Computational Finance and Financial Management

Masters Seminar

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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

01
Scientific Background

Literature Review

- *Definition of MSCI indexes*

- *Hacibedel and Bommel (2007)*

- *Chakrabarti, Huang, Jayaraman, and Lee (2015)*

- *Jain, Srivastava, and Sharma (2019)*
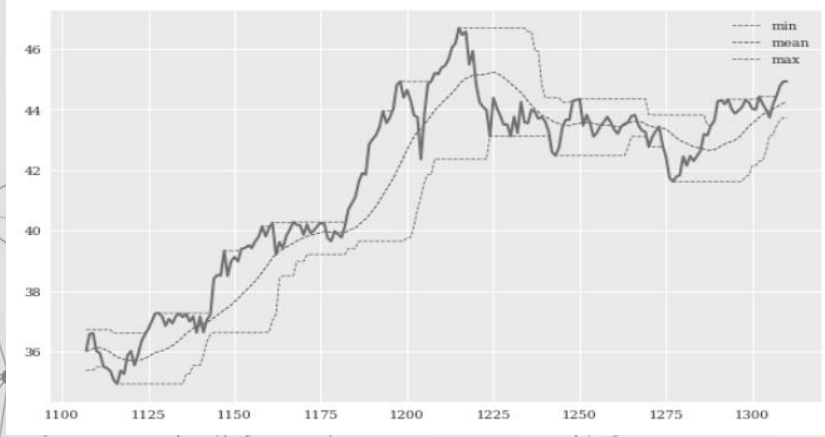
- *Wang, Fang and Ye (2013)*

02

Time Series Analysis
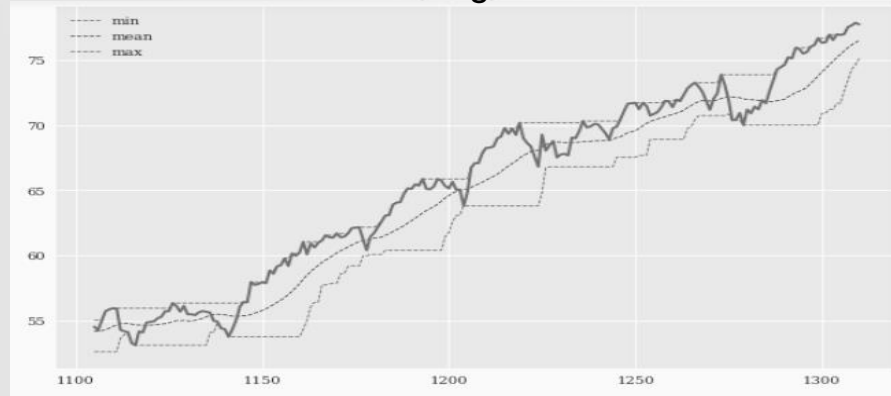
Rolling Statistics

IQQE Rolling Statistics

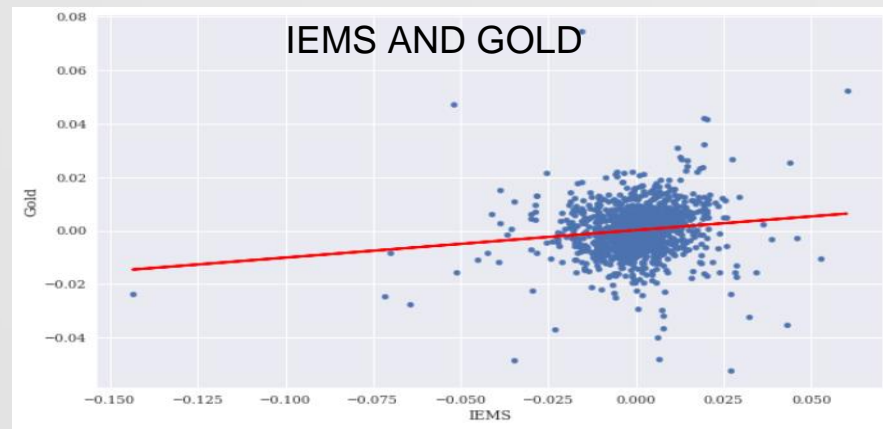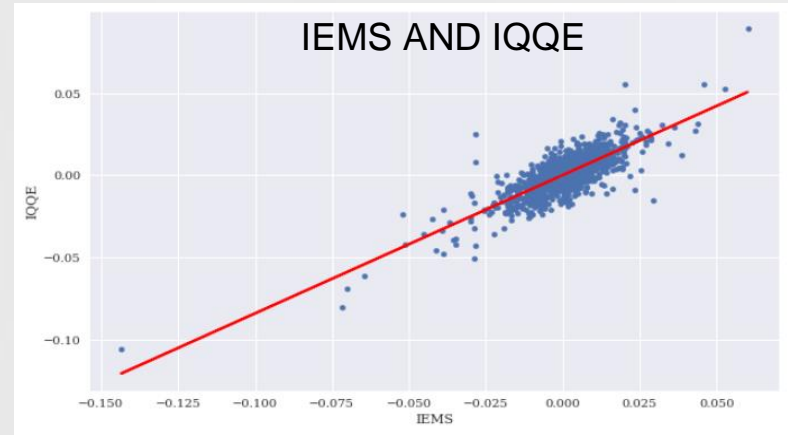Gold Rolling Statistics

IEMS Rolling Statistics

OLS Regression
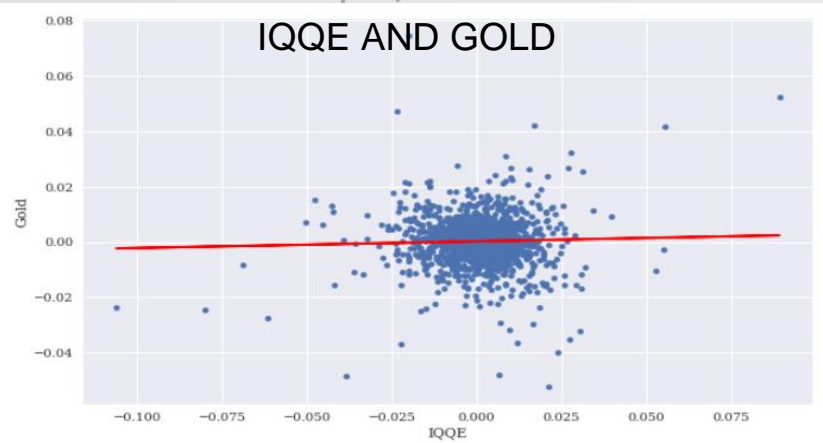
Stationarity

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
------------------------------------------------------------------------------
```
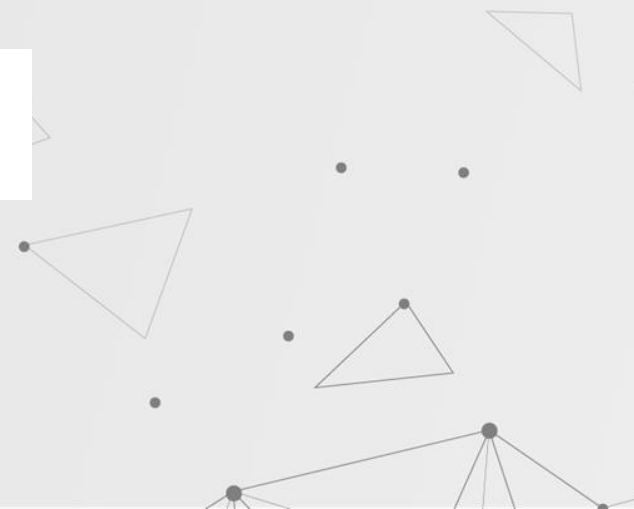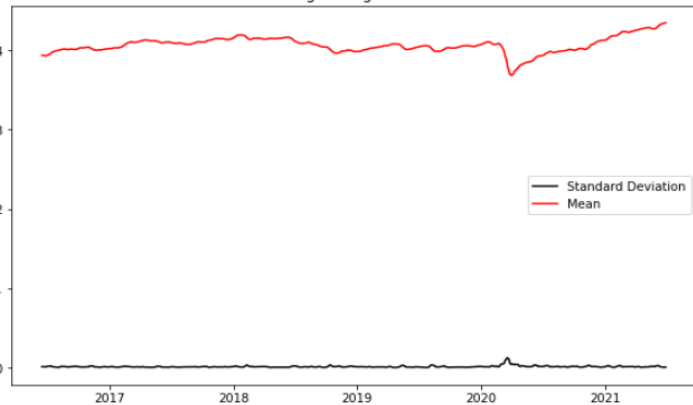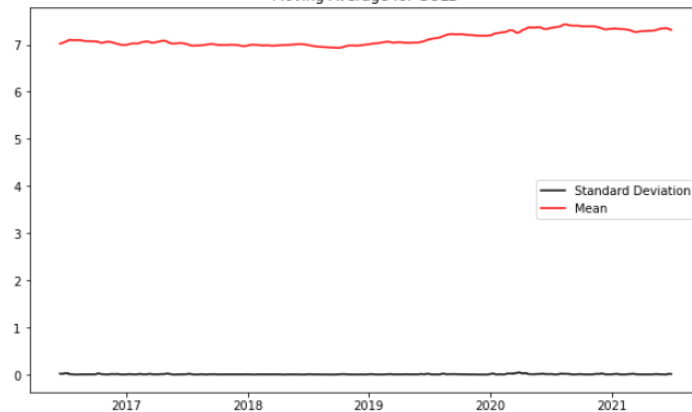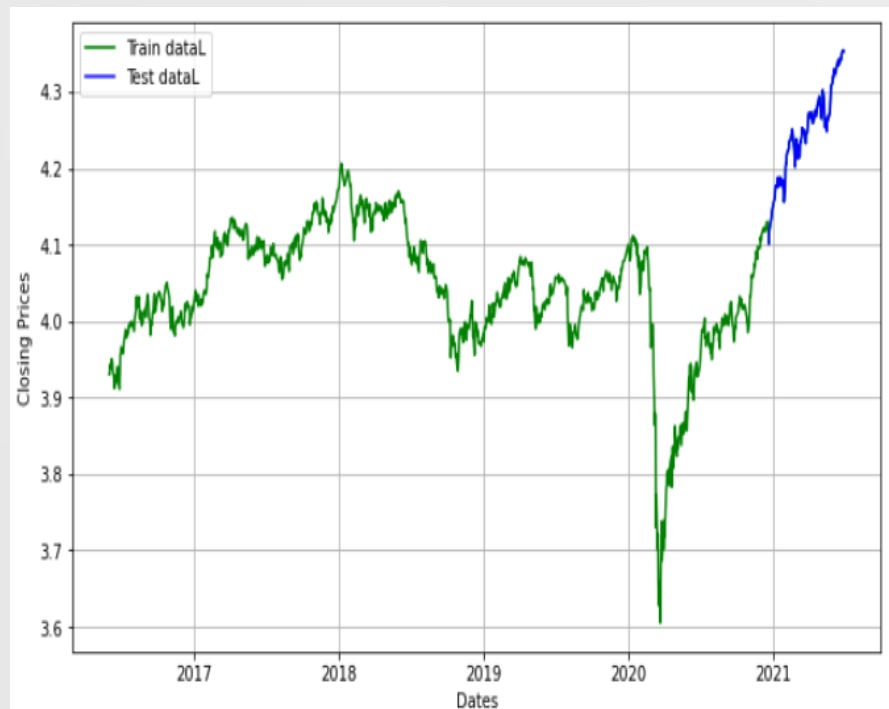
ARIMA MODEL (IQQE)

```
                        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
------------------------------------------------------------------------------
```
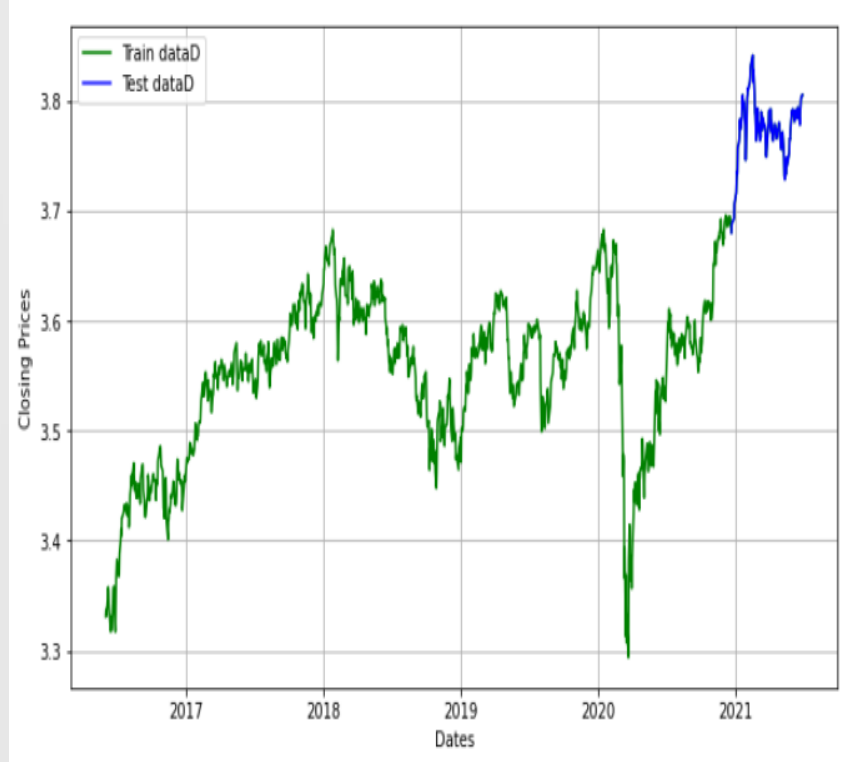
ARIMA MODEL (Gold)

```
                        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
------------------------------------------------------------------------------
```
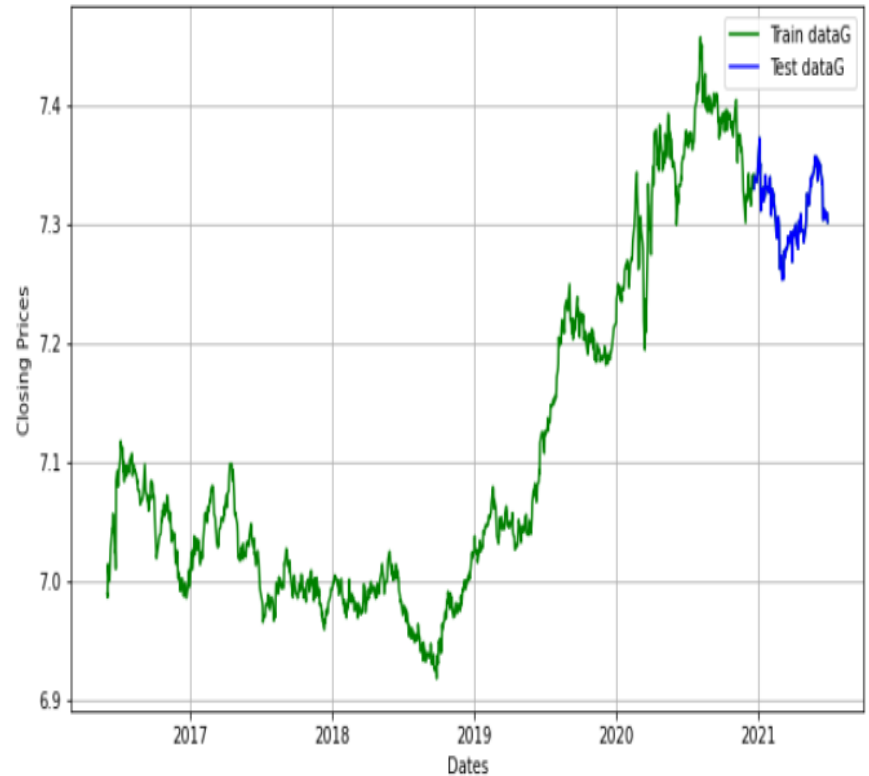
03

Portfolio Risk Return Analysis

Portfolio Analysis Track

Import data

Optimal Portfolio calculation

Calculate Daily Returns

Efficient Frontier

Calculate Alpha and Beta

Monte Carlo Simulation

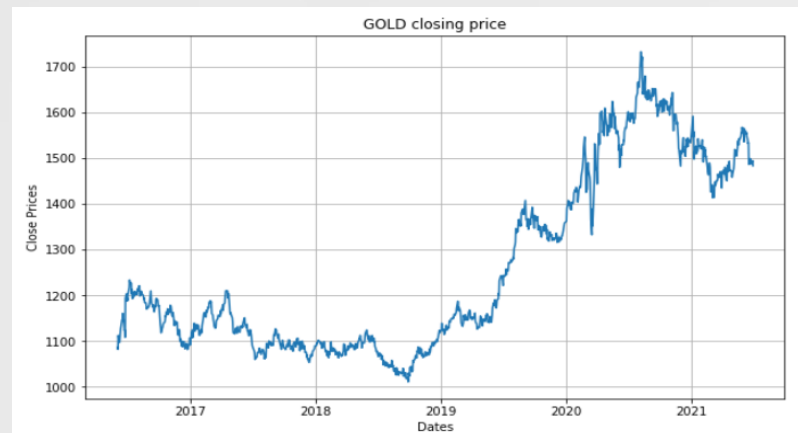CAPM Calculation

Calculation of the Variance

Historical Price Trend

MSCI EM

GOLD

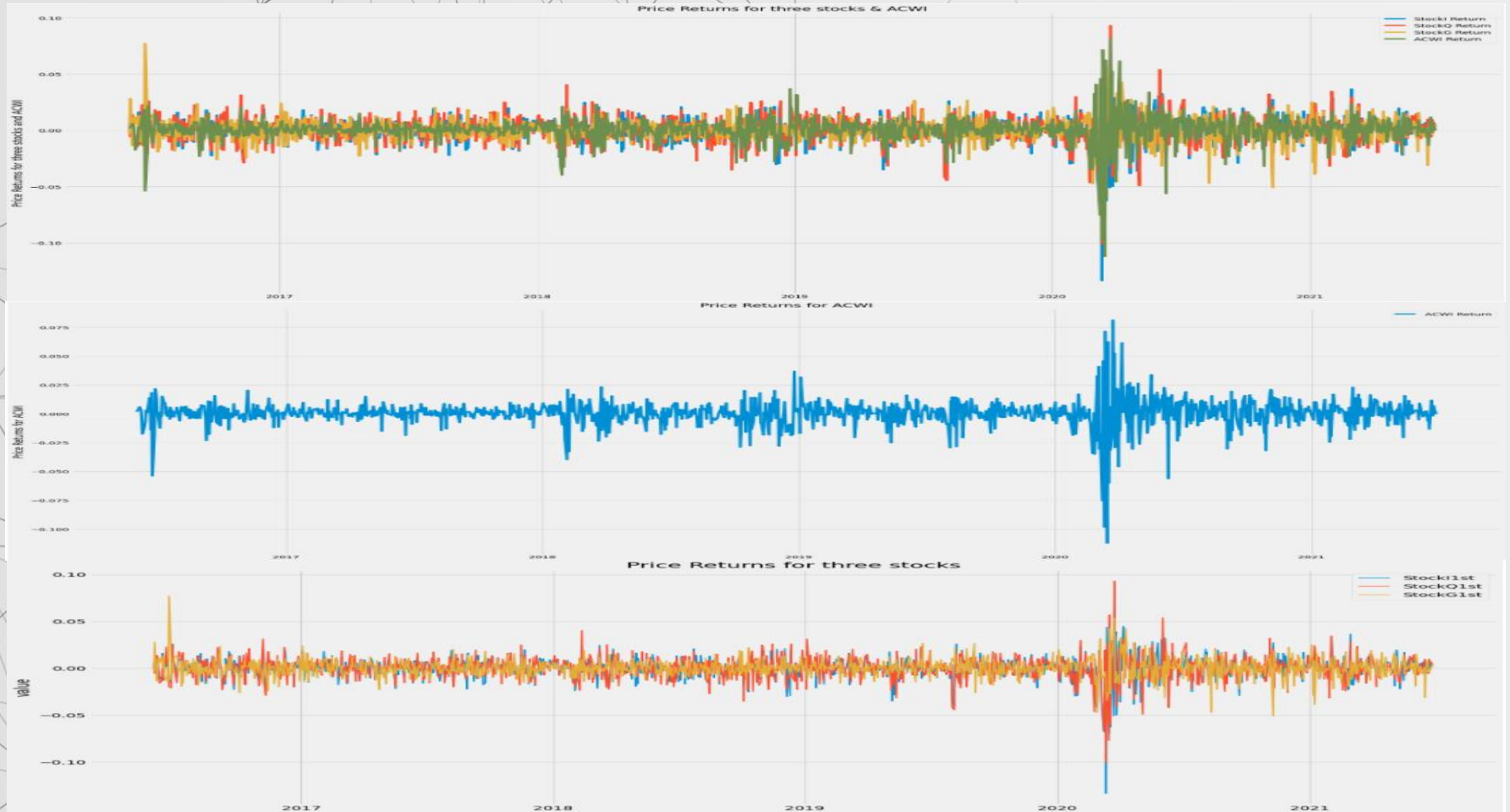**MSCI EM SC**

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>

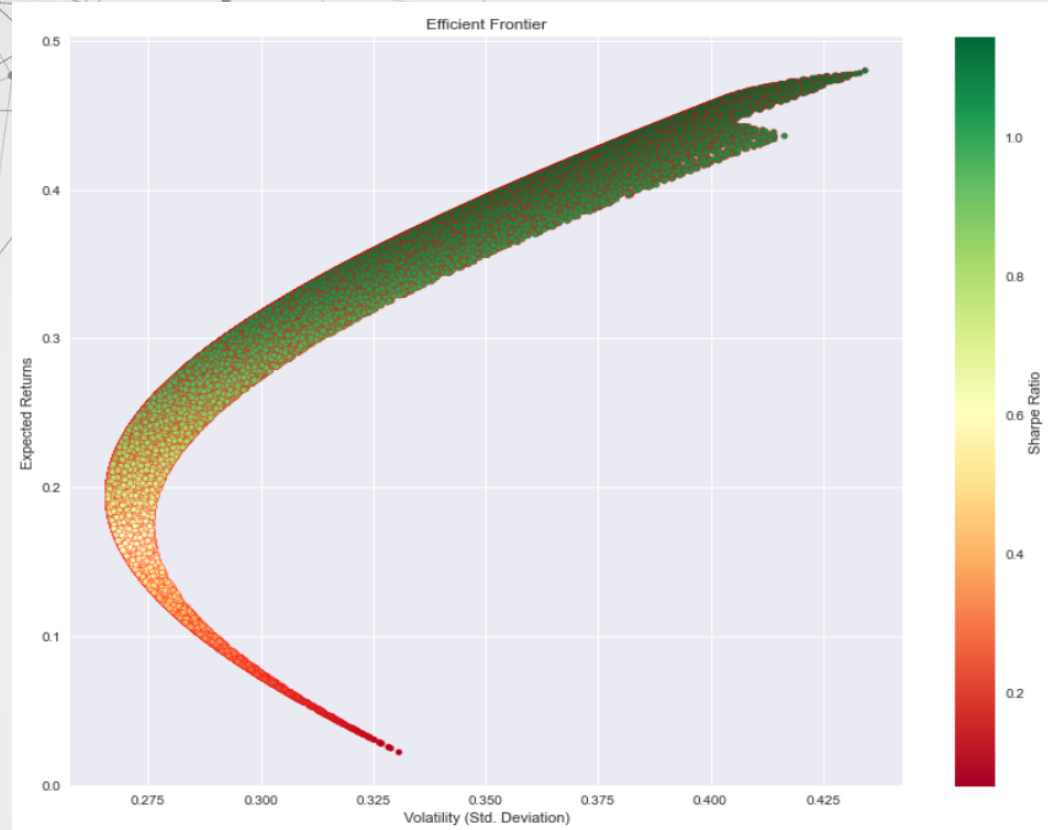# Stocks Return & Market Return Comparison

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 –
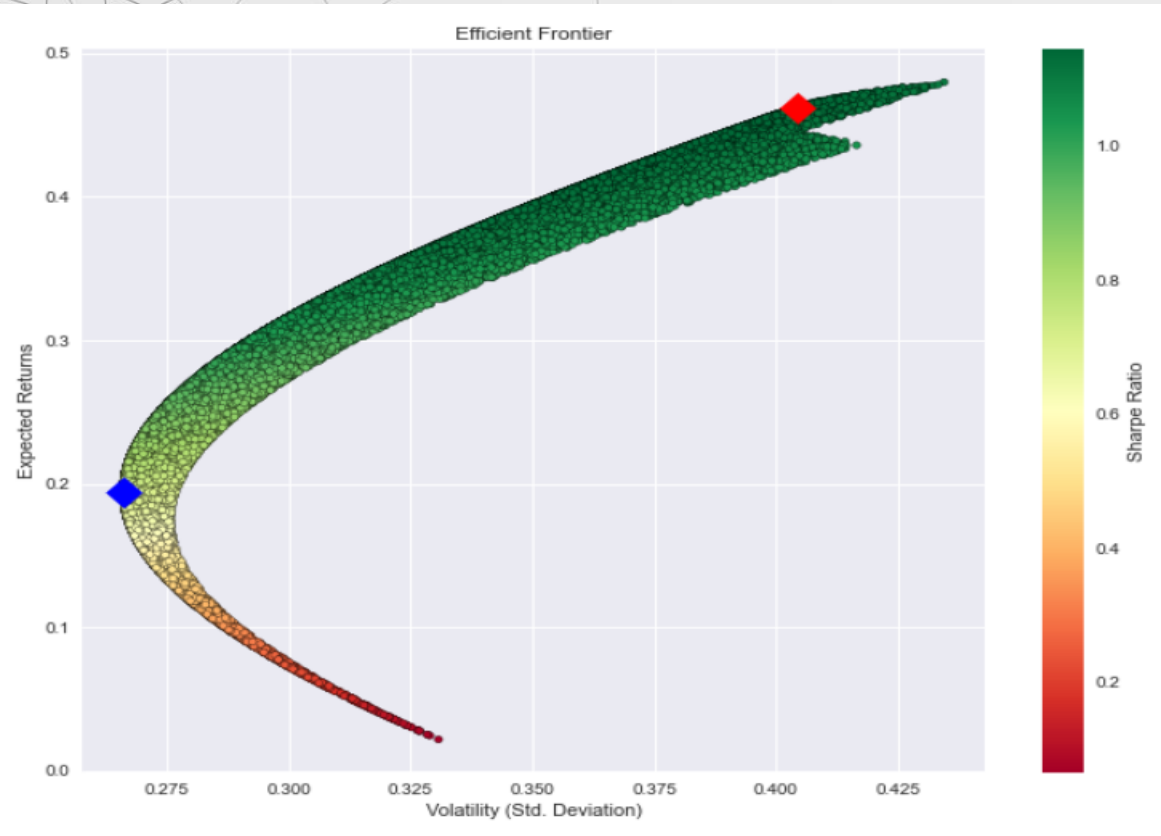**IEMS : 40.7%**
IQQE : 59.3%
Gold : 0.004%

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

Portfolio optimality_ metrics to be considered ...
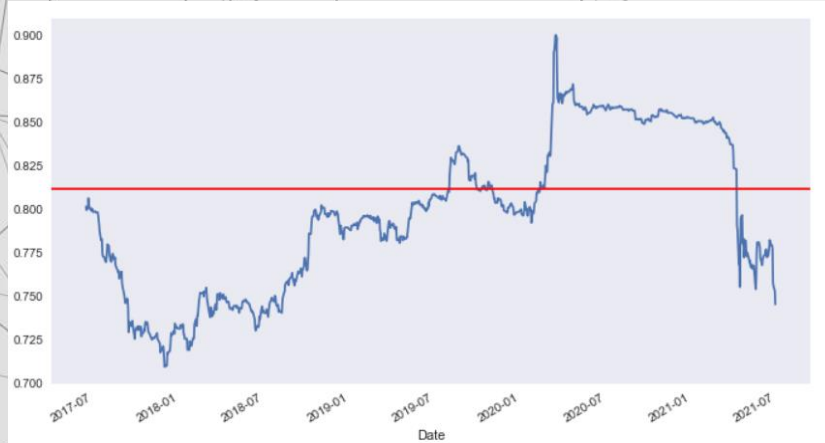
**Expected Return
Determined Volatility**

**Sharp Ratio
Correlation**

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

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!!!