Lab - 04

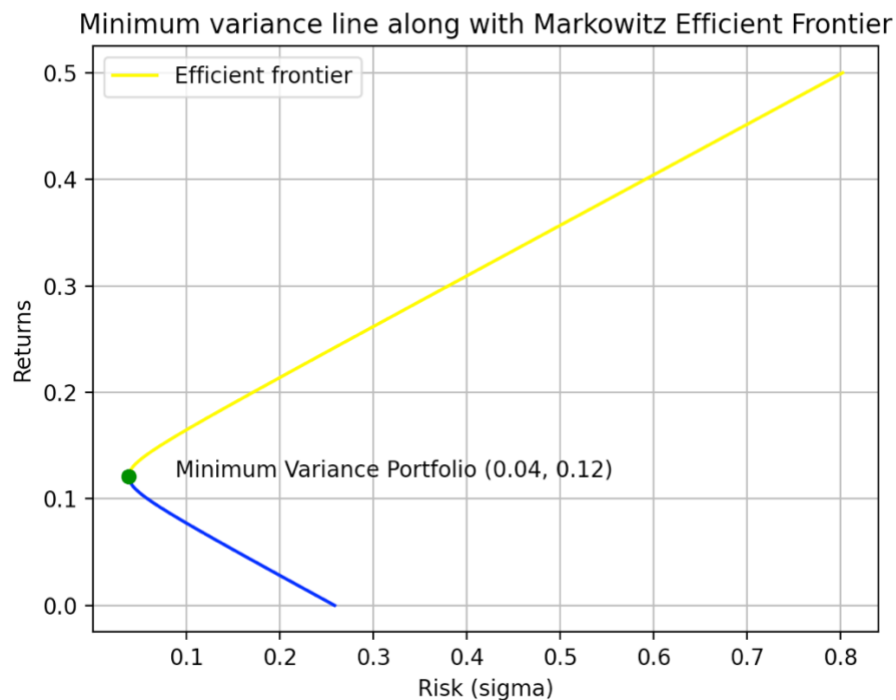Dipanshu Goyal   210123083

Ques – 1

(a) The Markowitz efficient frontier using given M and C is as follows: -

The efficient frontier is the one with higher expected return and lower standard deviation (lower risk). So, the points with higher return than the minimum variance portfolio point shows the efficient frontier on the curve.

(b) The weights, return and risk of the portfolios for 10 different values on the efficient frontier are as follows: -

```
*****************  1(b)  *****************

Index    weights                                  risk                       return

1.       [ 1.83550649 -0.1653936  -0.67011288]   0.04995499549954996        0.02405612017613471
2.       [ 1.11983859  0.11903851 -0.2388771 ]   0.09995999599959997        0.003457064791231648
3.       [0.40417069 0.40347062 0.19235869]      0.14996499649964998        0.005229455948986987
4.       [-0.3114972   0.68790274  0.62359447]   0.19996999699969997        0.029373293649400736
5.       [-1.0271651   0.97233485  1.05483025]   0.24997499749975           0.07588857789247296
6.       [-1.742833    1.25676696  1.48606604]   0.29997999799979996        0.1447753086782031
7.       [-2.4585009   1.54119907  1.91730182]   0.34998499849985           0.2360334860065915
8.       [-3.17416879  1.82563119  2.34853761]   0.3999899989999 0.3496631098776399
9.       [-3.88983669  2.1100633   2.77977339]   0.4499949994995003         0.4856641802913457
10.      [-4.60550459  2.39449541  3.21100917]   0.5        0.64403669724771
```

(c) For 15% risk,

```
****************** 1(c) ******************

Minimum return  = 0.052455245524552455
weights         = [ 1.79972309 -0.151172    -0.64855109]


Maximum return  = 0.1895689568956896
weights         = [-0.16263828  0.62874086  0.53389743]
```

(d) For 18% return, the minimum risk portfolio is: -

```
****************** 1(d) ******************

Minimum risk for 18% return   =  13.056827100982652  %
Weights                       =  [-0.02568807  0.57431193  0.45137615]
```

(e) The market portfolio is: -

```
****************** 1(e) ******************

Market Portfolio Weights     =  [0.59375  0.328125 0.078125]
Return                       =  0.13671875
Risk                         =  5.081128919221594  %

Equation of CML is:
y = 0.72 x + 0.10
```

The equation of the CML is: $\mu = 0.72\,\sigma + 0.1$
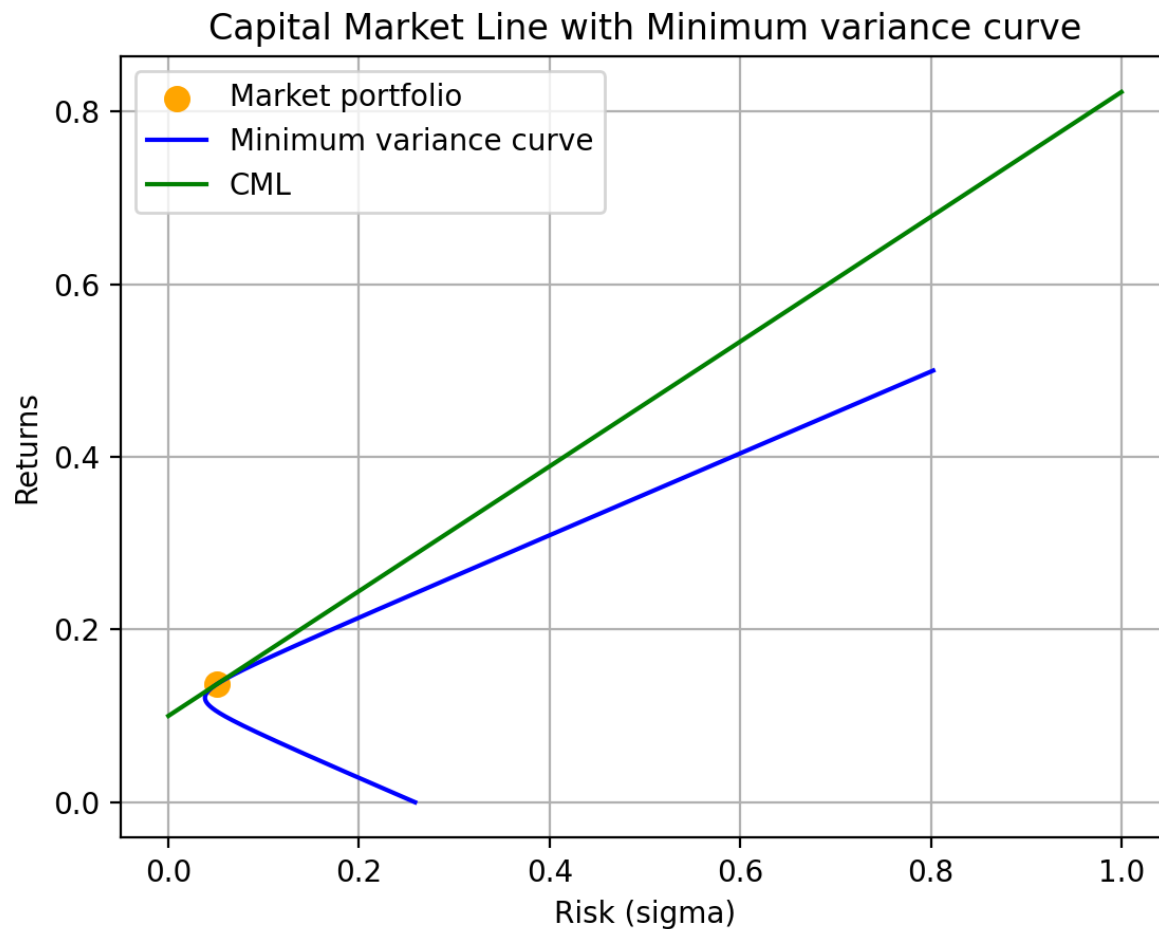
The equation is obtained using the following formula:
$$\mu = \frac{\mu_M - \mu_{rf}}{\sigma_M}\,\sigma + \mu_{rf}$$

where,

μ_M = return corresponding to market portfolio

μ_{rf} = risk free return

σ_M = risk corresponding to market portfolio

2

Capital Market Line with Minimum variance curve

(f) The required portfolio with risk at 10% is: -

```
****************** 1(f) ******************

Risk                    = 10.0  %
Risk-free weights       = -0.9680665771282883
Risky Weights           = [1.16853953 0.64577185 0.1537552 ]
Returns                 = 0.17226494462892933


Risk                    = 25.0  %
Risk-free weights       = -3.920166442820721
Risky Weights           = [2.92134883 1.61442961 0.384388  ]
Returns                 = 0.2806623615723233
```
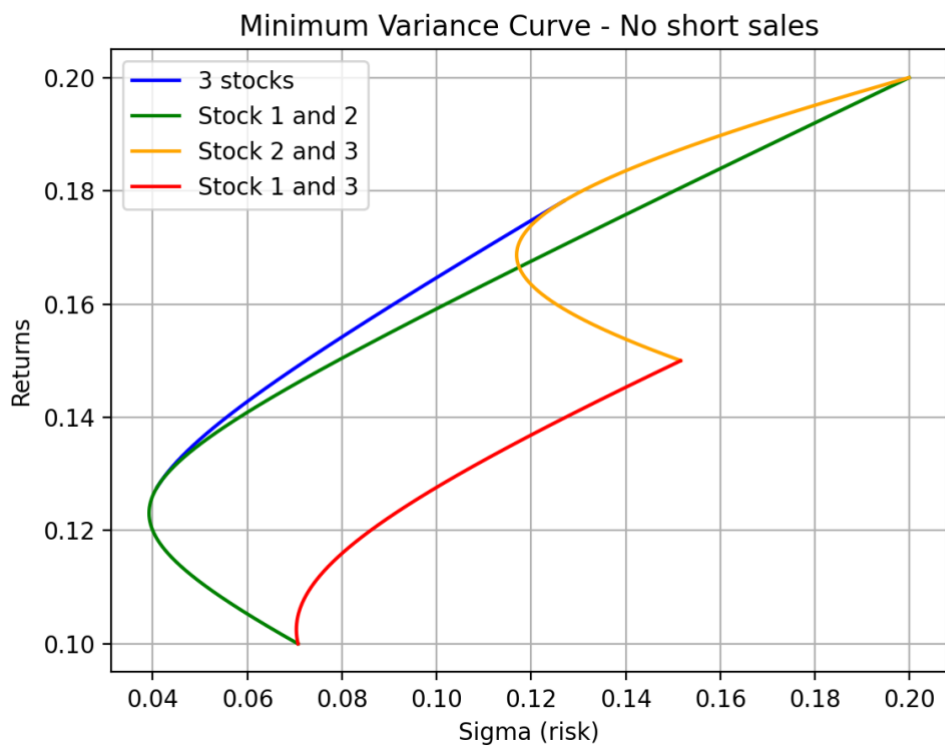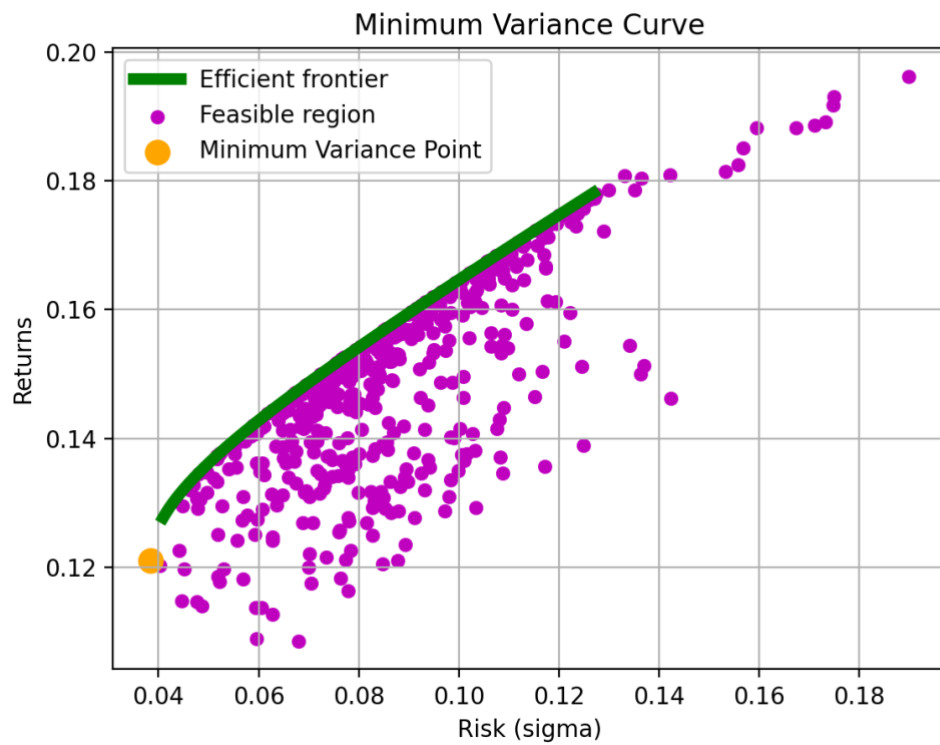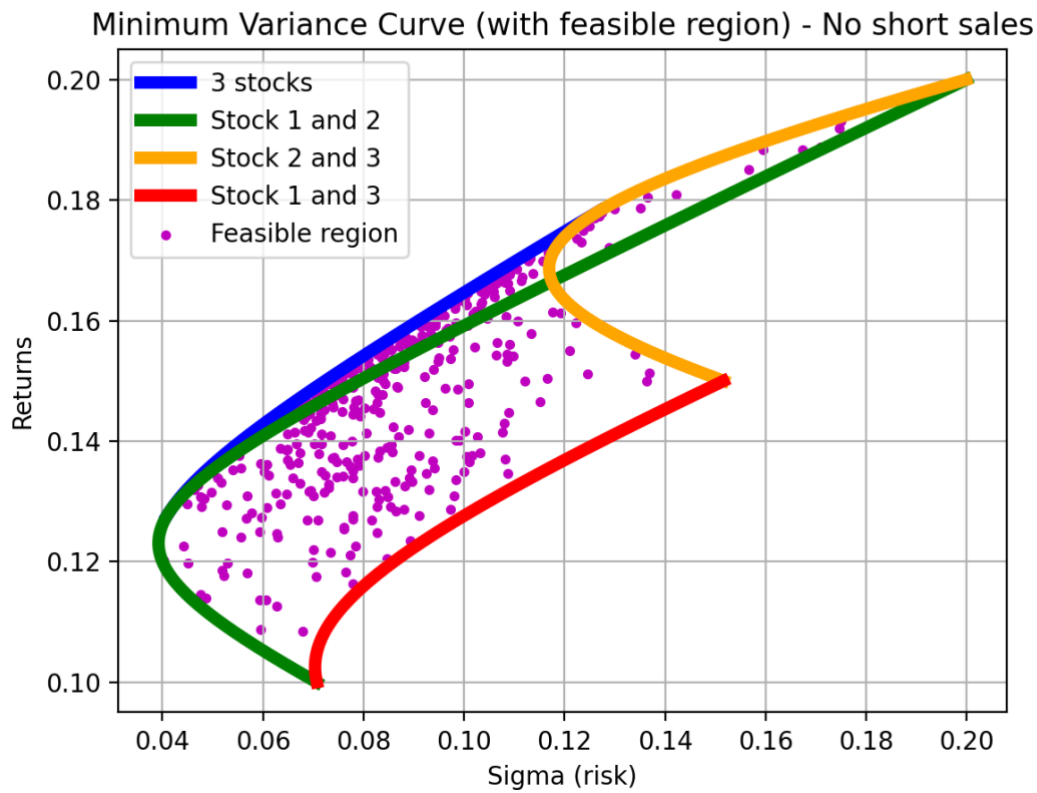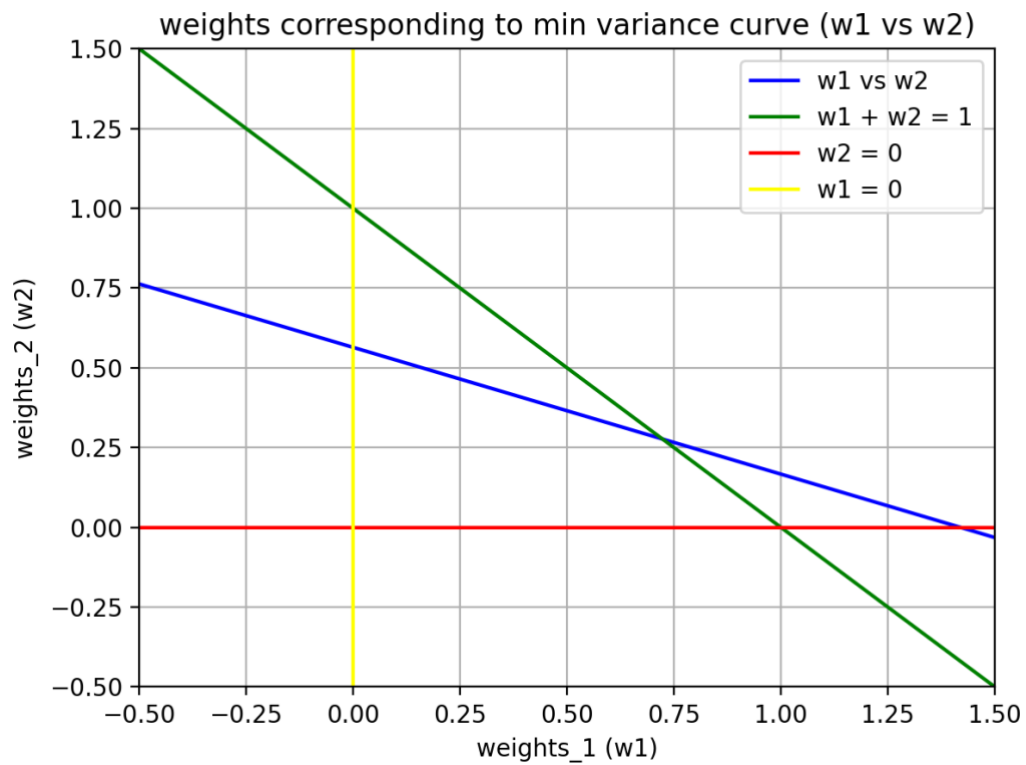
Ques – 2

Assuming short sales are not allowed, i.e., weights are non-negative, the various plots can be obtained like: -
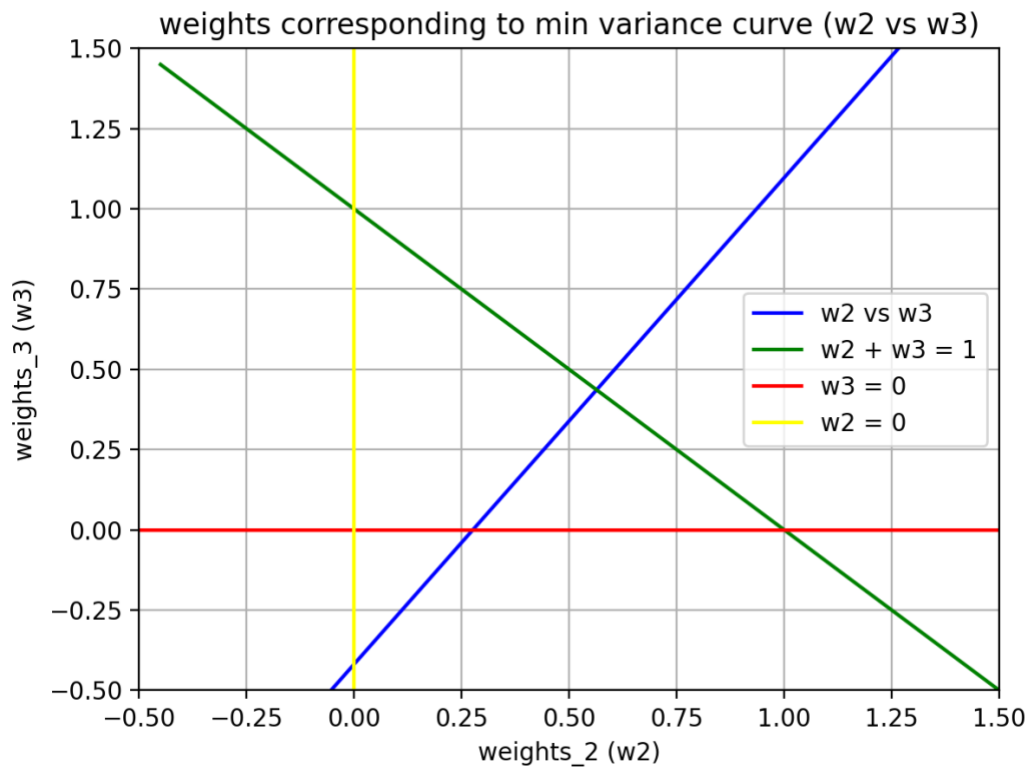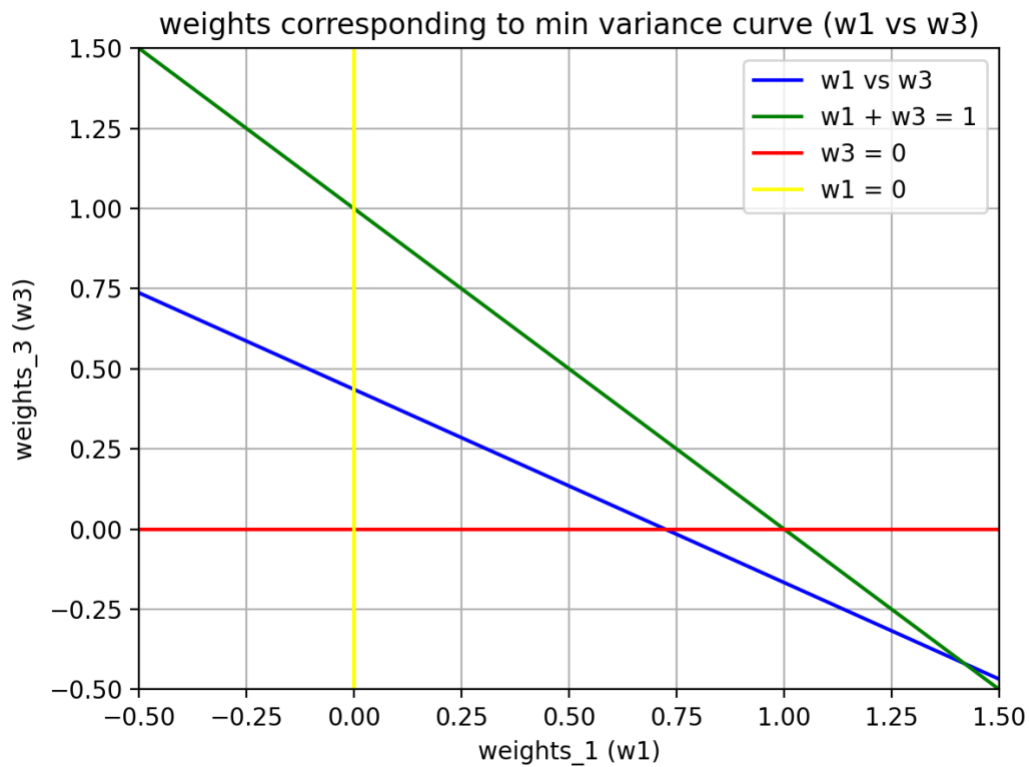
Minimum Variance Curve (with feasible region) - No short sales

➔ Equation of line w1 vs w2 is: - w2 = -0.40 w1 + 0.56

weights corresponding to min variance curve (w1 vs w2)

➔ Equation of line w2 vs w3 is: - w3 = 1.52 w2 + -0.42

weights corresponding to min variance curve (w2 vs w3)

➔ Equation of line w1 vs w3 is: - w3 = -0.60 w1 + 0.44

weights corresponding to min variance curve (w1 vs w3)

Ques – 3

Data for 10 stocks has been obtained from NSE from Feb 2019 to Jan 2024 to get 60 different time stamps for data points. The following 10 Stocks are considered for the purpose: -

,Amul India,Interglobe Aviation, ,Tata Motors,Ultratech Cement,ONGC, SBI,TCS

- IDBI Bank
- Amul India
- Interglobe Aviation
- Oil India
- Tata Motors
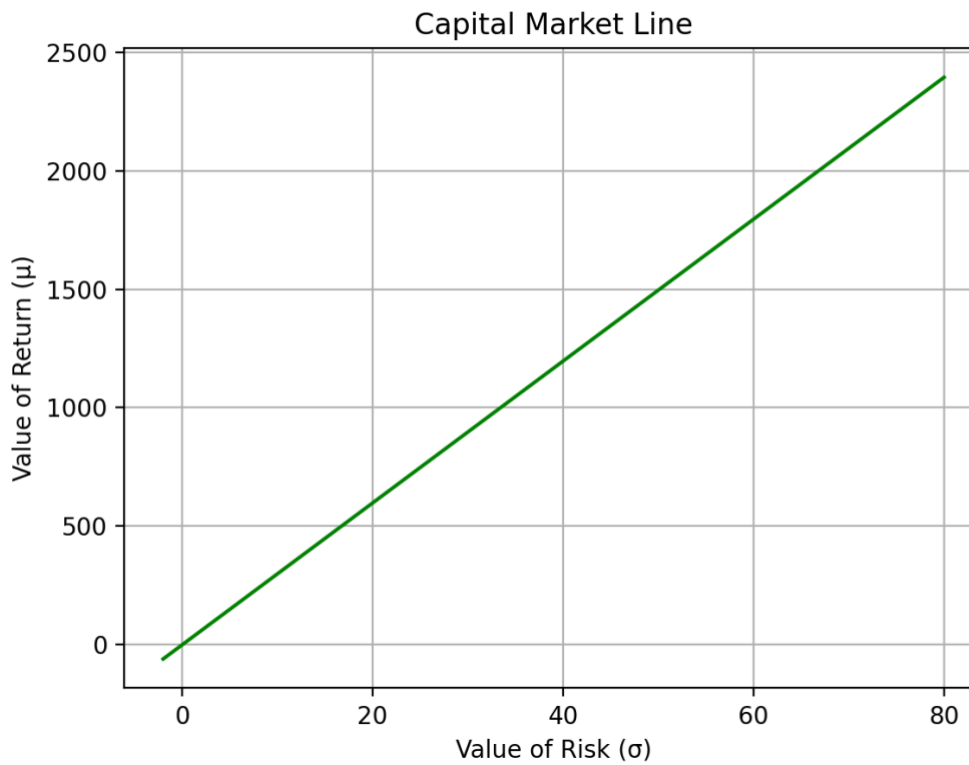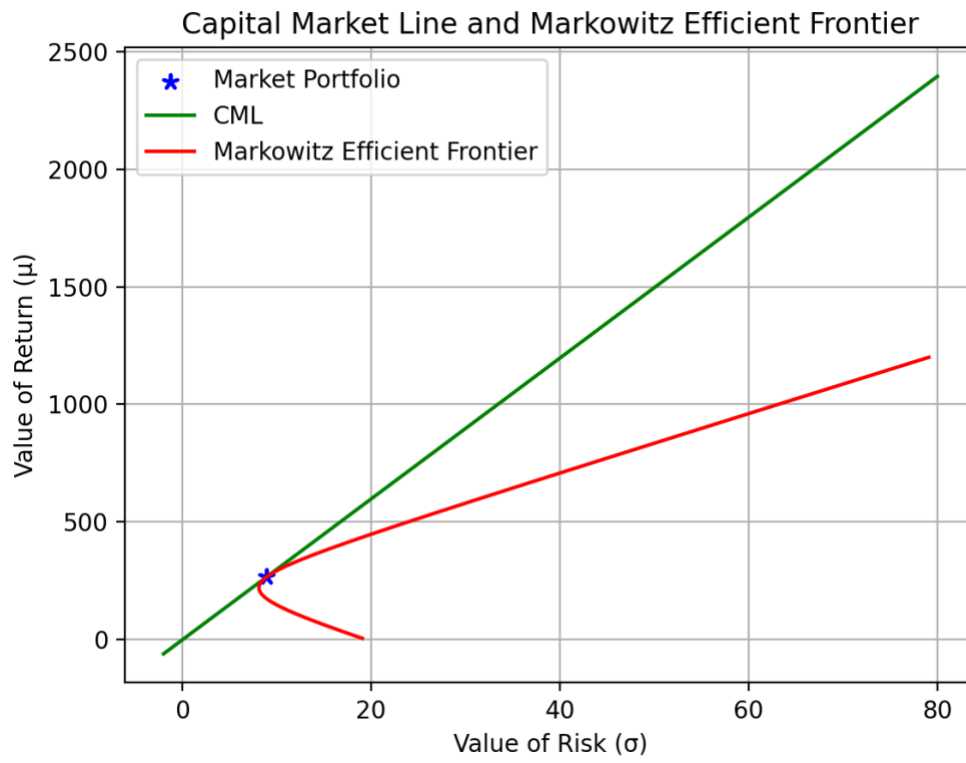- Ultratech Cement
- ONGC
- Reliance Industries
- SBI
- TCS

(a)

Markowitz Efficient Frontier for the historical data
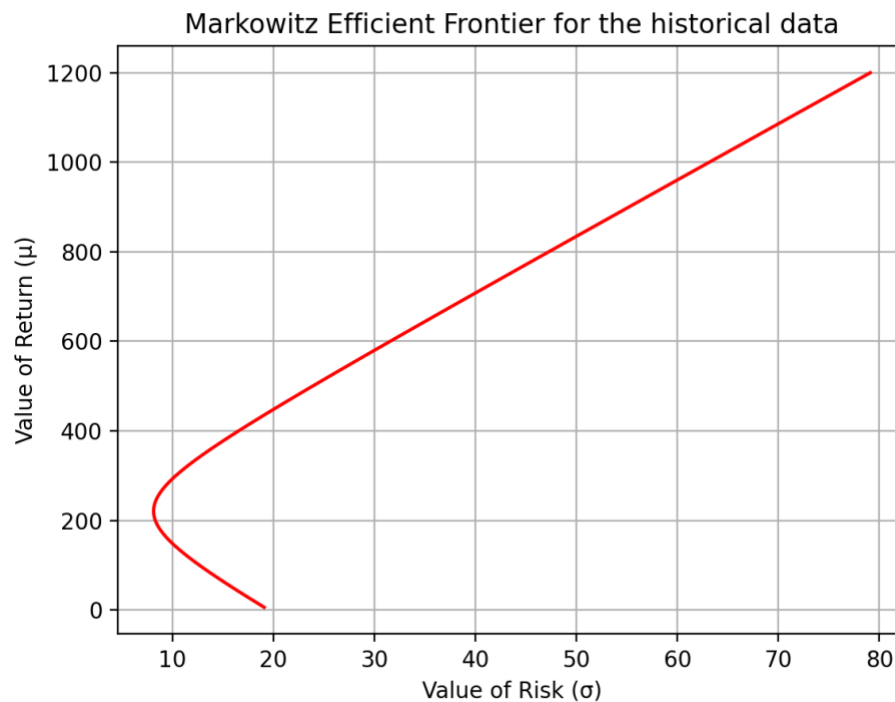
(b)

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For 5% risk-free return --
Weights : 0.0453, 0.4677, -0.0122, -0.2269, 0.0249, -0.0833, 0.9165, 0.0056, -0.1246, -0.0132
Return on market portfolio = 26694.6853%
Risk on market portfolio = 892.1222%
```

(c)

Capital Market Line and Markowitz Efficient Frontier

Capital Market Line

8

For plotting the Security Market Line, E[Ri] = Rf + (E[RM] - Rf)ß 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.
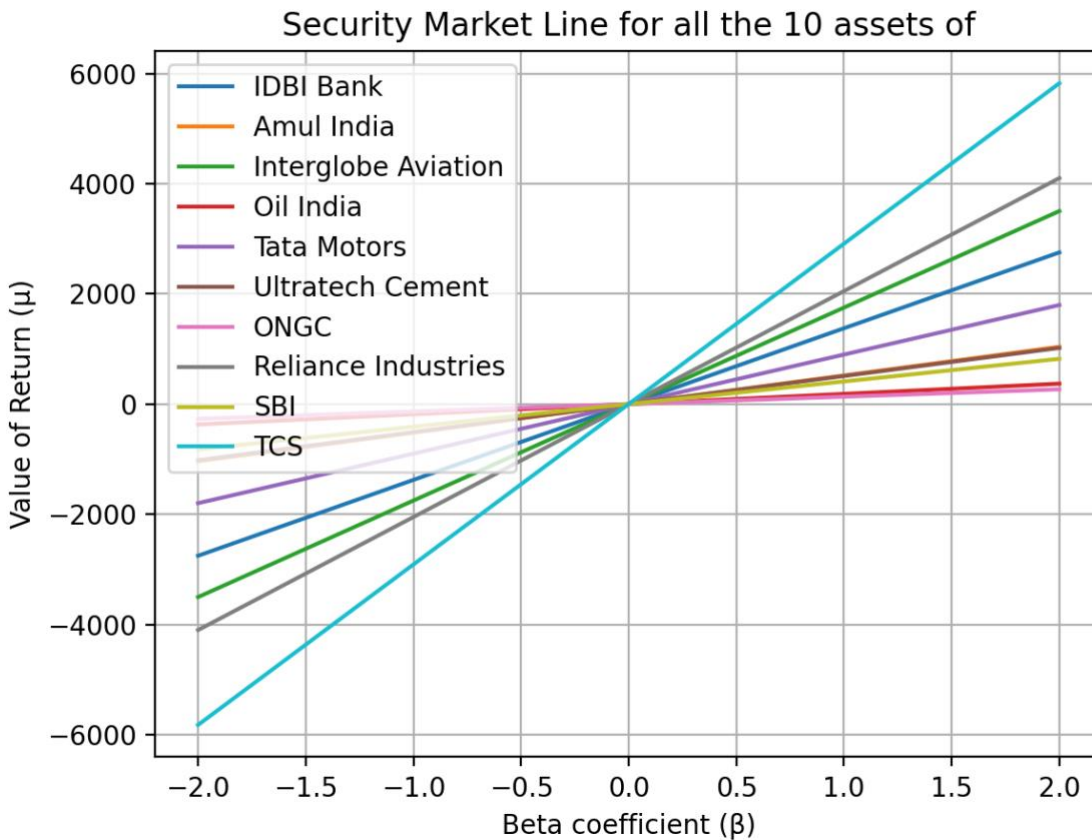
Note: - In the code please enter the proper path for '210123083_data.csv' file if moving it to other location, else it will produce an error stating no file found.