



भारतीय प्रौद्योगिकी संस्थान गुवाहाटी
INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

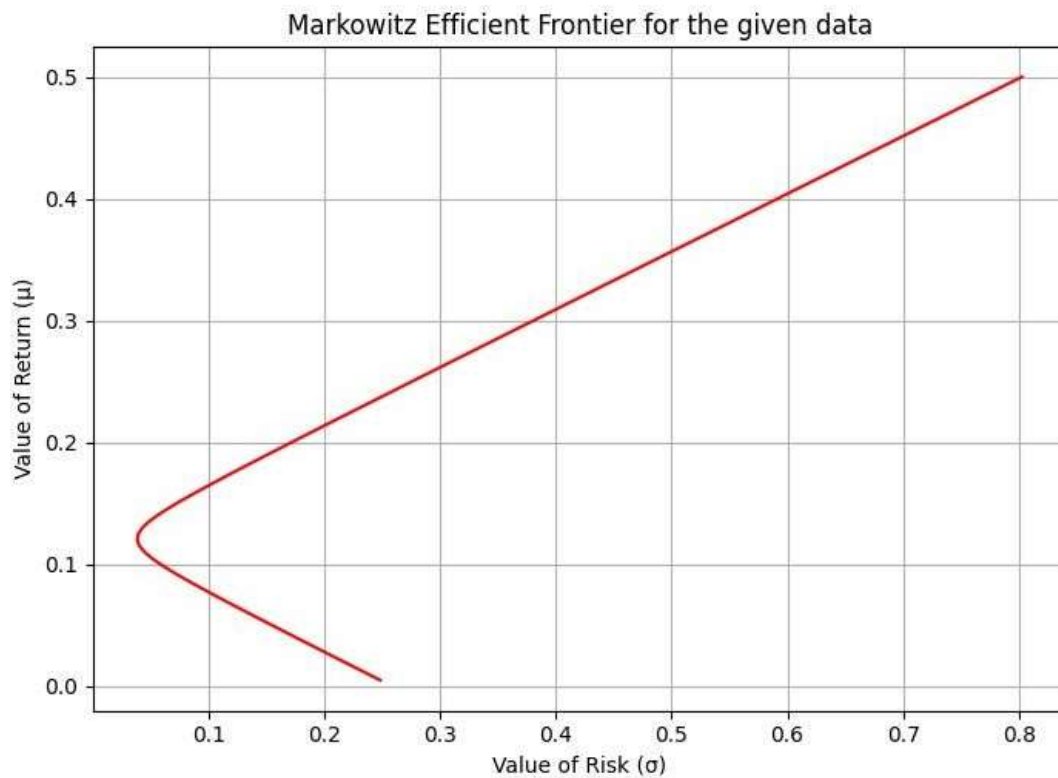
MA 374: Financial Engineering Lab

Lab 04

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Question 1.

(a)



The plot shows the Markowitz efficient frontier constructed using the data:

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

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

In constructing the efficient frontier as shown above no restrictions were put on short selling. As a result, the weights of individual assets could be negative. First, 100 points were chosen in the range $[0, 0.5]$, and then these were taken as the returns. Corresponding to the returns, the minimum possible risk was computed and plotted.

(b) The table of **weights**, **risk**, and **return** of the portfolios for 10 different values on the efficient frontier are as shown below:

Return	Risk	Weight1	Weight2	Weight3
0.05	0.1550	1.8349	-0.1651	-0.6697
0.10	0.0587	1.1193	0.1193	-0.2385
0.15	0.0724	0.4037	0.4037	0.1927
0.20	0.1714	-0.3119	0.6881	0.6239
0.25	0.2755	-1.0275	0.9725	1.0550
0.30	0.3805	-1.7431	1.2569	1.4862
0.35	0.4859	-2.4587	1.5413	1.9174
0.40	0.5913	-3.1743	1.8257	2.3486
0.45	0.6969	-3.8899	2.1101	2.7798
0.50	0.8025	-4.6055	2.3945	3.2110

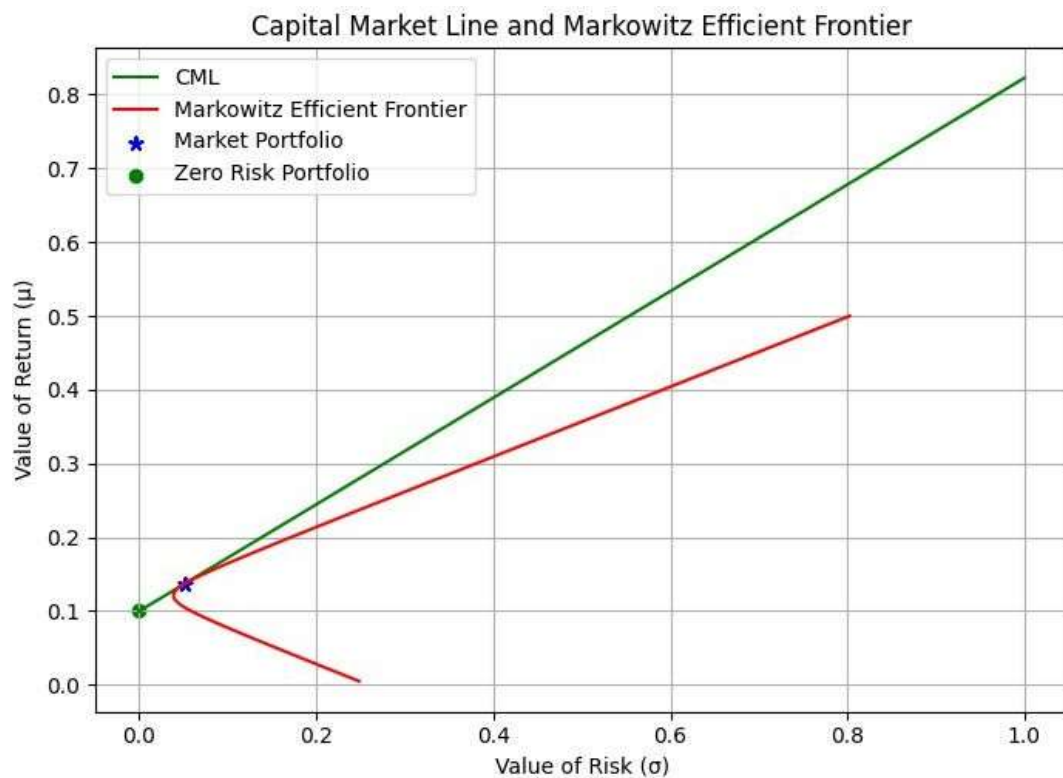
(c) For a 15% risk:

- Maximum Return Portfolio:
Return = 18.9555% and Weights : -0.1624, 0.6287, 0.5338
- Minimum Return Portfolio:
Return = 5.2447% and Weights : 1.7998, -0.1512, -0.6486

(d) Minimum Risk Portfolio for 18% return

Risk = 13.0568% and Weights : -0.0257, 0.5743, 0.4514

(e)



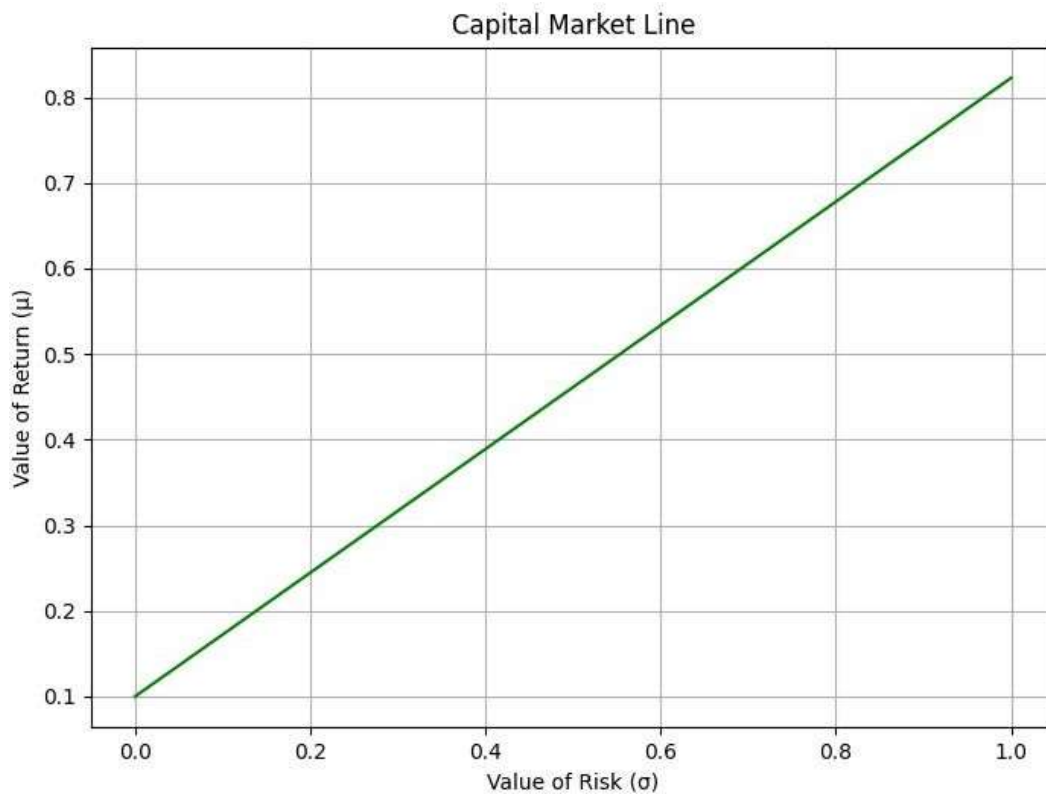
The figure shows the Market Portfolio, CML, Zero-risk Portfolio, and the Markowitz Efficient Frontier.

To get the market portfolio, the point on the Efficient Frontier, which gave the maximum Sharpe Ratio, with the given risk-free return ($\mu_{rf} = 10\%$), was used. The line joining the zero risk portfolio and the market portfolio is the Capital Market Line.

The computed market portfolio corresponds to the point $(0.051, 0.137)$, i.e.,

- Weights : 0.5938, 0.3281, 0.0781
- Return on market portfolio = 13.6719%
- Risk on market portfolio = 5.0811%

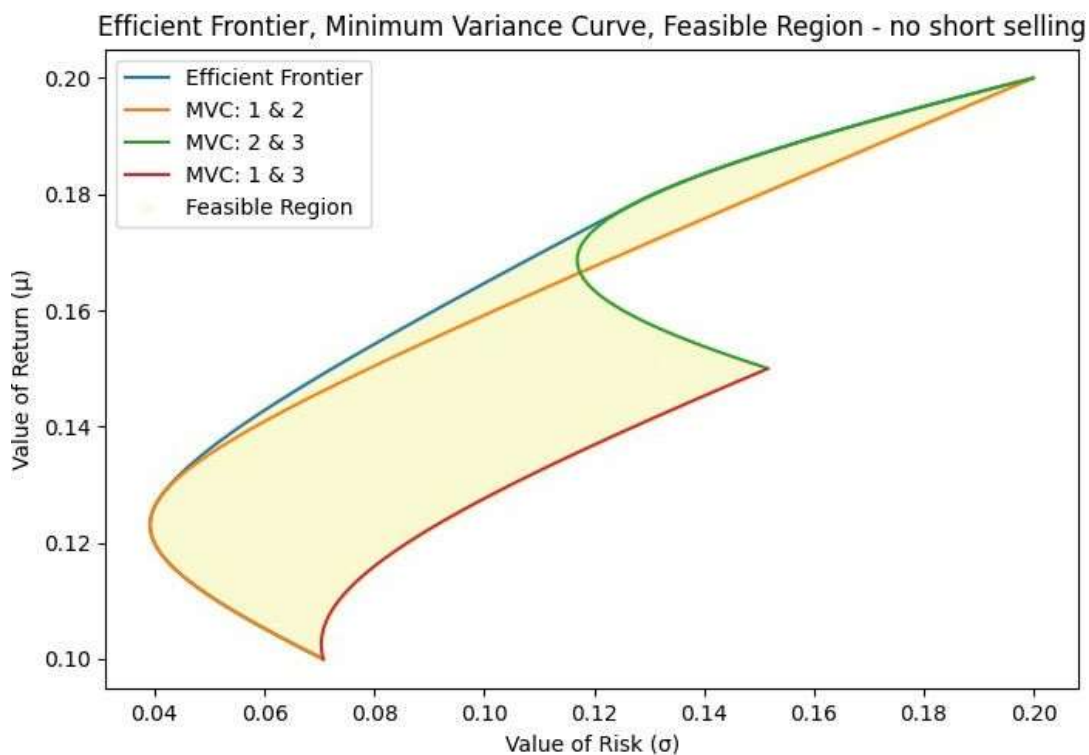
The plot of the CML individually is drawn below:



(f) The 2 portfolios obtained are:

- Portfolio for 10% risk:
 - Risk-Free Asset : -0.9681
 - Risky Assets Weights : 1.1685 , 0.6458 , 0.1538
- Portfolio for 25% risk:
 - Risk-Free Asset : -3.9202
 - Risky Assets Weights : 2.9213 , 1.6144 , 0.3844

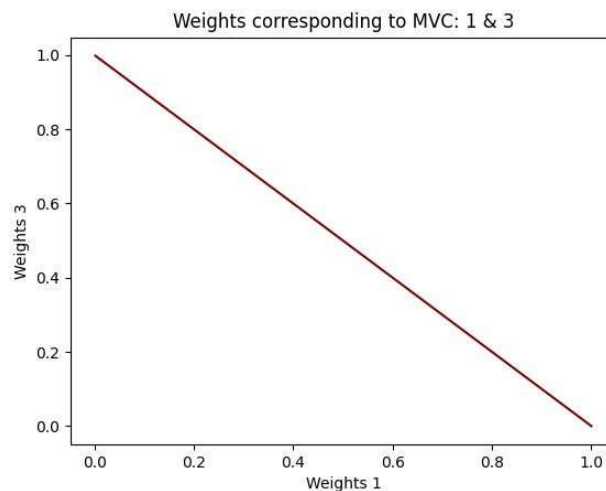
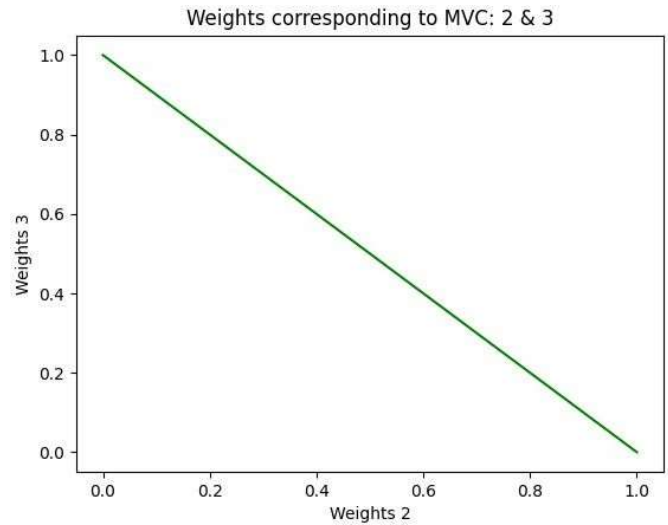
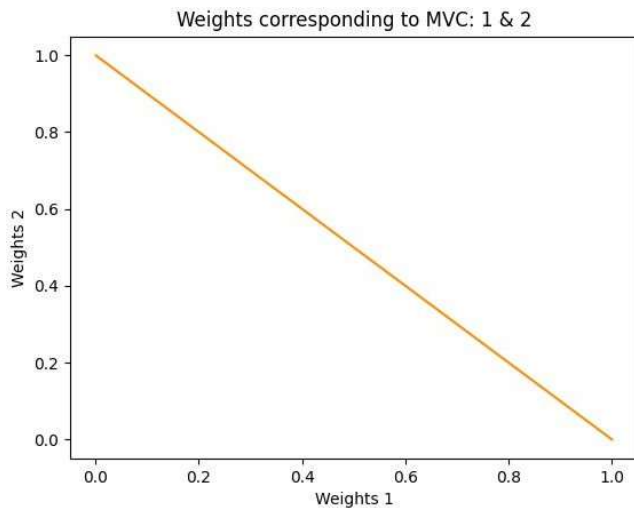
Question 2.



Graph showing efficient frontier, feasible region, and MVCs considering 2 out of 3 securities at a time.

In this question, we used a similar idea as question 1, with the difference that in this case short-selling was not allowed. Thus the weights needed to be strictly in the range $[0, 1]$

Plots of the weights corresponding to the minimum variance curve are:



As can be easily seen, the equation that these weights satisfy is $y = 1 - x$.

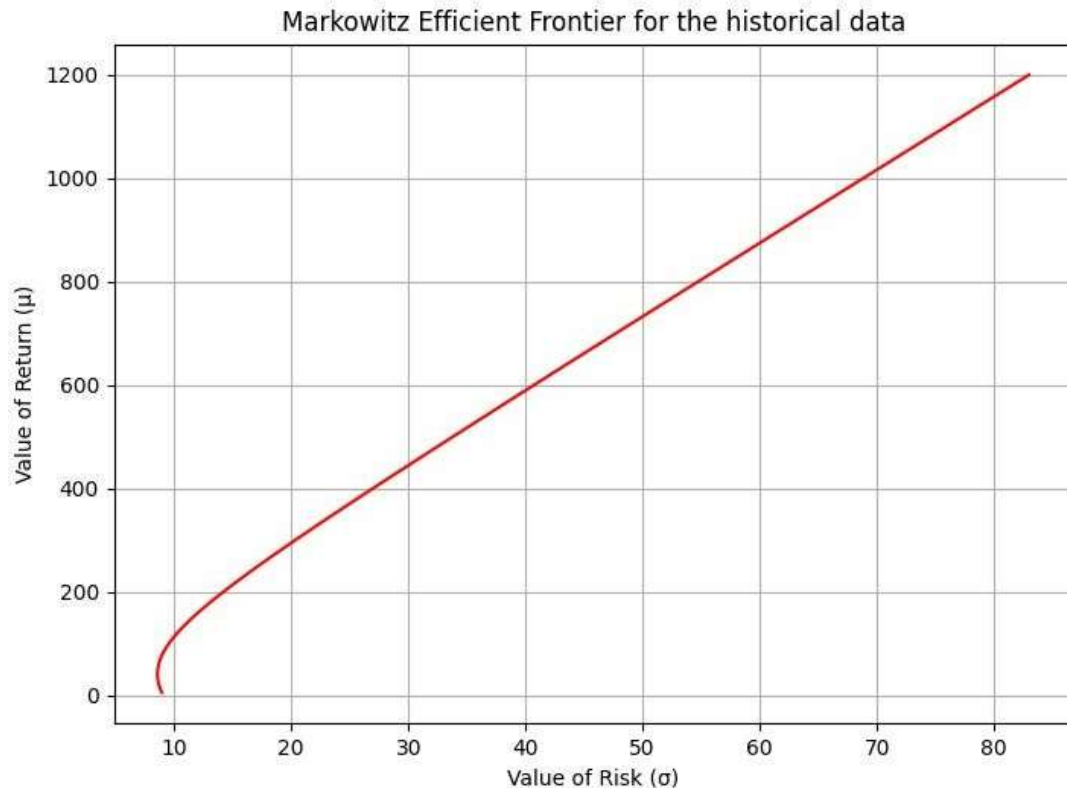
Question 3.

The data of monthly prices were obtained for 10 stocks each with 60 data points all taken at the same duration over 5 years (Feb 01, 2016 - Feb 01, 2021) from <https://in.finance.yahoo.com/>. The following companies were considered:

SBI, Asian Paints, BharatiAirtel, CIPLA, IOC, JSW Steel, Maruti, Wipro, Axis Bank, ONGC

Following a similar approach in question 1 after having obtained the Mean Return Vector and Covariance Matrix, we get the following graphs and results.

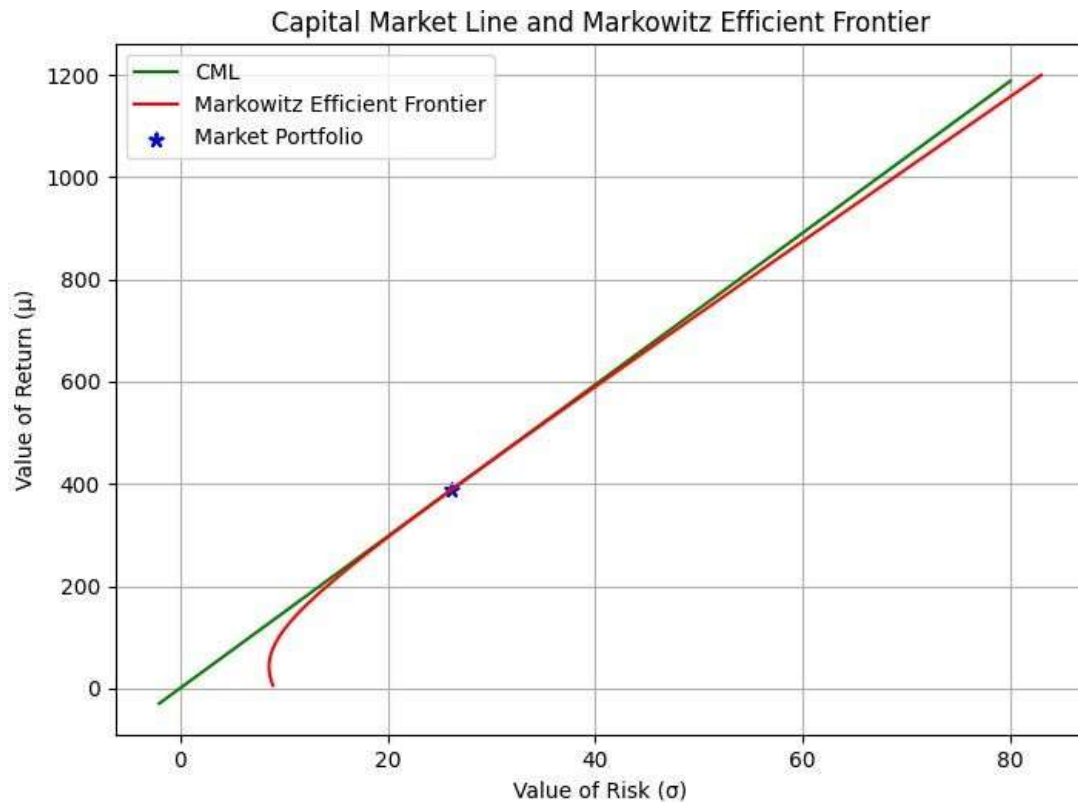
(a)



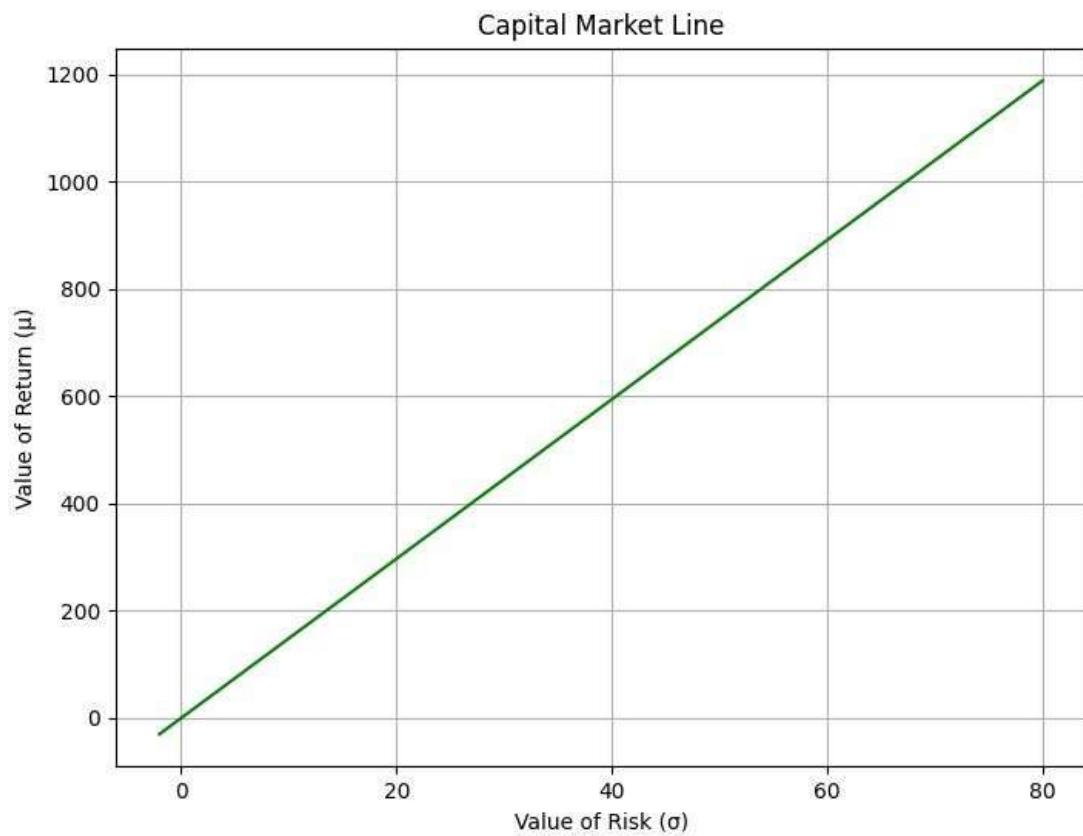
(b) Assuming a 5% risk free return:

- Weights : -0.2859 , 0.0371 , 0.1714 , 0.2898 , -0.063 , -0.4082 , 0.0021 , -0.1064 , 0.2788 , 1.0845
- Return on market portfolio = 38836.9569%
- Risk on market portfolio = 2614.2522%

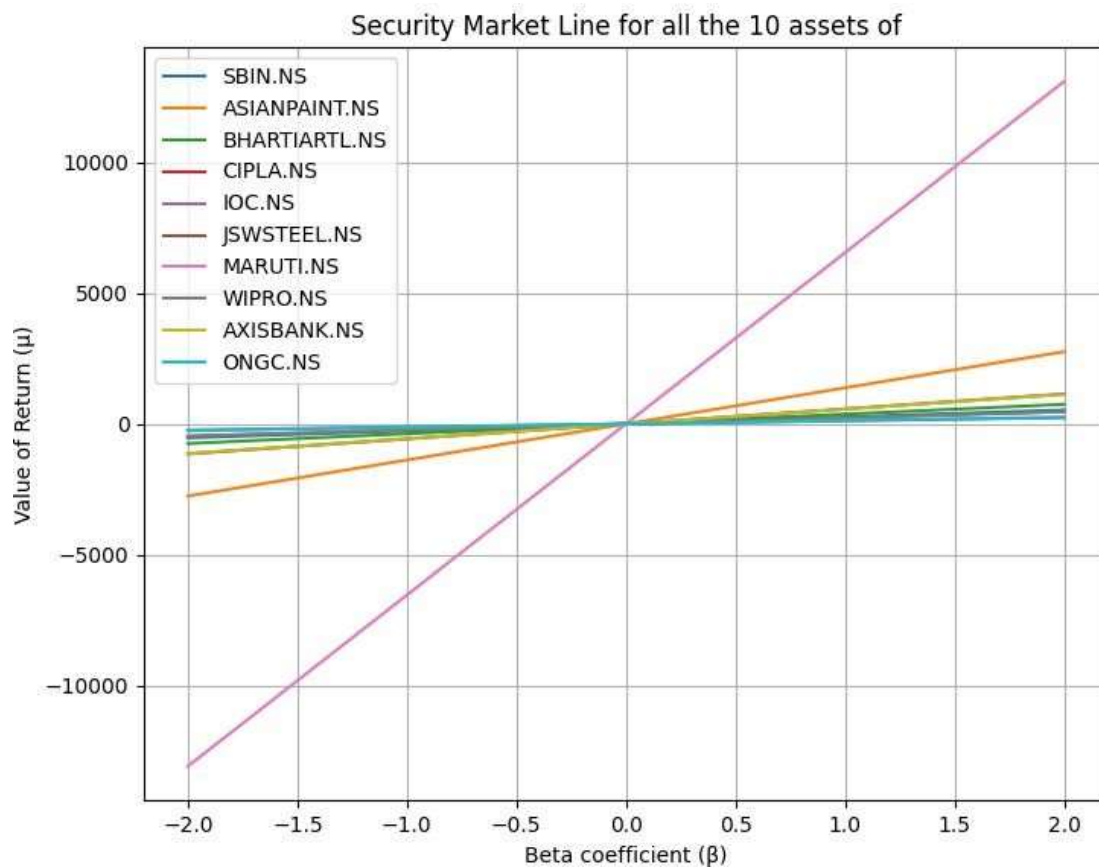
(c)



The plots for the Capital Market Line, Efficient Frontier, and the Market Portfolio are shown above. A plot of only the CML is drawn below.



(c) For plotting the Security Market Line, $E[R_i] = R_f + (E[RM] - R_f)\beta$ was used. Beta was generated uniformly between $[-2, 2]$, and making use of the rest of the values, the Security Market Lines were plotted for all the 10 assets.



Note: For this question, the mean return vector has been obtained by taking the mean of all the columns for the 10 different stocks. The same could also be obtained using $\frac{S(i)-S(i-1)}{S(i)}$. The graphs won't change in either case, only the mean return will get scaled.

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