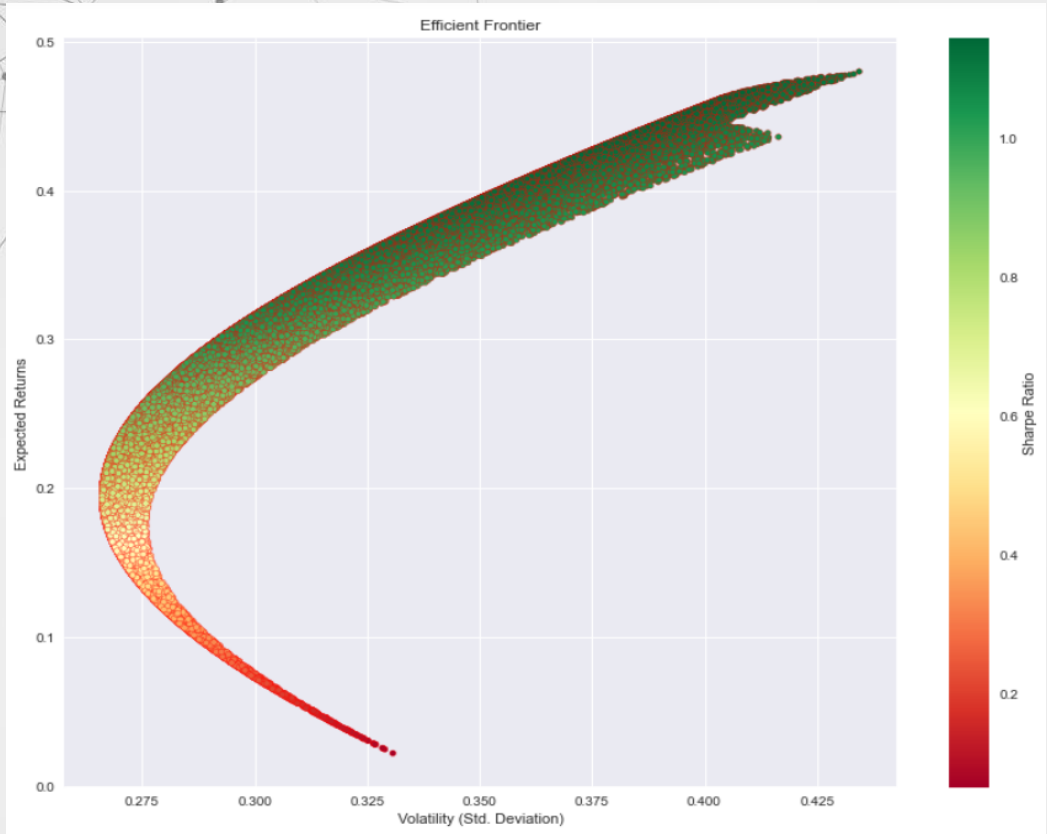
Monte Carlo Simulation & Optimal Portfolio

Calculation of Alpha and Beta

IEMS
Alpha : 1.54
Beta : 0.67

IQQE
Alpha : 3.66
Beta : 0.74

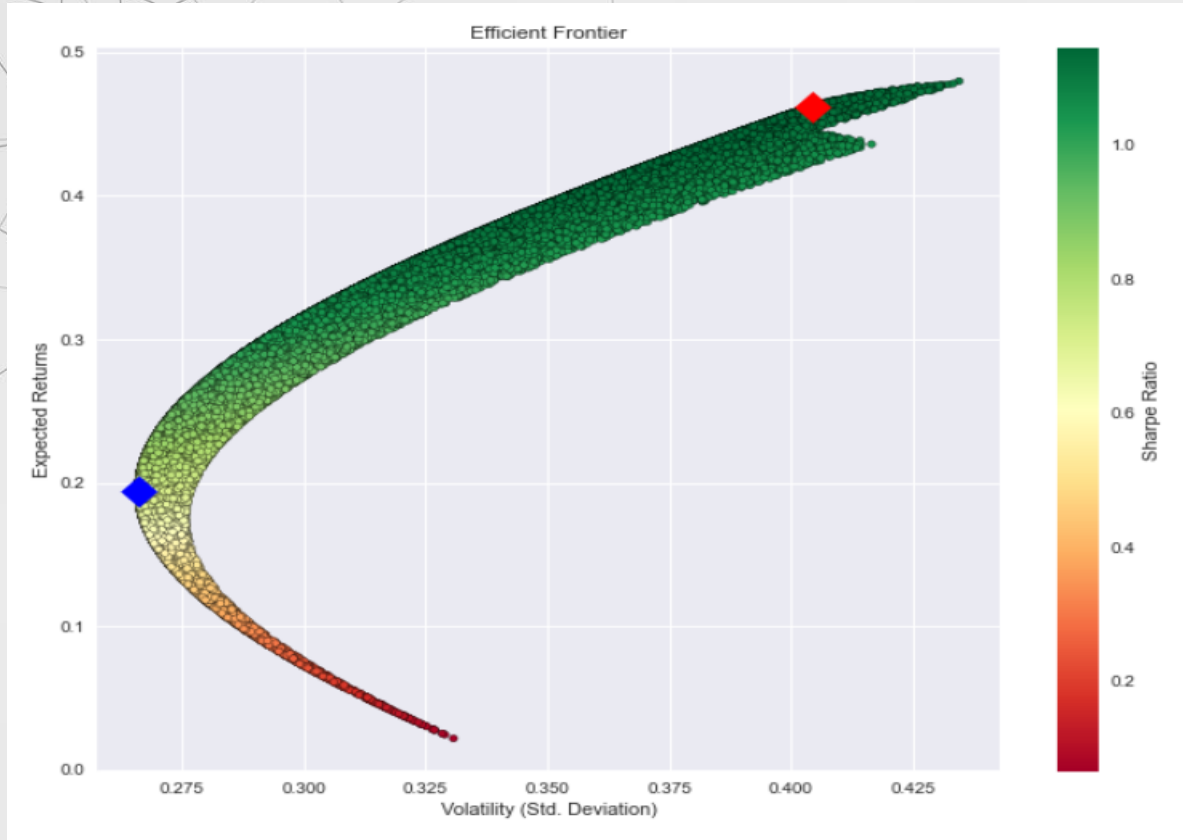
Gold
Alpha : 0.00028
Beta : 0.03



Efficient Frontier

Red square denotes Sharpe Portfolio
Stock Weight –
IEMS : 40.7%
IQQE : 59.3%
Gold : 0.004%

Blue square denotes Minimum Variance Portfolio
Stock Weight –
IEMS : 13.5%
IQQE : 25.6%
Gold : 60.9%



Portfolio optimality_ metrics to be considered ...

Expected Return
Determined Volatility

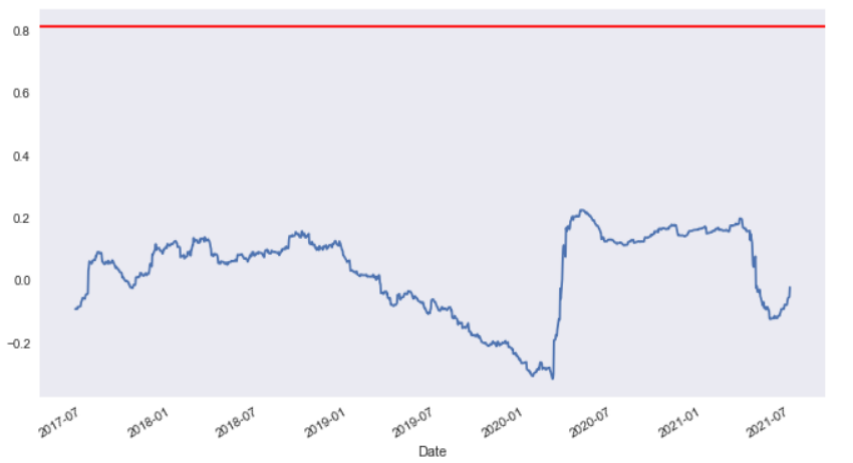
Sharp Ratio
Correlation

$$\text{Sharpe Ratio} = \frac{E[R] - rf}{SD(R)}$$

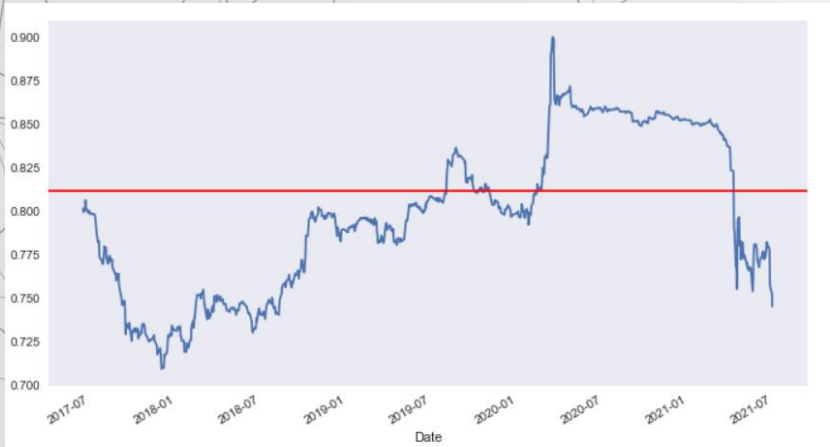
Correlation Analysis

	IEMS	IQQE	Gold
IEMS	1.000000	0.811416	0.131668
IQQE	0.811416	1.000000	0.032145
Gold	0.131668	0.032145	1.000000

Corr(IQQE & Gold)



Corr(IQQE & IEMS)



Corr(Gold & IEMS)

04

Portfolio Optimality & Evaluation

Portfolio Performance

Minimum Variance Portfolio

Sharpe Ratio
0.73

Portfolio Return
0.19

Portfolio Volatility
0.27

Tangent Portfolio

Sharpe Ratio
1.14

Portfolio Return
0.46

Portfolio Volatility
0.40

Investment Evaluation

Minimum Variance Portfolio:

Number of Stock:
IEMS - 167
IQQE - 578
Gold – 41

Total Investment - 99750.69
Withhold fund - 1089.31

In case of Tangent Portfolio:

Number of Stock:
IEMS - 527
IQQE - 1290
Gold – 0

Total Investment - 98910.69
Withhold fund - 652.125

05

Conclusion

To sum up!!!!

- Autoregressive Integrated Moving Average Model (ARIMA) - predicting future values of the Time Series – MSCI EM SC is better among three assets.
- During COVID crisis, Gold investment is better than MSCI ETFs.

- For diversification – allocate more weight on Gold – less correlated with MSCI ETFs.
- Sharpe portfolio is for risk lover investors // Tangent portfolio is for risk-averse investor
- Gold is considered less risky investment with less return.

Questions!!!