Financial Engineering Lab MA – 374 Lab – 5

Name – Rasesh Srivastava

Roll Number – 210123072

Branch – Mathematics and Computing

Question 1:

1. Recall the Lab 04 assignment with the data part (Problem 3). In a similar way, do the following: Collect the data of basic BSE (SENSEX) and NSE (NIFTY) index (daily) values (from their respective official websites/other sources) for the period from January 1, 2019 to December 31, 2023 (i.e., five years of data). Now, for the same period, collect the stock price data for 10 stocks that are included in the index and 10 stocks that are not included in the index, for each of the index. That is, you will have data for 20 stocks from BSE and 20 stocks from NSE. Remember that, depending on the source, you may have to work on the downloaded data to get a clean data (accounting for dividends, splits, etc.).

   Consider the SENSEX and 20 stocks from BSE as one group and rest (i.e., NIFTY and 20 stocks from NSE) as another group. Keep the data in two separate Excel files and name them as "**bsedata1**" and "**nsedata1**". Obtain data on stocks yourself (and do not copy from others). We will use these data in future assignments too.

Kindly download all the folders and files submitted along with bsedata1.csv and nsedata1.csv

The stocks used are as follows:

10 stocks included in BSE (SENSEX) index:

- RELIANCE.BO: Reliance Industries Limited
- TCS.BO: Tata Consultancy Services Limited
- HDFCBANK.BO: HDFC Bank Limited
- HINDUNILVR.BO: Hindustan Unilever Limited
- INFY.BO: Infosys Limited
- KOTAKBANK.BO: Kotak Mahindra Bank Limited
- ICICIBANK.BO: ICICI Bank Limited
- LT.BO: Larsen & Toubro Limited
- AXISBANK.BO: Axis Bank Limited
- SBIN.BO: State Bank of India

10 stocks included in NSE (NIFTY) index:

- TCS.NS: Tata Consultancy Services Limited

- HINDUNILVR.NS: Hindustan Unilever Limited
- INFY.NS: Infosys Limited
- KOTAKBANK.NS: Kotak Mahindra Bank Limited
- ICICIBANK.NS: ICICI Bank Limited
- LT.NS: Larsen & Toubro Limited
- SBIN.NS: State Bank of India
- RELIANCE.NS: Reliance Industries Limited
- ITC.NS: ITC Limited
- ONGC.NS: Oil and Natural Gas Corporation Limited

10 stocks not included in BSE (SENSEX) index:

- GOOGL: Alphabet Inc. (Google)
- AAPL: Apple Inc.
- AMZN: Amazon.com Inc.
- MSFT: Microsoft Corporation
- NVDA: NVIDIA Corporation
- ADBE: Adobe Inc.
- NFLX: Netflix Inc.
- TSLA: Tesla Inc.
- ORCL: Oracle Corporation
- CSCO: Cisco Systems Inc.

10 stocks not included in NSE (NIFTY) index:

- NKE: NIKE Inc.
- BIDU: Baidu Inc.
- NVDA: NVIDIA Corporation
- KO: The Coca-Cola Company
- PYPL: PayPal Holdings Inc.
- SNAP: Snap Inc.
- MCD: McDonald's Corporation
- WMT: Walmart Inc.
- BABA: Alibaba Group Holding Limited
- PEP: PepsiCo Inc.

```
stocksInBSEindex = ['RELIANCE.BO', 'TCS.BO', 'HDFCBANK.BO', 'HINDUNILVR.BO', 'INFY.BO','KOTAKBANK.BO', 'ICICIBANK.BO', 'LT.BO', 'AXISBANK.BO', 'SBIN.BO']
stocksNotInBSEindex = ['GOOGL', 'AAPL', 'AMZN', 'MSFT', 'NVDA', 'ADBE', 'NFLX', 'TSLA', 'ORCL', 'CSCO']
stocksInNSEindex = ['RELIANCE.NS', 'TCS.NS', 'HINDUNILVR.NS', 'INFY.NS','KOTAKBANK.NS', 'ICICIBANK.NS', 'LT.NS', 'SBIN.NS', 'ITC.NS', 'ONGC.NS']
stocksNotInNSEindex = ['NKE', 'BIDU', 'NVDA', 'KO', 'PYPL', 'SNAP', 'MCD', 'WMT', 'BABA', 'PEP']
```

Question 2:

2. Now, consider the data obtained as above. Repeat what you have done in Lab 04, with the index as market portfolio (for both the indices). From the CAPM formula (SML), draw inference about each of the stocks, taking the riskfree rate to be 5% (if required, you may change this value). Compare the betas of securities (by taking the actual data and computing from your data for each index).

Basic BSE and NSE Index values:

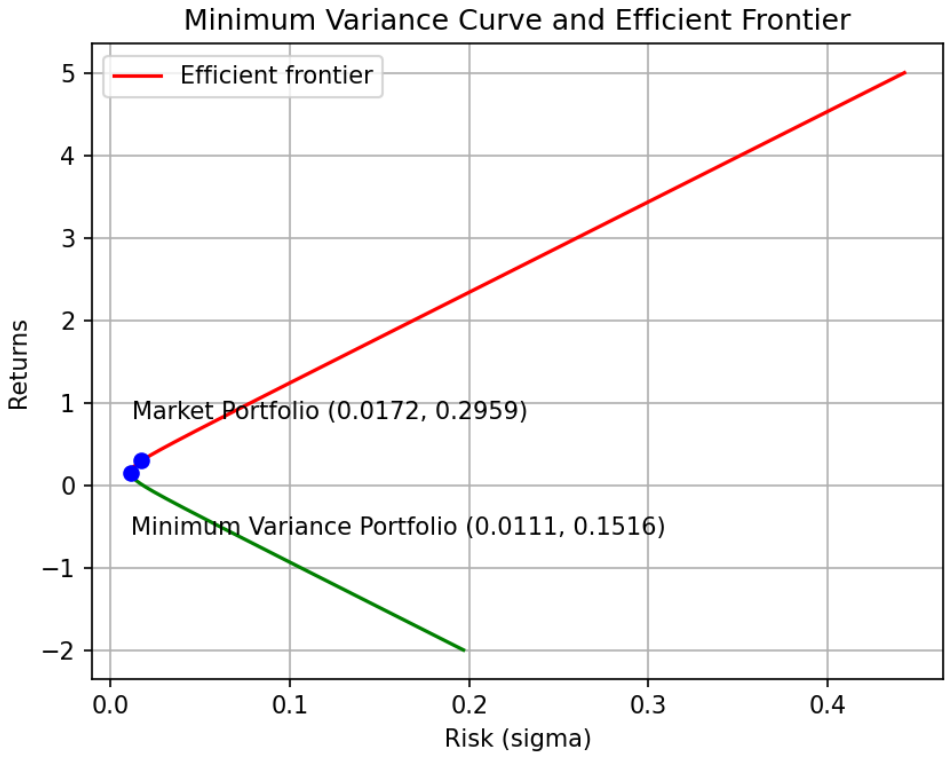
```
Market portfolio for BSE using Index
Market return    = 0.21218926808253924
Market risk      = 0.9985215748556788 %


Market portfolio for NSE using Index
Market return    = 0.17679467861513648
Market risk      = 0.9611371595084666 %
```

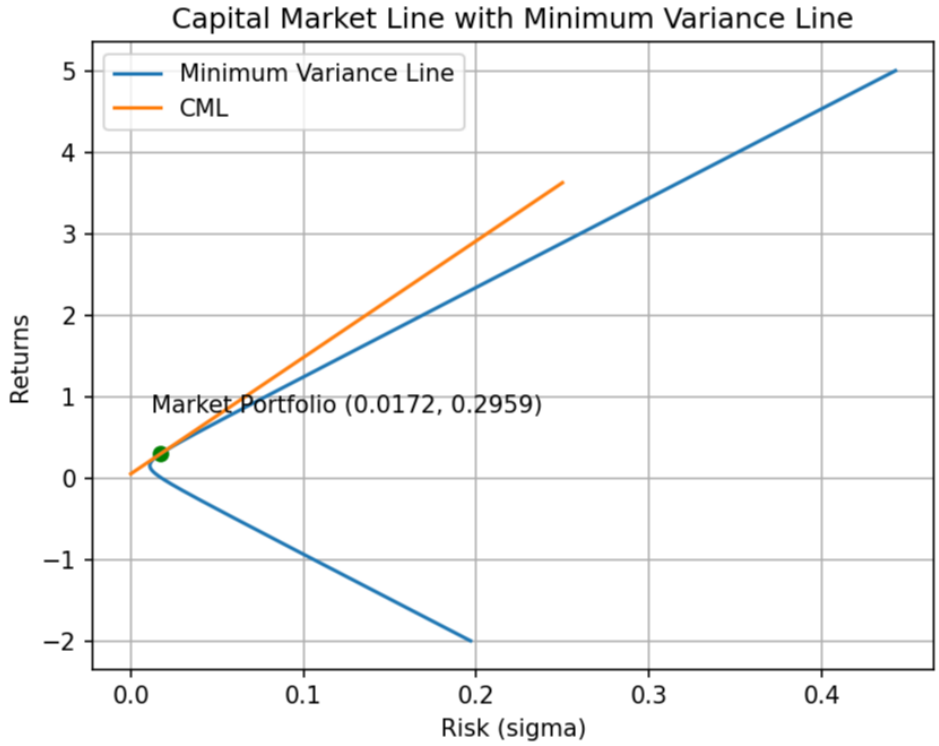
10 stocks included in the BSE Index:

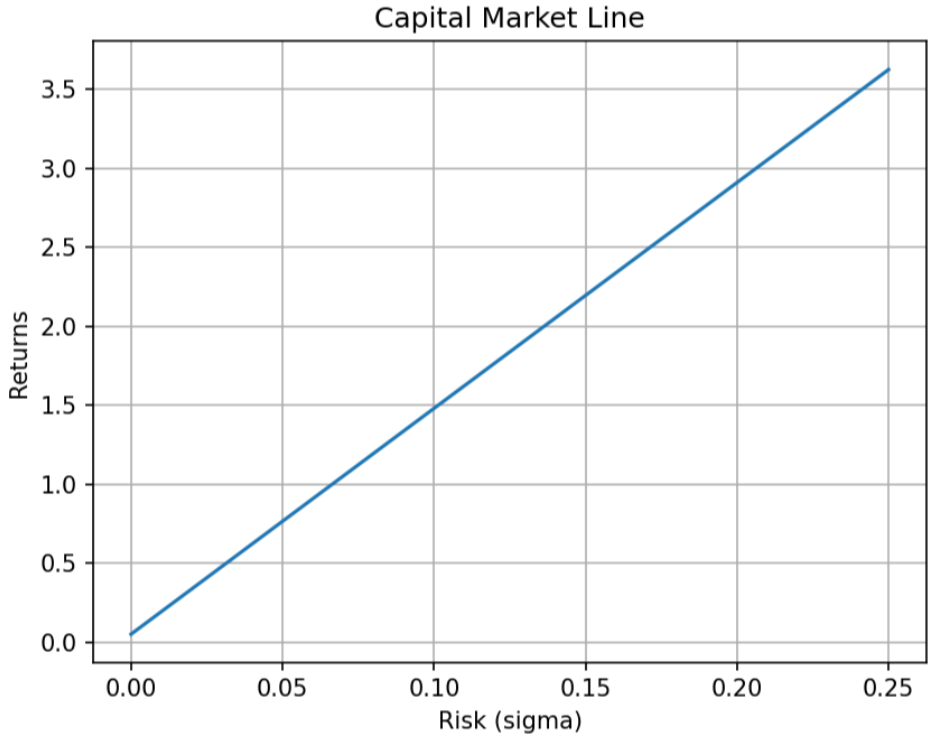
```
10 stocks from the BSE Index
Market Portfolio Weights =  [ 0.31178232  0.20544651 -0.39686445 -0.10402592  0.28850156 -0.13087855
  0.622268    0.42277694 -0.2483984   0.02939201]
Return =  0.29591186504128714
Risk =  1.7199018666555568  %
```

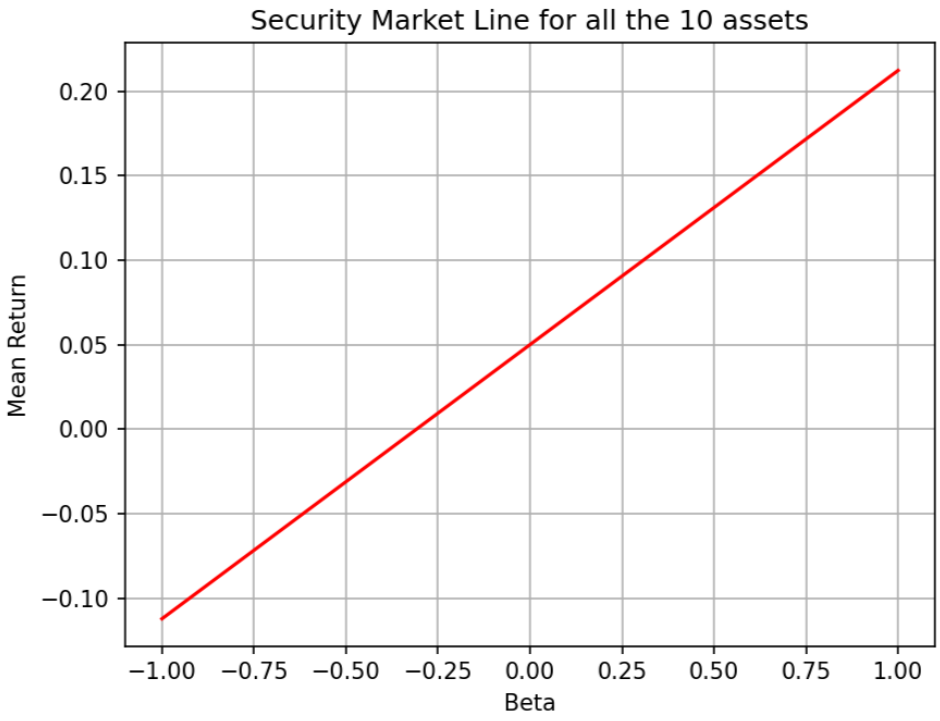
```
Equation of Capital Market Line is:
y = 14.2980 x + 0.0500

Equation of Security Market Line is:
mu = 0.16 beta + 0.05
```

The market portfolio shown is calculated from the values of the 10 stocks, and not taken from the market portfolio found from the index values. The market portfolio mean used in calculating the SML equation is that value which was calculated from the corresponding index values.







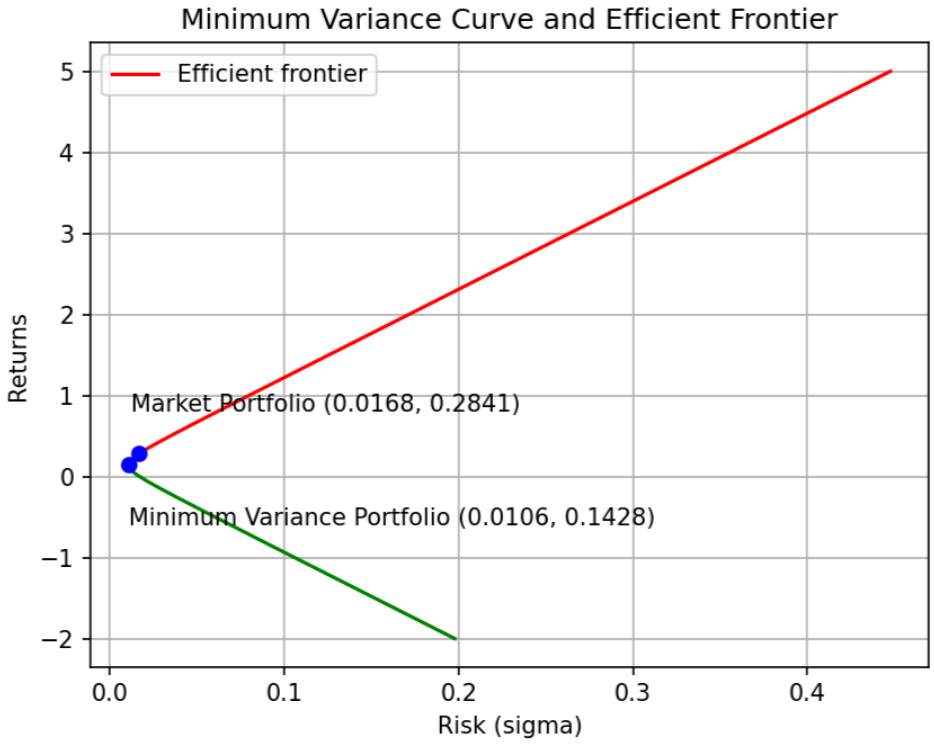


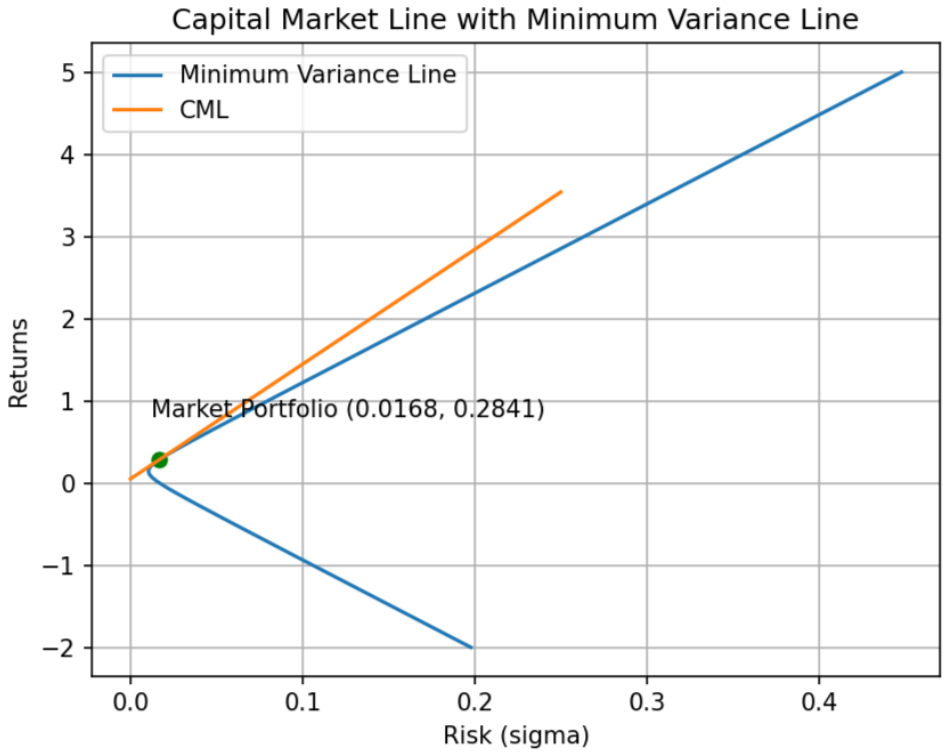
10 stocks included in the NSE Index:

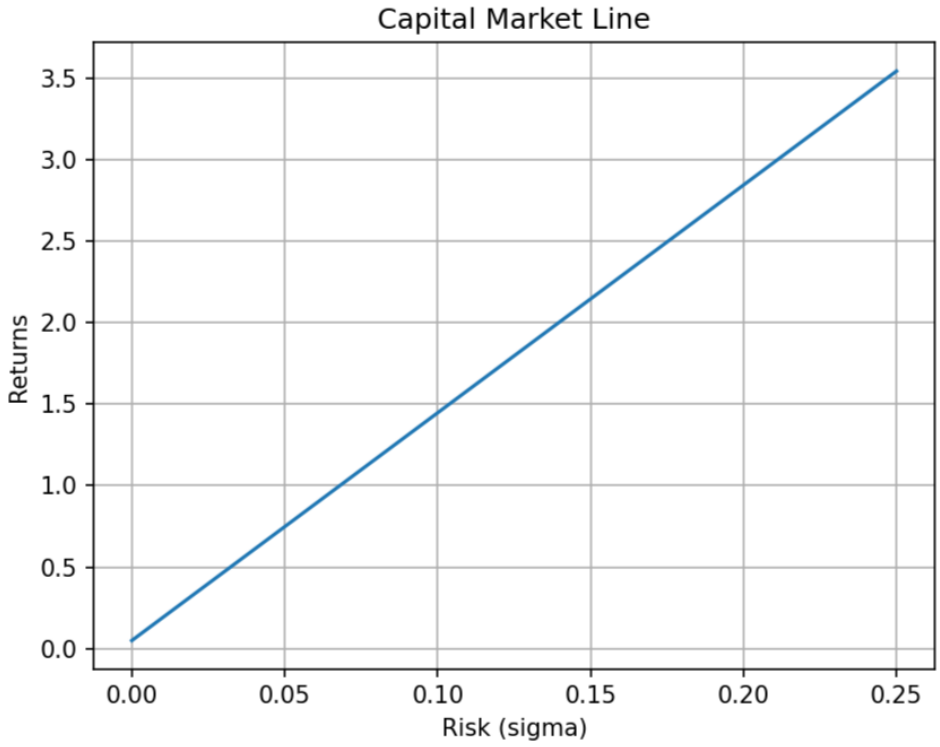
```
10 stocks from the NSE Index
Market Portfolio Weights =  [ 0.3829385   0.12378453 -0.18789725  0.31919301 -0.33988701  0.41691034
  0.31454477 -0.03183097  0.08114103 -0.07889696]
Return =  0.2841182009460446
Risk =  1.6763920044395513  %
```

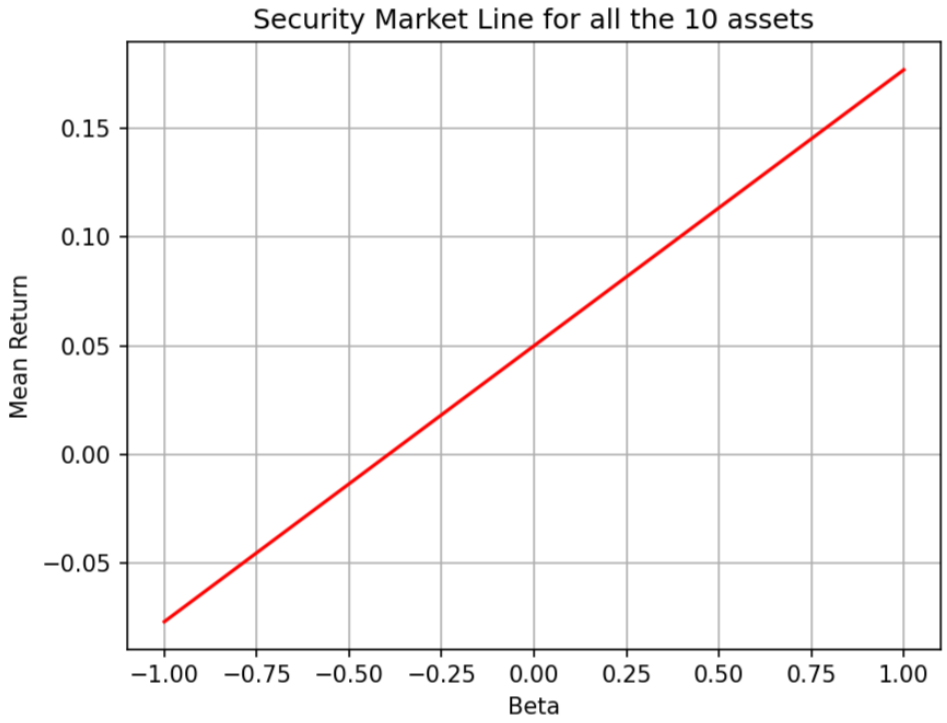
```
Equation of Capital Market Line is:
y = 13.9656 x + 0.0500

Equation of Security Market Line is:
mu = 0.13 beta + 0.05
```

The market portfolio shown is calculated from the values of the 10 stocks, and not taken from the market portfolio found from the index values. The market portfolio mean used in calculating the SML equation is that value which was calculated from the corresponding index values.




Capital Market Line with Minimum Variance Line
Minimum Variance Line
CML
Market Portfolio (0.0168, 0.2841)
Returns
Risk (sigma)
5
4
3
2
1
0
−1
−2
0.0
0.1
0.2
0.3
0.4


Capital Market Line
Returns
Risk (sigma)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.05
0.10
0.15
0.20
0.25

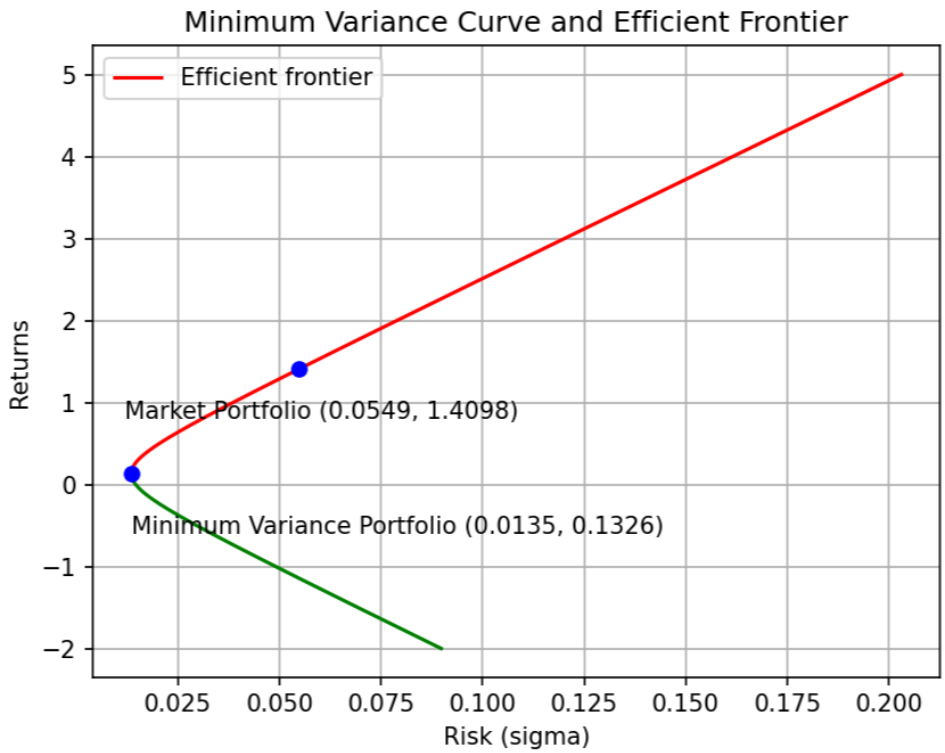


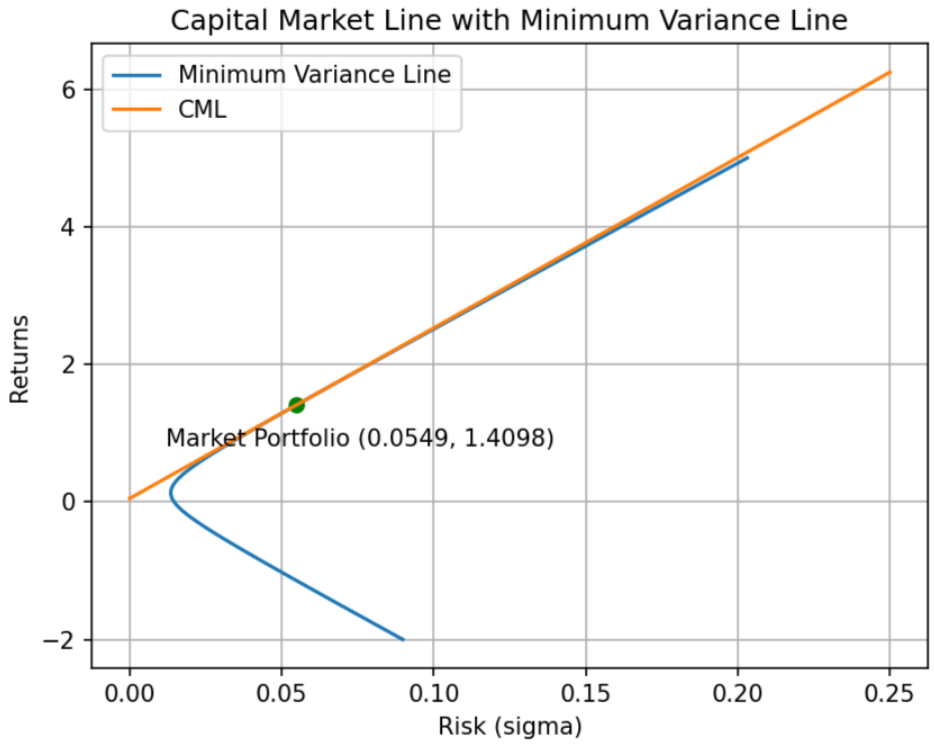
10 stocks not included in the BSE Index:

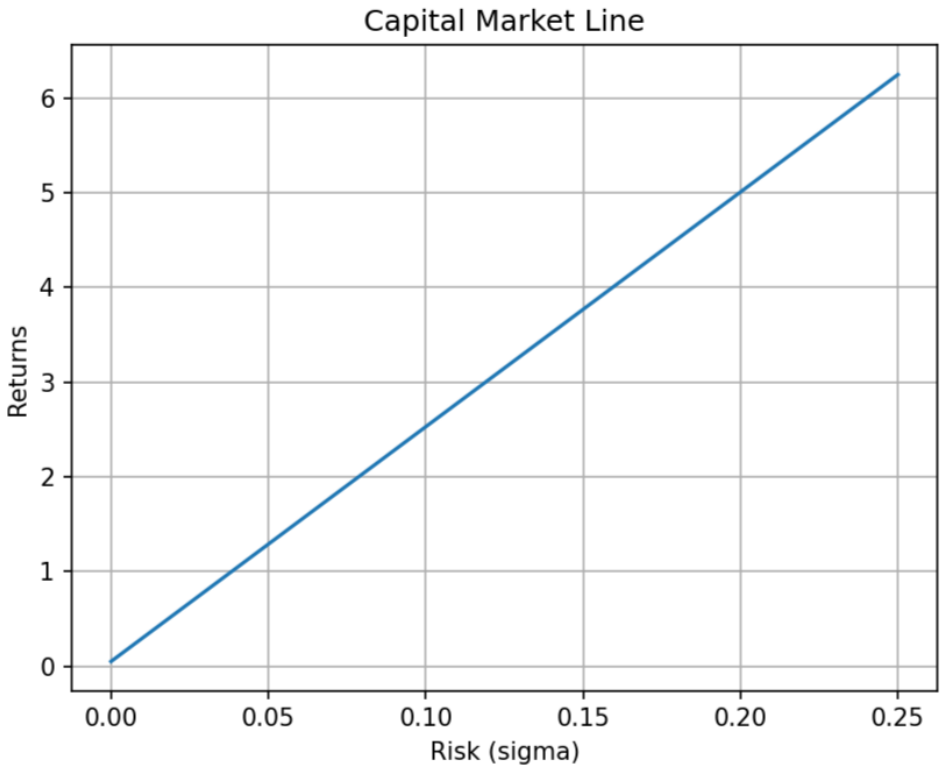
```
10 stocks not from the BSE Index
Market Portfolio Weights =  [-0.12029768  1.20886291 -0.99976477  1.15962821  1.09899011 -0.81823305
 -0.16385926  0.43175406  0.6122181  -1.40929864]
Return =  1.409760640538716
Risk =  5.485811529042587  %
```

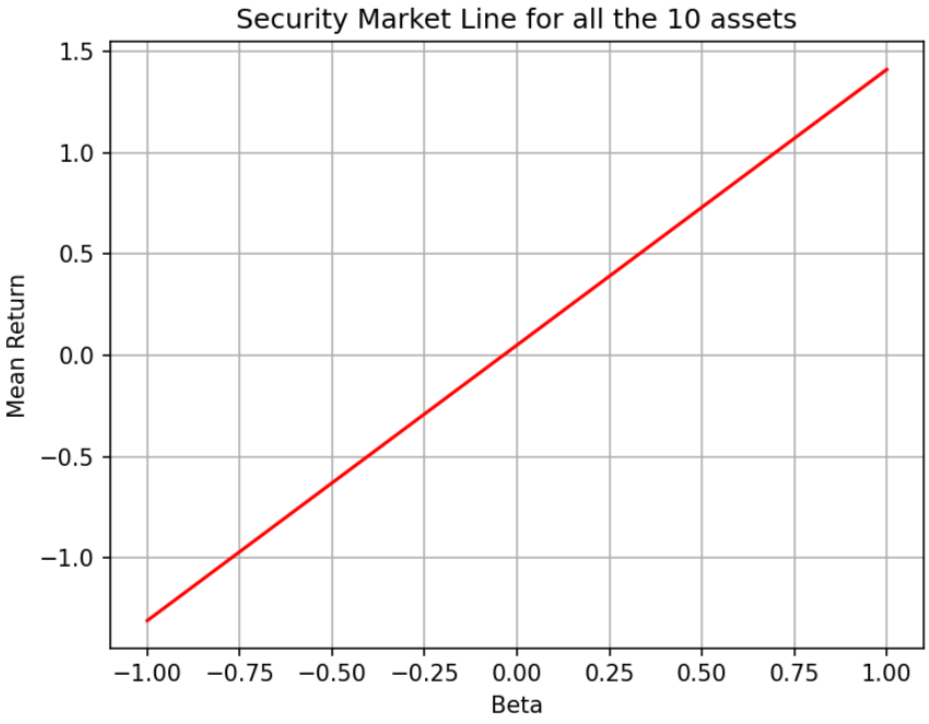
```
Equation of Capital Market Line is:
y = 24.7869 x + 0.0500

Equation of Security Market Line is:
mu = 1.36 beta + 0.05
```

The market portfolio mean used in calculating the SML equation and in the plot for the efficient frontier is found from considering all the 10 stocks in a single portfolio.


Minimum Variance Curve and Efficient Frontier
Efficient frontier
Market Portfolio (0.0549, 1.4098)
Minimum Variance Portfolio (0.0135, 0.1326)
Returns
Risk (sigma)
5
4
3
2
1
0
−1
−2
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200


Capital Market Line with Minimum Variance Line
Minimum Variance Line
CML
Market Portfolio (0.0549, 1.4098)
Returns
Risk (sigma)
6
4
2
0
−2
0.00
0.05
0.10
0.15
0.20
0.25



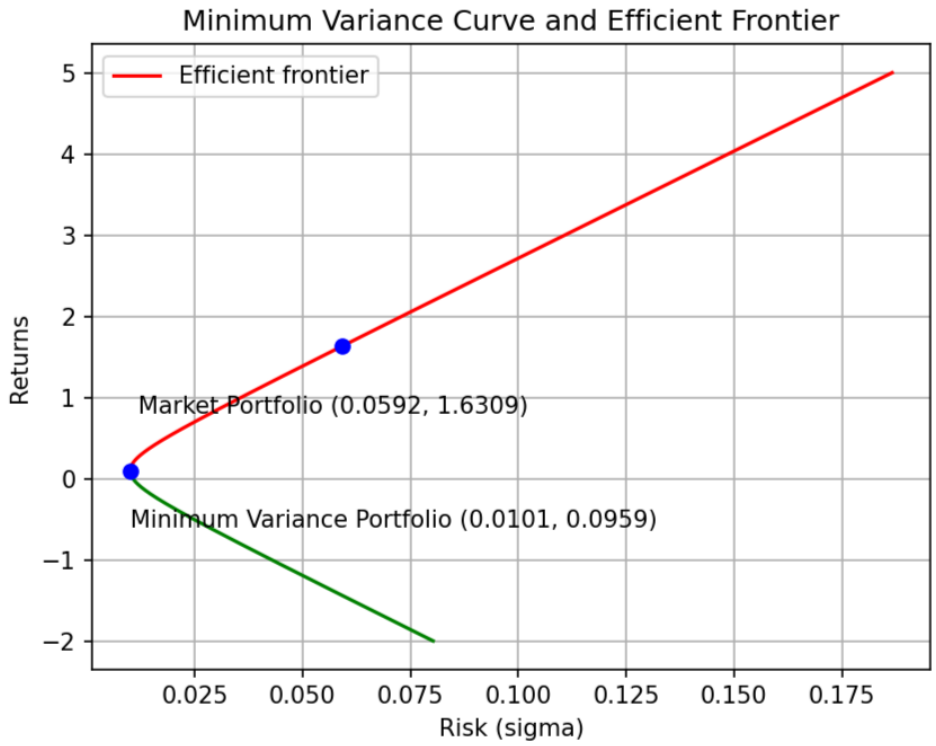


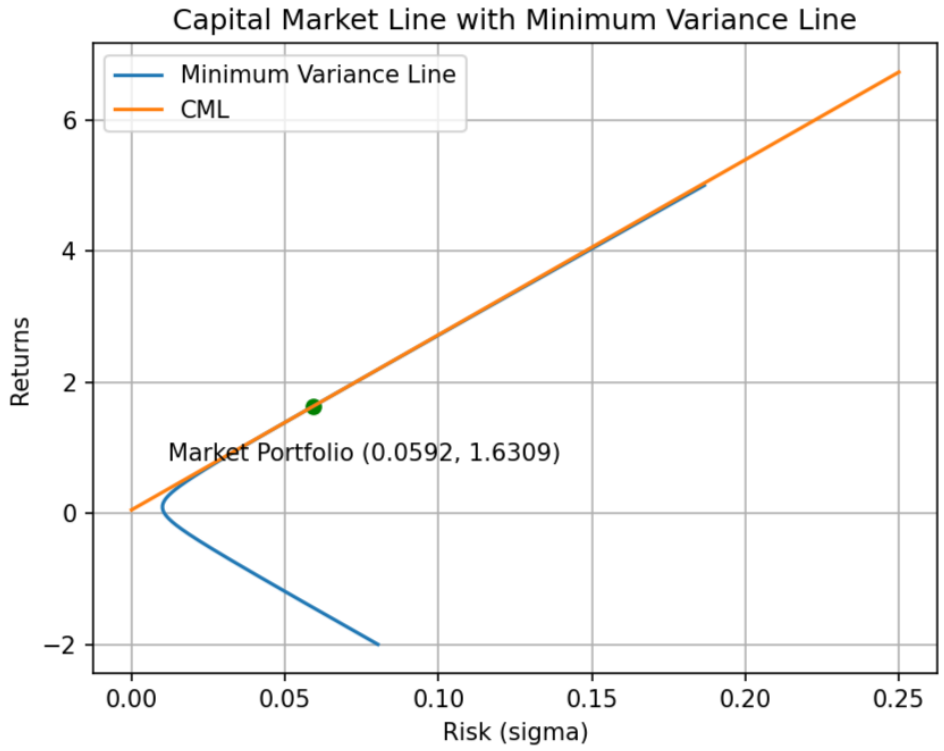
10 stocks not included in the NSE Index:

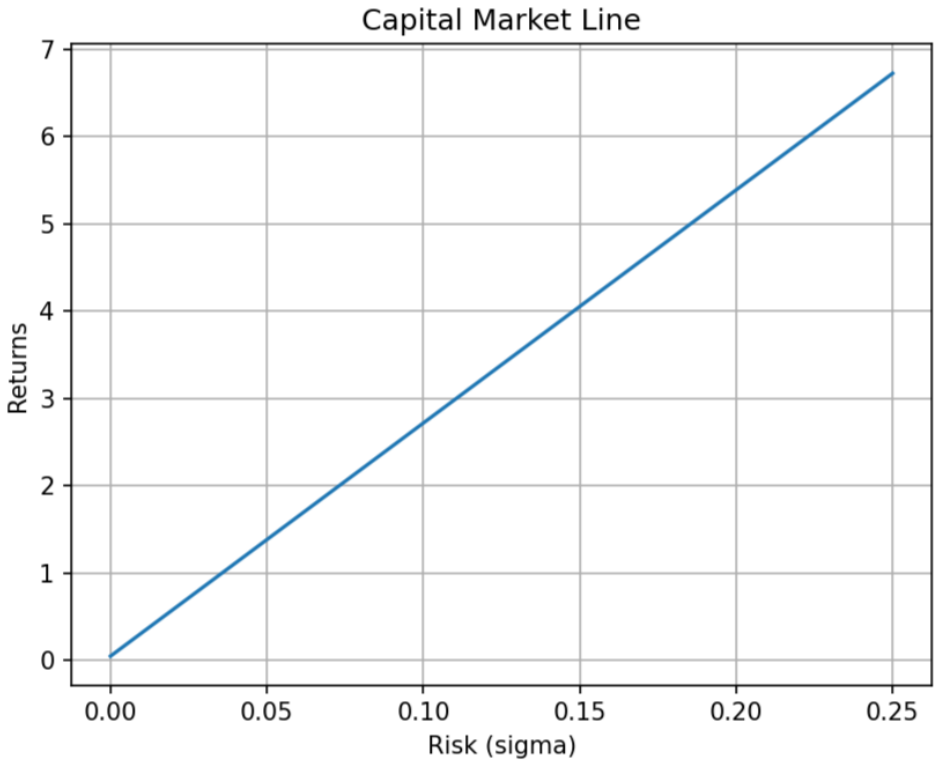
```
10 stocks not from the NSE Index

Market Portfolio Weights =  [-0.30460423 -0.1116684   1.989476   -0.86805747 -1.37424765  0.4334495
  0.24601099  0.59124982 -0.69699078  1.09538223]
Return =  1.6308871429178846
Risk =  5.918978327269787  %
```

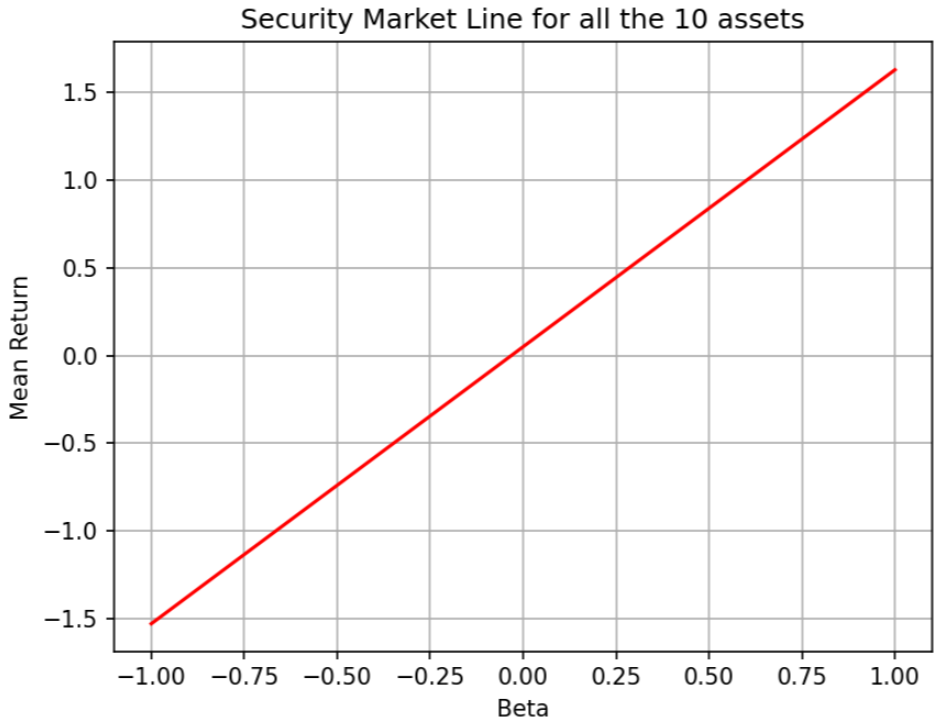
```
Equation of Capital Market Line is:
y = 26.7088 x + 0.0500

Equation of Security Market Line is:
mu = 1.58 beta + 0.05
```

The market portfolio mean used in calculating the SML equation and in the plot for the efficient frontier is found from considering all the 10 stocks in a single portfolio.




Capital Market Line with Minimum Variance Line
Minimum Variance Line
CML
Market Portfolio (0.0592, 1.6309)
Returns
Risk (sigma)
6
4
2
0
−2
0.00
0.05
0.10
0.15
0.20
0.25


Capital Market Line
Returns
Risk (sigma)
7
6
5
4
3
2
1
0
0.00
0.05
0.10
0.15
0.20
0.25



Please ignore the formatting and table spacing during printing, the first column is the ticker symbol for the stock, the second column is the actual return value, and the third column is the expected return value.

Following table compares the actual return and expected return value of each stock, where the expected return value is computed by making use of the security market line equation:

<u>For the 10 stocks included in BSE index:</u>

```
Inference about stocks taken from BSE


Stock's Name                    Actual Return           Expected Return

RELIANCE_BO                     0.213880635188          0.231061625136
TCS_BO                  0.167156761829          0.156897986596
HDFCBANK_BO                     0.133297768837          0.235075176747
HINDUNILVR_BO                   0.100890875461          0.147914194121
INFY_BO                 0.211139197007          0.168872919162
KOTAKBANK_BO                    0.132425226466          0.226565352574
ICICIBANK_BO                    0.258914289409          0.264366342103
LT_BO                   0.217545447171          0.211086799616
AXISBANK_BO                     0.180324100398          0.258936097623
SBIN_BO                 0.217912382217          0.265537213612
```

For the 10 stocks included in NSE index:

```
Inference about stocks taken from NSE


Stock's Name                    Actual Return           Expected Return

RELIANCE_NS                     0.230748127808          0.193891242476
TCS_NS                  0.167810608528          0.131344719433
HINDUNILVR_NS                   0.100519871167          0.128830069419
INFY_NS                 0.211207772167          0.141312586466
KOTAKBANK_NS                    0.128292728492          0.185778142927
ICICIBANK_NS                    0.257037529844          0.215339890315
LT_NS                   0.219754388469          0.179261433428
SBIN_NS                 0.218716966046          0.220706516642
ITC_NS                  0.135483962550          0.132977410298
ONGC_NS                 0.129987753596          0.143505920215
```

For the 10 stocks not included in BSE index:

```
Inference about stocks not taken from BSE index with index taken from BSE values

Stock's Name                    Actual Return          Expected Return

GOOGL                  0.246113324790          0.047550099076
AAPL                   0.372984023534          0.042293800625
AMZN                   0.213944417490          0.032976506067
MSFT                   0.305783524447          0.053636043819
NVDA                   0.679071088935          0.043394635441
ADBE                   0.261323493405          0.058784193365
NFLX                   0.221947592850          0.038813769166
TSLA                   0.741980773700          0.046186293966
ORCL                   0.217303374049          0.052259214002
CSCO                   0.072171472376          0.051356861070
```

For the 10 stocks not included in NSE index:

```
Inference about stocks not taken from NSE index with index taken from NSE values

Stock's Name                    Actual Return          Expected Return

NKE                    0.141013216495          0.029085471574
BIDU                   0.084716833945          0.044059752838
NVDA                   0.679071088935          0.042586370678
KO                     0.068214273902          0.042521636608
PYPL                   0.033966511807          0.057475102450
SNAP                   0.492228587430          0.058459556802
MCD                    0.130281338253          0.050013446741
WMT                    0.132762743884          0.030744642575
BABA                   0.001902152969          0.040727404903
PEP                    0.105552374744          0.047320065390
```

Please ignore the formatting and table spacing during printing, the first column is the ticker symbol for the stock, the second column is the beta value.

The betas of securities (by taking the actual data and computing from our data for each index) are as follows:

The betas of the securities for the stocks from BSE index are as follows:

```
Beta for securities in BSE
RELIANCE_BO             =              1.1163600852053512
TCS_BO          =              0.6590940810096556
HDFCBANK_BO             =              1.141106183752262
HINDUNILVR_BO           =              0.6037032861596945
INFY_BO         =              0.7329271570632576
KOTAKBANK_BO            =              1.0886377049586062
ICICIBANK_BO            =              1.3217048491411434
LT_BO           =              0.993202580667719
AXISBANK_BO             =              1.2882239379547327
SBIN_BO         =              1.3289240167393281
```

The betas of the securities for the stocks from NSE index are as follows:

```
Beta for securities in NSE
RELIANCE_NS             =              1.1348366039302167
TCS_NS          =              0.6415467929829194
HINDUNILVR_NS           =              0.6217143359651625
INFY_NS         =              0.7201610309132548
KOTAKBANK_NS            =              1.070850483710001
ICICIBANK_NS            =              1.303997077171849
LT_NS           =              1.0194547187615843
SBIN_NS         =              1.3463224048993032
ITC_NS          =              0.6544234442991909
ONGC_NS         =              0.7374593416422386
```

The betas of the securities for the stocks not from BSE index using market portfolio from BSE index are as follows:

```
Beta for securities not in BSE using BSE Index
GOOGL           =              -0.015105197480155368
AAPL            =              -0.04751362076263856
AMZN            =              -0.10496066807684719
MSFT            =              0.022418522892917084
NVDA            =              -0.040726273918622186
ADBE            =              0.05416013938023323
NFLX            =              -0.06897022821464616
TSLA            =              -0.023513923448263193
ORCL            =              0.013929491318272714
CSCO            =              0.008365911541068539
```

The betas of the securities for the stocks not from NSE index using market portfolio from NSE index are as follows: