Assignment 4

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Question 1

Data Used –

$$M = [0.1\ ,\ 0.2,\ 0.15]$$

$$C = \begin{bmatrix} 0.005 & -0.010 & 0.004 \\ -0.010 & 0.040 & -0.002 \\ 0.004 & -0.002 & 0.023 \end{bmatrix}$$

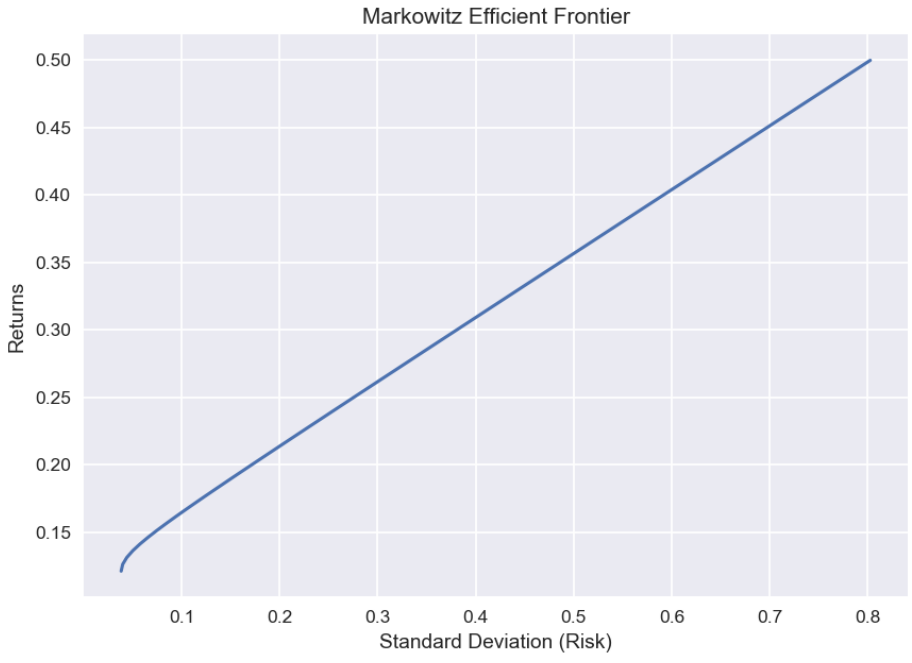
Formula Used –

$$\text{Returns} = \sum_{i=0}^{i=2} w[i] * M[i]$$

where w is the weight on the i^{th} asset.

$$\text{Standard Deviation (Risk)} = \sqrt{\sum_{i=0}^{i=2}\sum_{j=0}^{j=2} w[i] * w[j] * C[i][j]}$$

(a) Below graph is plotted by iterating over the returns and computing the minimum risk we can achieve given the returns. Plot is plotted only for points with returns greater than the returns at the tip of the bullet to achieve the Morkowitz efficient frontier.



(b) Some points from the above curve are tabulate with the weights on various assets.

Returns	Standard Deviation	W1	W2	W3
0.126263	0.040006	0.743390	0.268643	-0.012033
0.131313	0.044186	0.671718	0.297981	0.030301
0.136364	0.050323	0.599040	0.326313	0.074648
0.141414	0.057799	0.526579	0.354862	0.118560
0.146465	0.066160	0.454071	0.383364	0.162566
0.151515	0.075113	0.381981	0.412284	0.205736
0.156566	0.084468	0.309686	0.440999	0.249315
0.161616	0.094106	0.237429	0.469752	0.292819
0.166667	0.103949	0.165138	0.498471	0.336391
0.171717	0.113942	0.092853	0.527196	0.379951

(c)

For a 15% risk maximum return is 18.9555% and corresponding weights on the assets should be -0.1624, 0.6287, 0.5337.

For a 15% risk minimum return is 5.2447% and corresponding weights on the assets should be 1.7998, -0.1512, -0.6486.

(d)

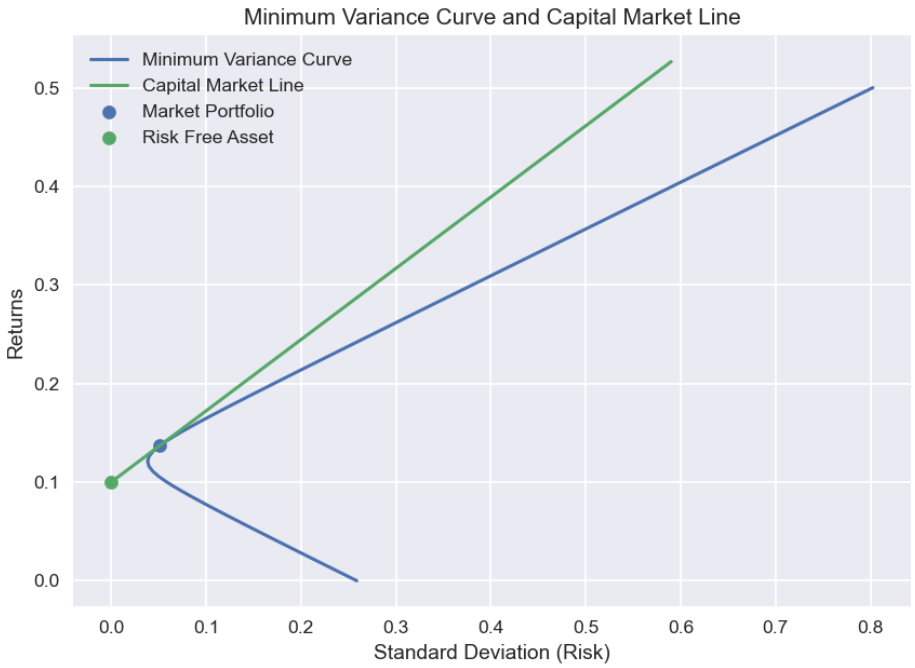
Minimum risk would be 13.0568% and corresponding weights on the assets should be -0.0258, 0.5742, 0.4516

(e)

Market portfolio can be found by maximizing the sharpe ratio which is –

$$Sharpe\ Ratio = \frac{Return - \mu_{rf}}{Risk(\sigma)}$$

Market portfolio has risk = 0.0508 and return = 0.1367. Corresponding weights on the assets should be 0.5938, 0.3281, 0.0781.



(f)

These portfolios are taken from the Capital market line.

For 0.1 risk

Weight on risk free asset is -0.9683

Weights on risky assets are 1.1688, 0.6458, 0.1537

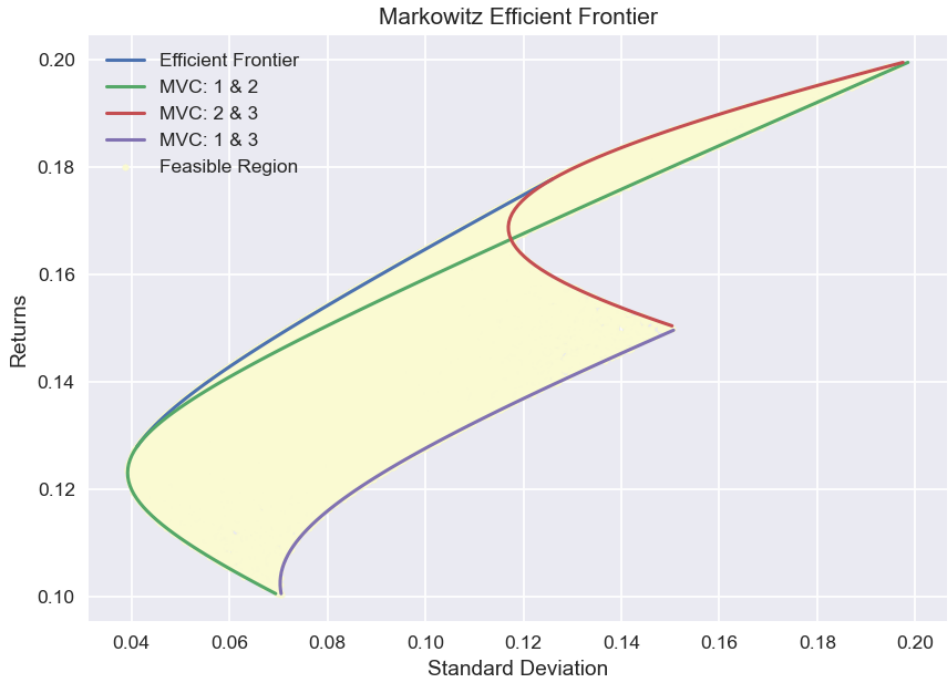
For 0.25 risk

Weight on risk free asset is -0.9683

Weights on risky assets are 2.9219, 1.6145, 0.3842

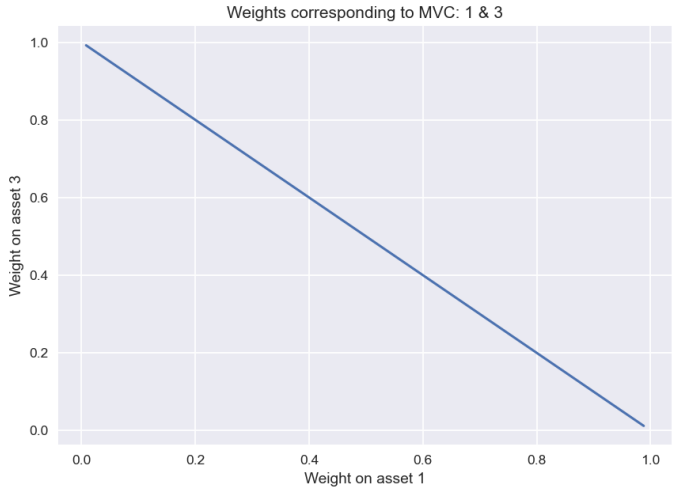
Question 2

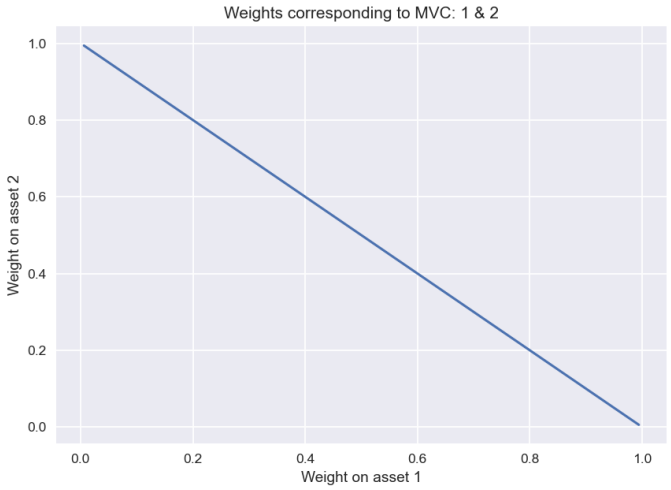
Below curve shows the Minimum variance curve considering 2 assets and all assets at a time. These curves are drawn under the condition that short selling is not allowed in any assets. Feasible region represents the portfolios where no asset is shorted.

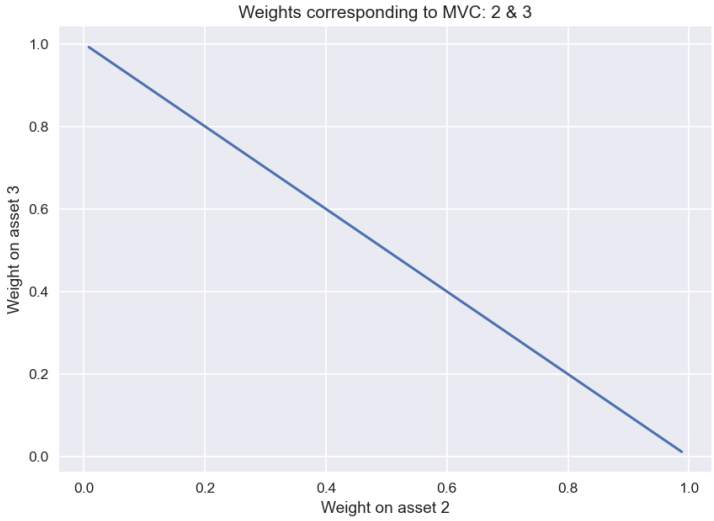


Below graphs shows the relation between the weights on the assets corresponding to above MVC curve taking two assets at a time.

These straight line represents the constraint $w_i + w_j = 1$.







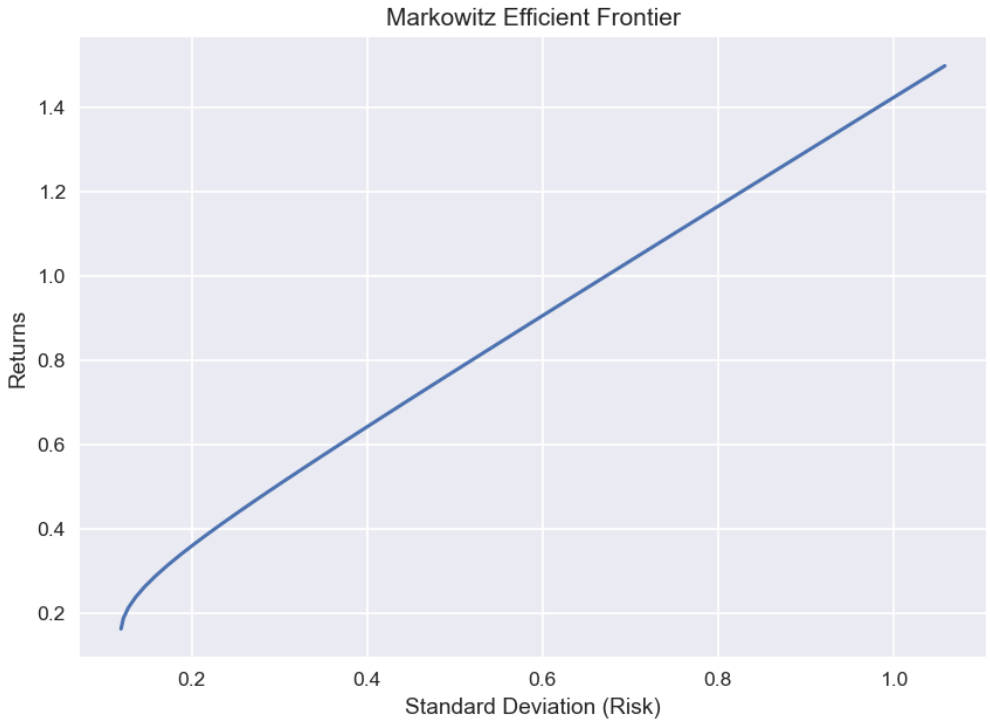
Question 3

The data of monthly prices were obtained for 10 companies stocks from Yahoo Finance. 60 data points were taken from March 2017 to Feb 2022. The companies whose stock prices are analysed are as follows –

> Reliance, SBI, TCS, Wipro, Bajaj Finance, Bharti Airtel, HDFC bank, Hindustan Unilever, ICICI bank, Infosys.

CSV of the data is also attached. Risk free return is assumed to be 5%.

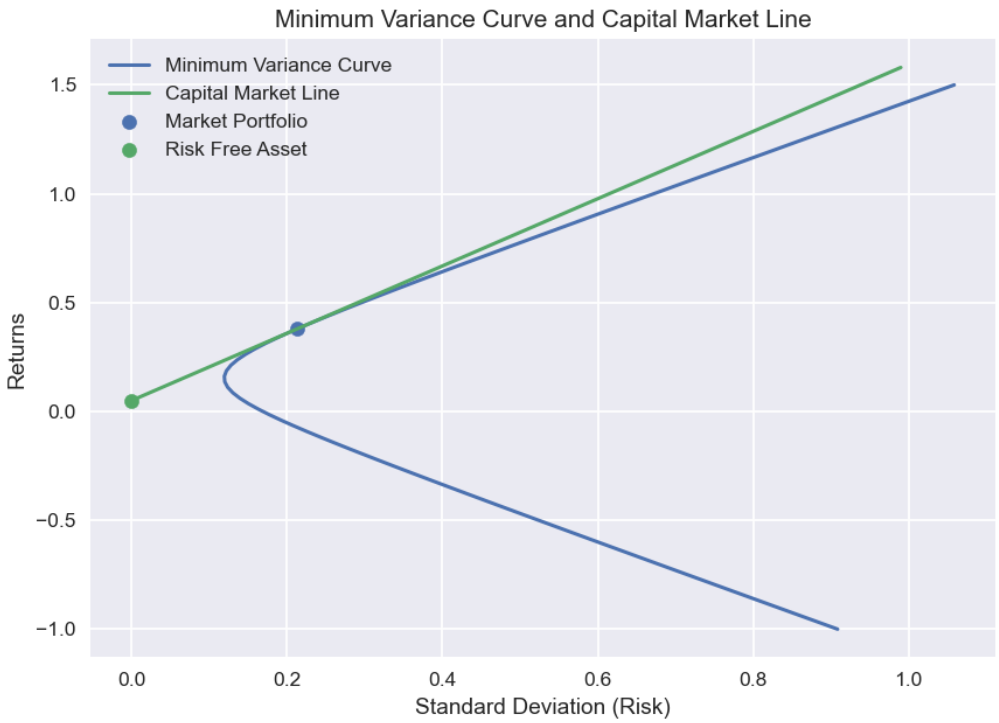
(a) Markowitz efficient frontier is plotted by same method as in question 1.



(b) Market portfolio has risk as 21.284% and returns as 37.895%. Weights on the various companies stocks are given below -

Company	Weights on their stocks
Reliance	0.193643
SBI	-0.188861
TCS	0.087505
Wipro	0.062155
Bajaj Finance	0.231487
Bharti Airtel	0.064474
HDFC Bank	-0.374919
Hindustan Unilever	0.311407
ICICI Bank	0.359065
Infosys	0.254044

(c) Plot of minimum variance curve and capital market line is plotted. Market portfolio and risk free asset is also shown.



(d) Security market line is plotted for all the 10 assets using the following equation by varying β.

$$\mu_v = \mu_{rf} + (\mu_v - \mu_{rf})^*\beta$$

where μ_{rf} is the risk free rate.