MA 374 Financial Engineering Lab Lab 04

Karan Garg - 210123076

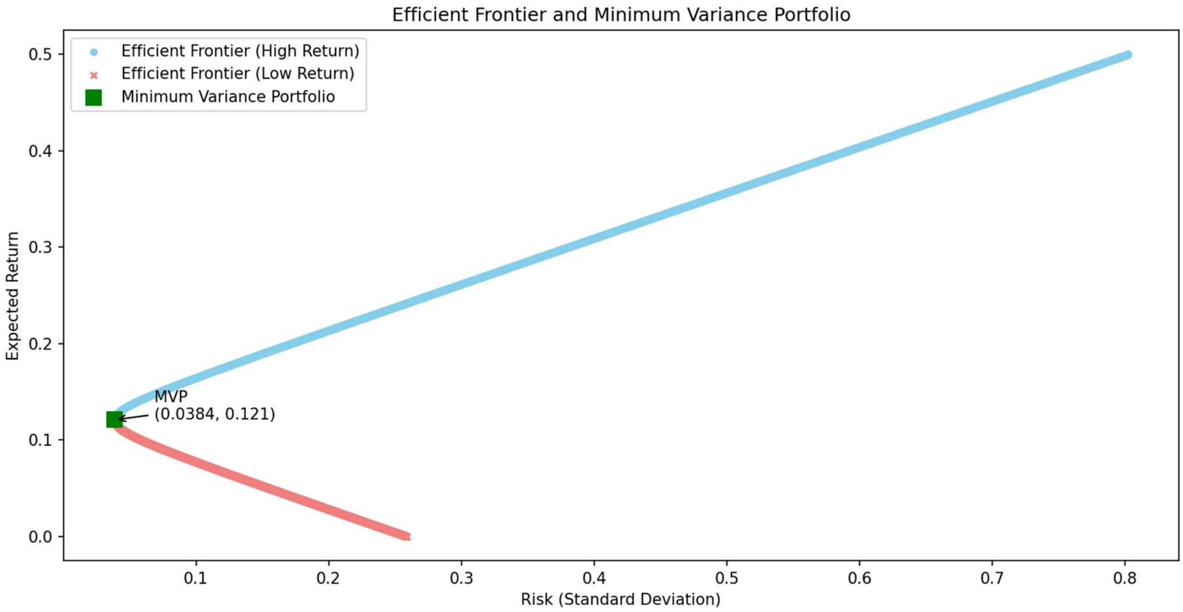
Q1)

a)

$$\boldsymbol{\mu} = \begin{bmatrix} 0.1 & 0.2 & 0.15 \end{bmatrix}$$

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

Markowitz efficient frontier:



Weights of the portfolio are obtained by the following formula:

$$w = \frac{\begin{vmatrix} 1 & uC^{-1}M^T \\ \mu_v & MC^{-1}M^T \end{vmatrix} uC^{-1} + \begin{vmatrix} uC^{-1}u^T & 1 \\ MC^{-1}u^T & \mu_v \end{vmatrix} MC^{-1}}{\begin{vmatrix} uC^{-1}u^T & uC^{-1}M^T \\ MC^{-1}u^T & MC^{-1}M^T \end{vmatrix}}$$

where, μ_v = return,

u = [1, 1, 1, ..., 1] (with same dimension as that of number of assets)

The value of σ_v^2 is calculated as per the following formula:

$$\sigma_v^2 = wCw^T$$

Now, the weights of the minimum variance portfolio is :

$$w = \frac{uC^{-1}}{uC^{-1}u^T}$$

b) For 10 different values on efficient frontier:

Weights	Return	Risk
[[0.40217697] [0.404263] [0.19356003]]	0.150104	0.0725647
[[0.25044341] [0.46456736] [0.28498923]]	0.160706	0.0923526
[[-0.26264014] [0.66848518] [0.59415495]]	0.196556	0.164358
[[-1.10554001] [1.00348385] [1.10205616]]	0.255451	0.286953
[[-1.57748551] [1.19105193] [1.38643357]]	0.288427	0.356192
[[-2.00659474] [1.36159534] [1.64499939]]	0.31841	0.419292
[[-3.28913988] [1.87132482] [2.41781505]]	0.408023	0.608279
[[-3.6868442] [2.0293868] [2.65745741]]	0.435812	0.666945
[[-4.2246442] [2.24312782] [2.98151638]]	0.473389	0.746304
[[-4.59508449] [2.39035409] [3.2047304]]	0.499272	0.800981

c)

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For Part C:

For 15% Risk:

Maximum Return is : 18.96%
And the corresponding weights are :  [-0.16243566  0.62866033  0.53377534]

Minimum Return is : 5.24%
And the corresponding weights are :  [ 1.79984338 -0.1512198   -0.64862357]
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d)

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For Part D:

For 18% return:

Minimum Risk is: 0.1306
And the corresponding weights are :  [-0.02568807  0.57431193  0.45137615]
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e)

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For Part E:

Market Portfolio Weights =  [0.59375  0.328125 0.078125]
Return = 13.67%
Risk = 5.08%
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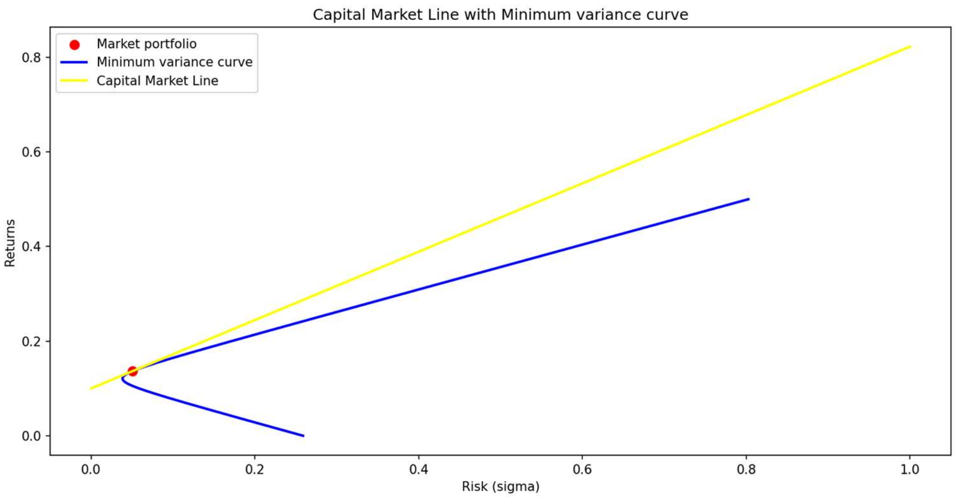

Equation: 0.732x + 0.100

f)

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For Part F:

Risk = 10.00%
Risk-free weights = -0.9680665771282883
Risky Weights = [1.16853953 0.64577185 0.1537552 ]
Returns = 17.23%

Risk = 25.00%
Risk-free weights = -3.9201664428207224
Risky Weights = [2.92134883 1.61442961 0.384388  ]
Returns = 28.07%
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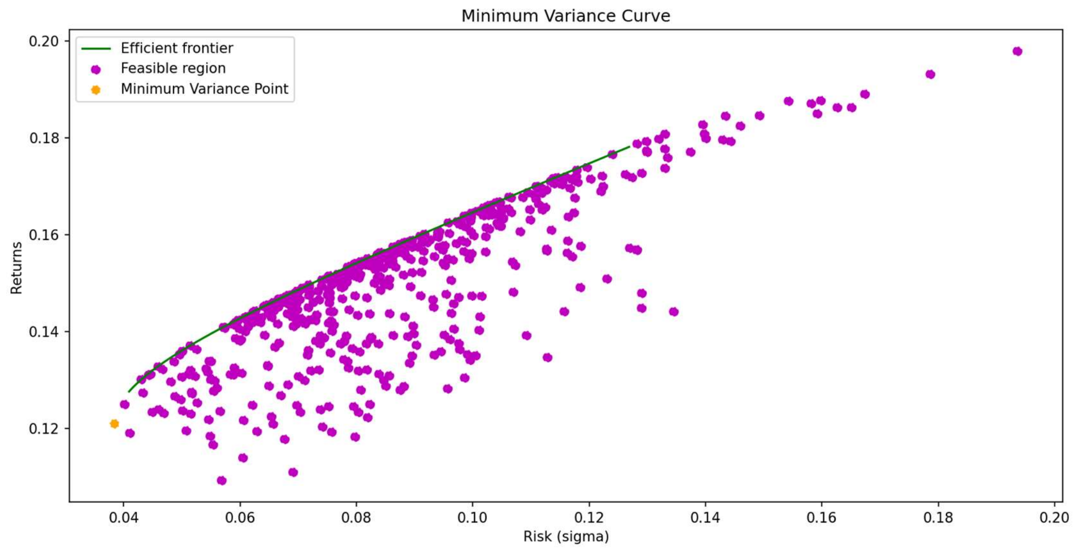
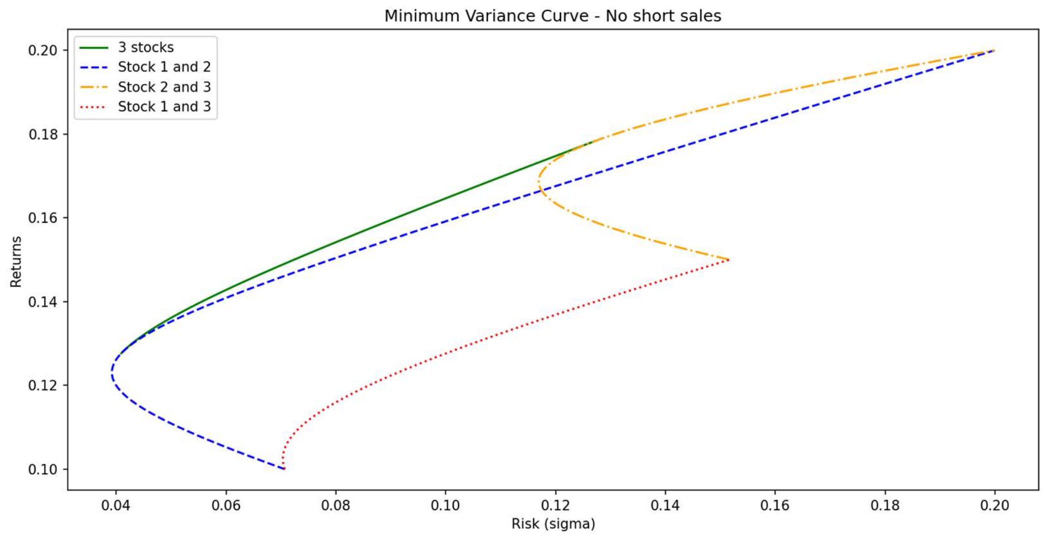
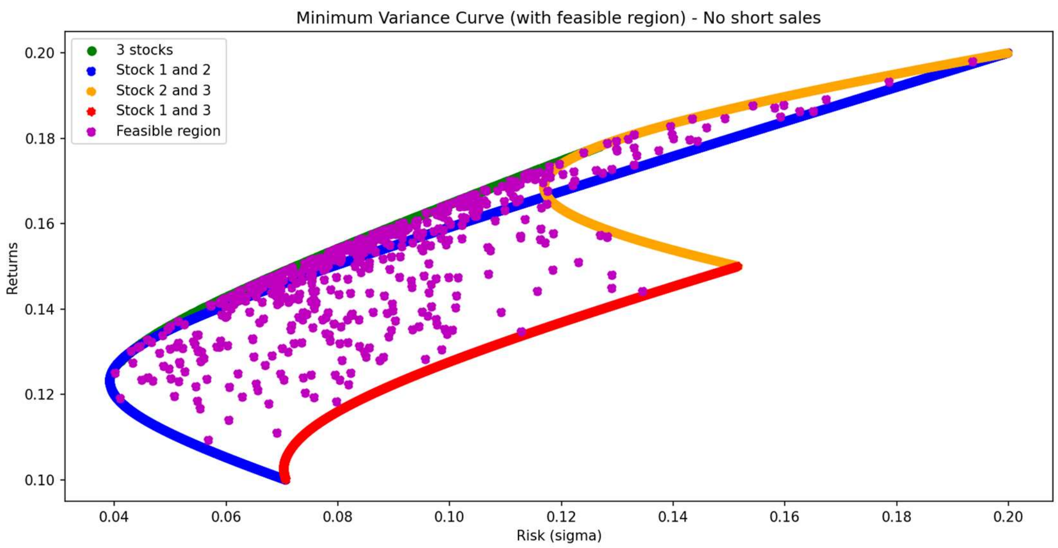
Q2)


Minimum Variance Curve
Efficient frontier
Feasible region
Minimum Variance Point
Returns
Risk (sigma)
0.20
0.18
0.16
0.14
0.12
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20


Minimum Variance Curve - No short sales
3 stocks
Stock 1 and 2
Stock 2 and 3
Stock 1 and 3
Returns
Risk (sigma)
0.20
0.18
0.16
0.14
0.12
0.10
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20


Minimum Variance Curve (with feasible region) - No short sales
3 stocks
Stock 1 and 2
Stock 2 and 3
Stock 1 and 3
Feasible region
Returns
Risk (sigma)
0.20
0.18
0.16
0.14
0.12
0.10
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20

Plots for the weights of corresponding minimum variance curve:

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Eqn of line w1 vs w2 is:
w2 = -0.40 w1 + 0.56
Eqn of line w2 vs w3 is:
w3 = 1.52 w2 + -0.42
Eqn of line w1 vs w3 is:
w3 = -0.60 w1 + 0.44
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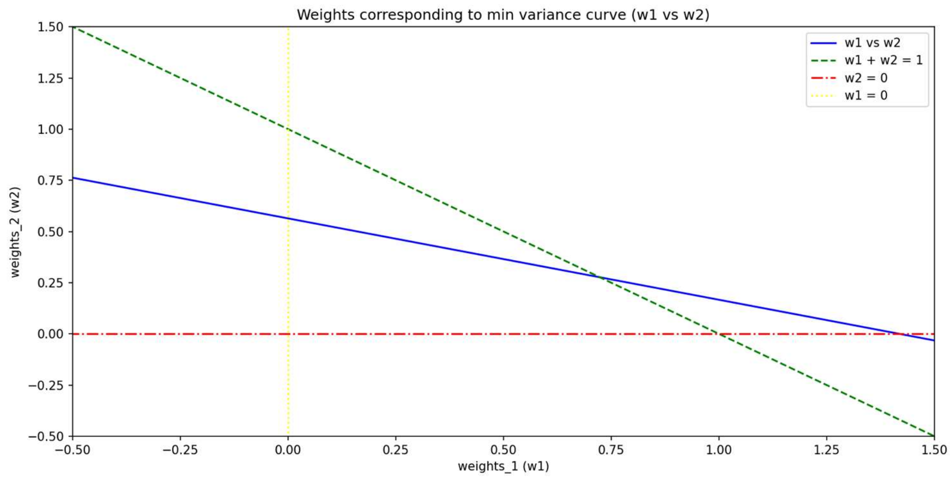
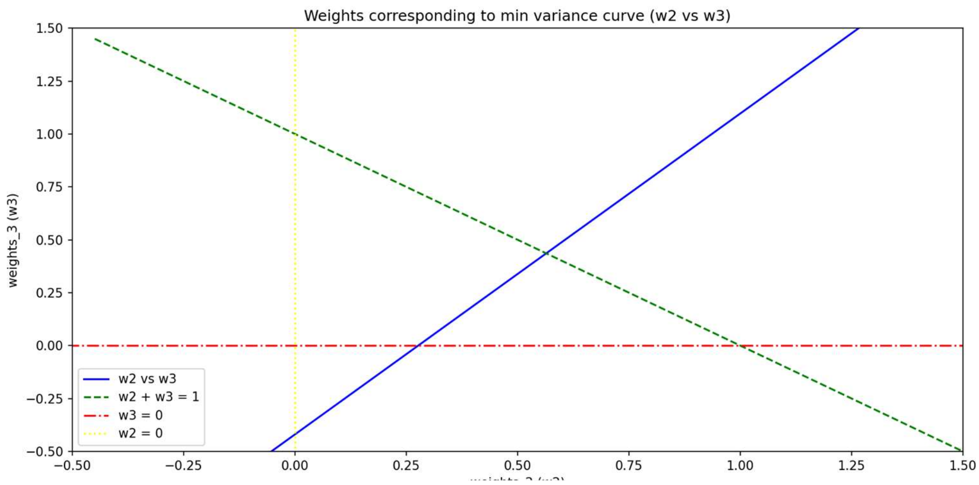
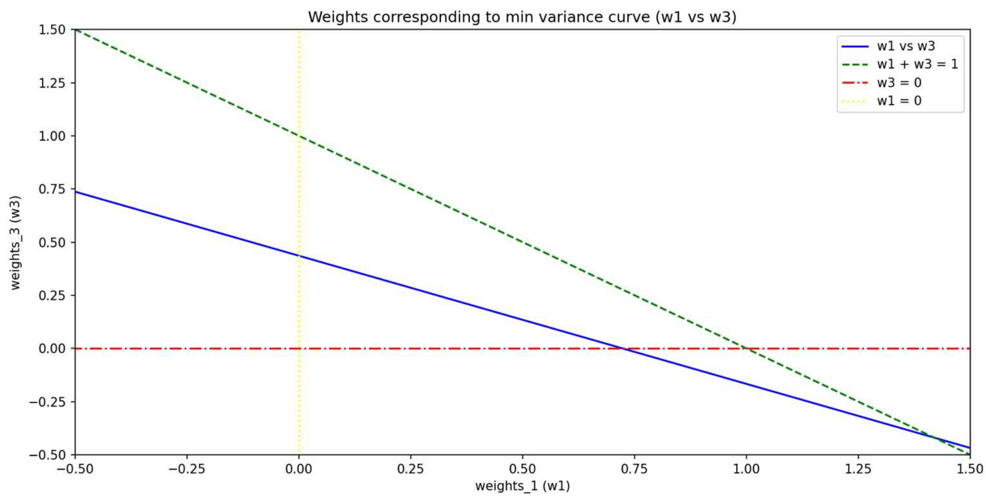
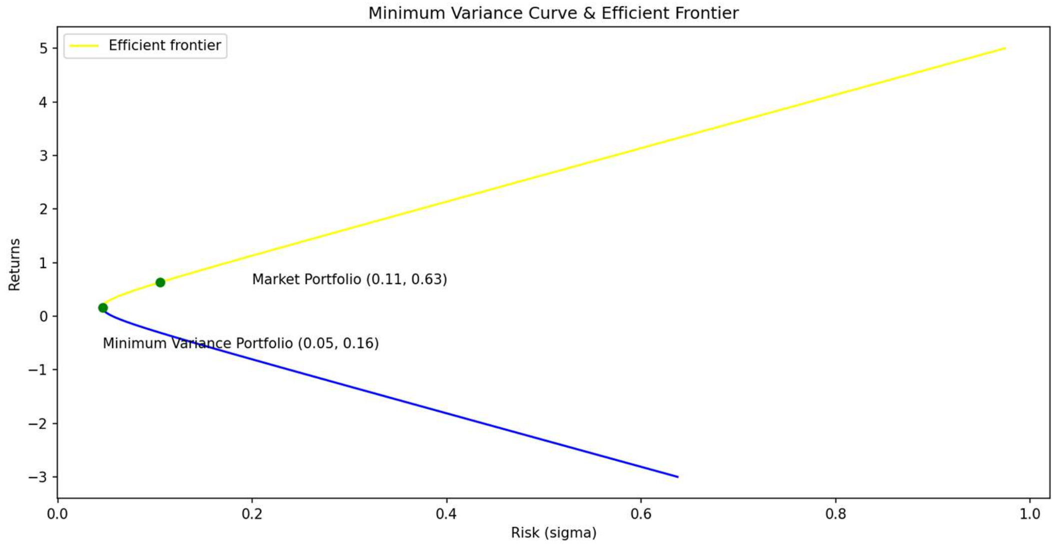






Q3)

60 data points have been collected for stock prices. The companies chosen are *Apple, Alphabet, Wipro, Amazon, Tesla, Nike, Netflix, Google, Cipla, and TCS.* These prices are from *2019-01-01* to *2023-12-31*, monthly.



b)

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Market Portfolio Weights        =  [ 1.32821289 -1.388525    0.49226446  4.12874917 -3.62281257  0.16583204
 -0.4901424   0.31536575  0.16045482 -0.08939916]
Return                          =  0.6318177978970293
Risk                            =  10.518837964370856  %
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c)

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Equation of CML is:
y = 5.53 x + 0.05
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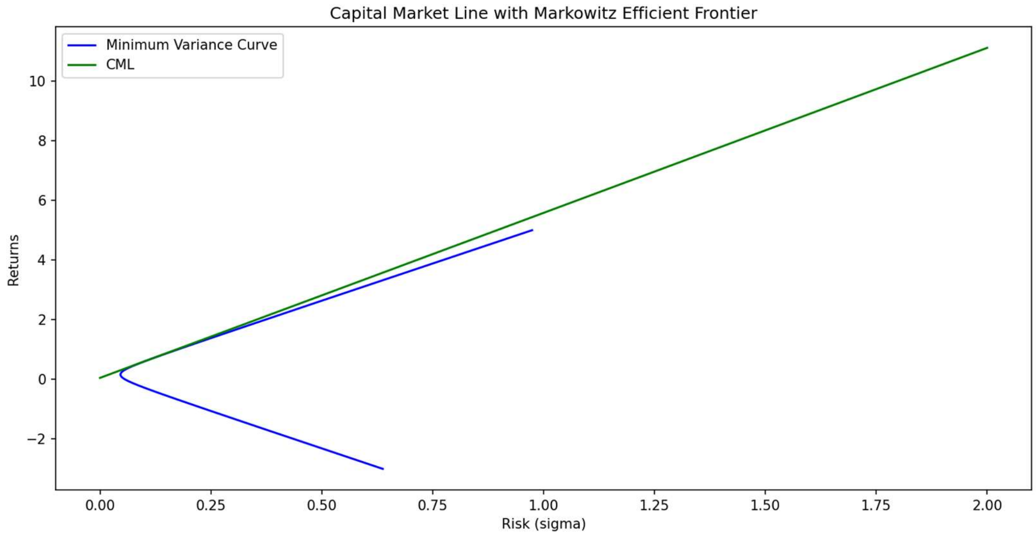

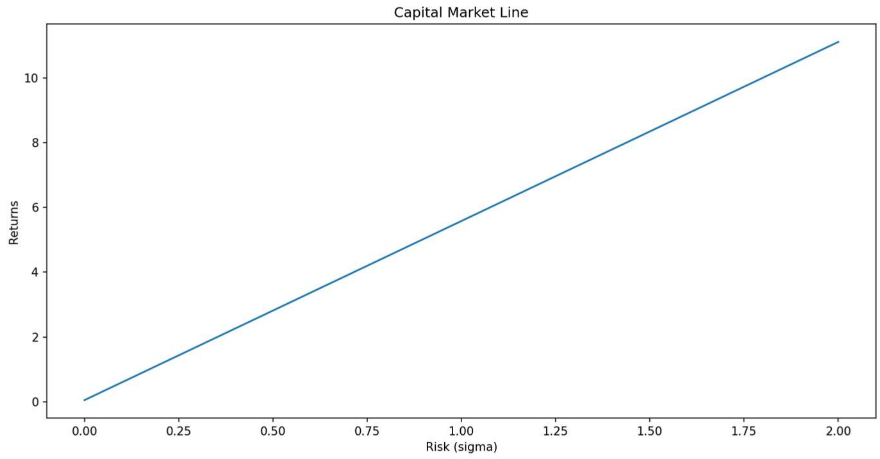

d)

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Eqn of Security Market Line is:
mu = 0.58 beta + 0.05
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