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Q1.

Firstly, all the required data was collected.

Monthly stock/index prices for the period from **January 1, 2014** to **December 31, 2018** was considered. So, each **stock/index data** would have **60 time points**.

Monthly Index Prices for **SENSEX 30** for the above period was stored in the file **bse_index.csv**
Monthly Index Prices for **NIFTY 50** for the above period was stored in the file **nse_index.csv**

Monthly Stock Prices of **Ten Stocks** included in the **SENSEX** was stored in the file **bsedata1.csv**
Monthly Stock Prices of **Ten Stocks** included in the **NIFTY** was stored in the file **nsedata1.csv**

Monthly Stock Prices of **Ten Stocks** not included in the **SENSEX** (but still listed in **BSE**) was stored in the file **bse_non_index_data1.csv**
Monthly Stock Prices of **Ten Stocks** included in the **NIFTY** (but still listed in the **NSE**) was stored in the file **nse_non_index_data1.csv**

Note: Using the stock/index prices, the **corresponding returns** were calculated. (They were also converted from **monthly** to **yearly** format).
The Data was collected from **Yahoo Finance** website.

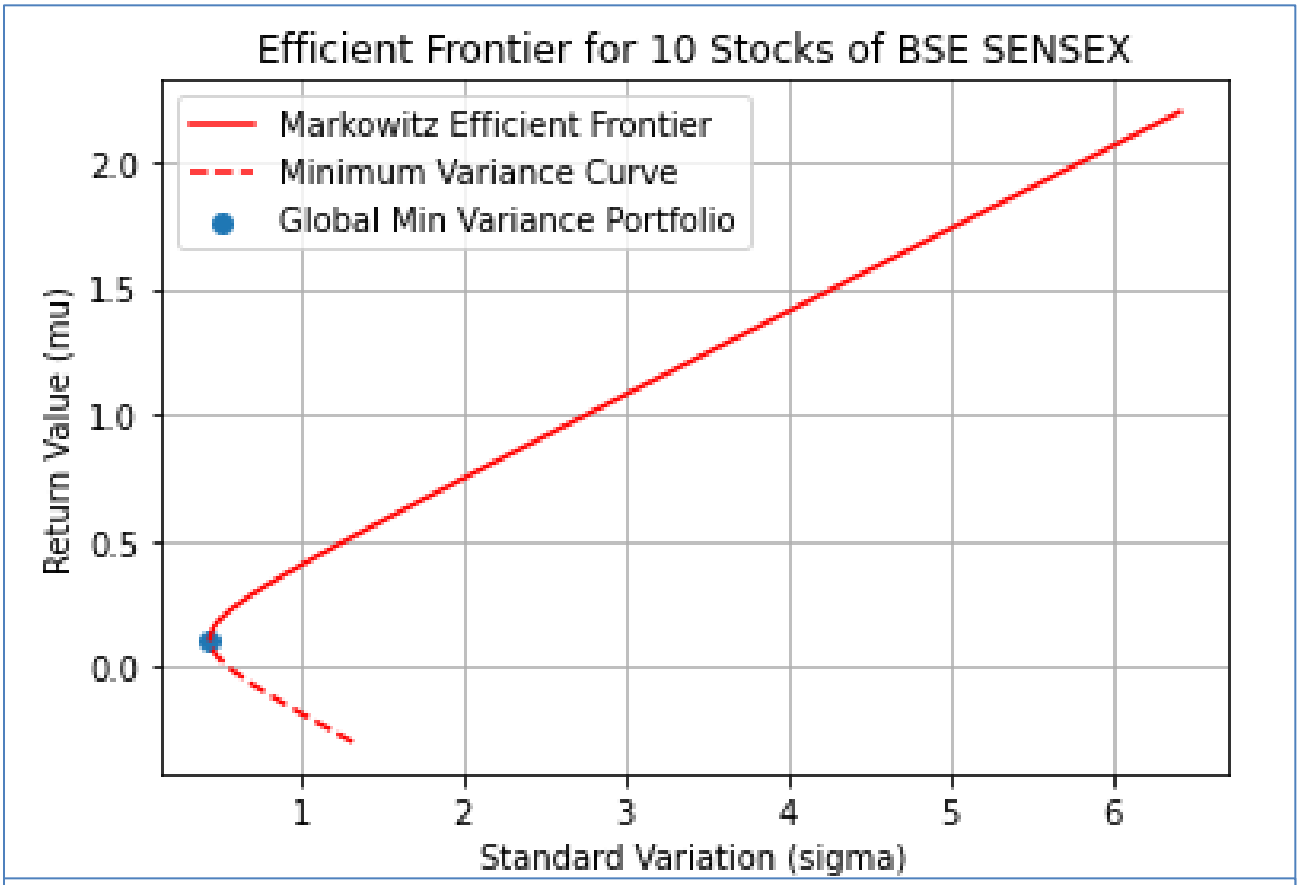
After data collection, the **mean return (yearly)** and the **Standard Deviation (Risk (yearly))** of the given index values for **NIFTY** and **SENSEX** was calculated. They are as follows:

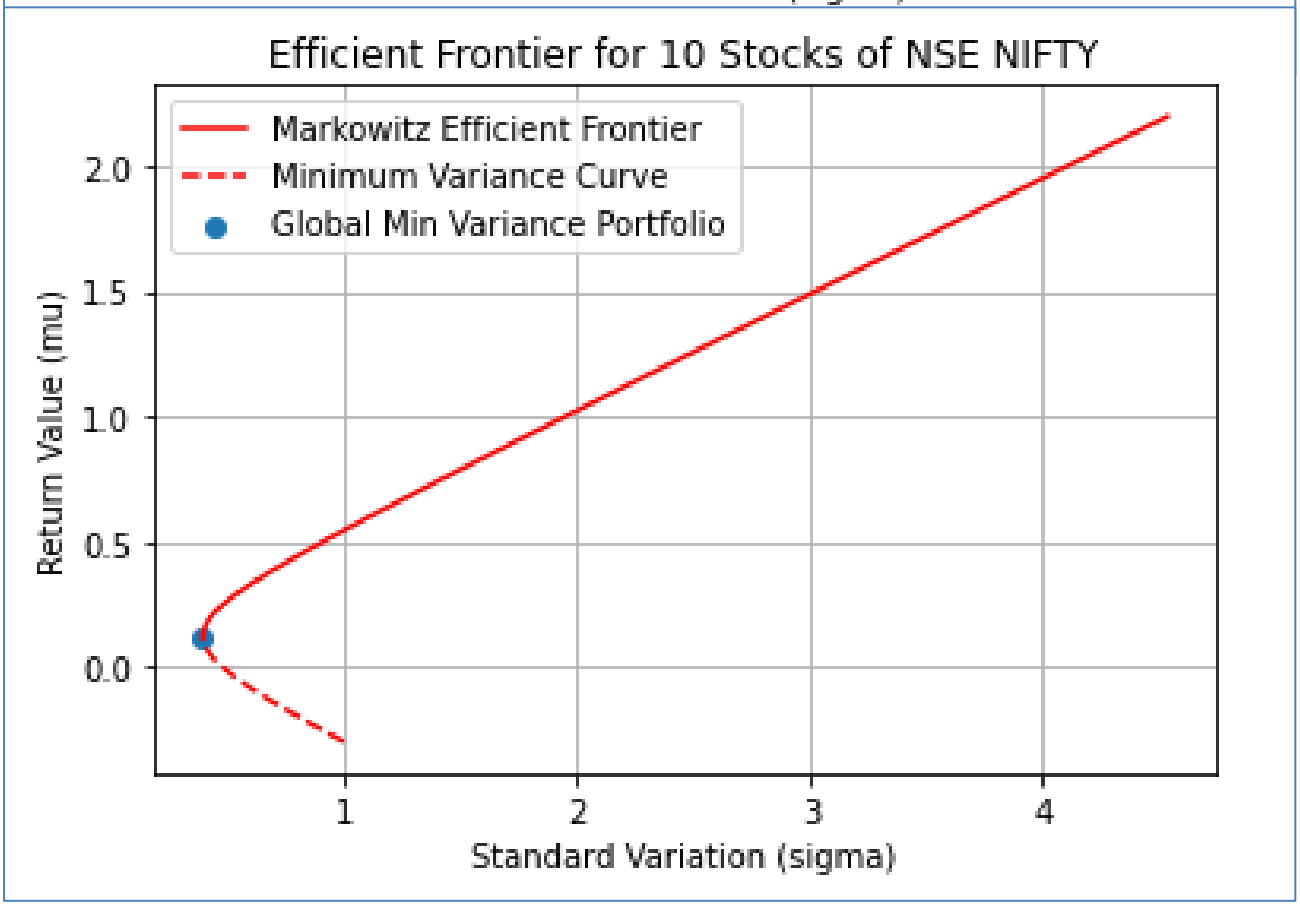
```
Mean Return for NIFTY is: 0.1274085826169013
Standard Variation (Risk) for NIFTY is: 46.905846609383175 %

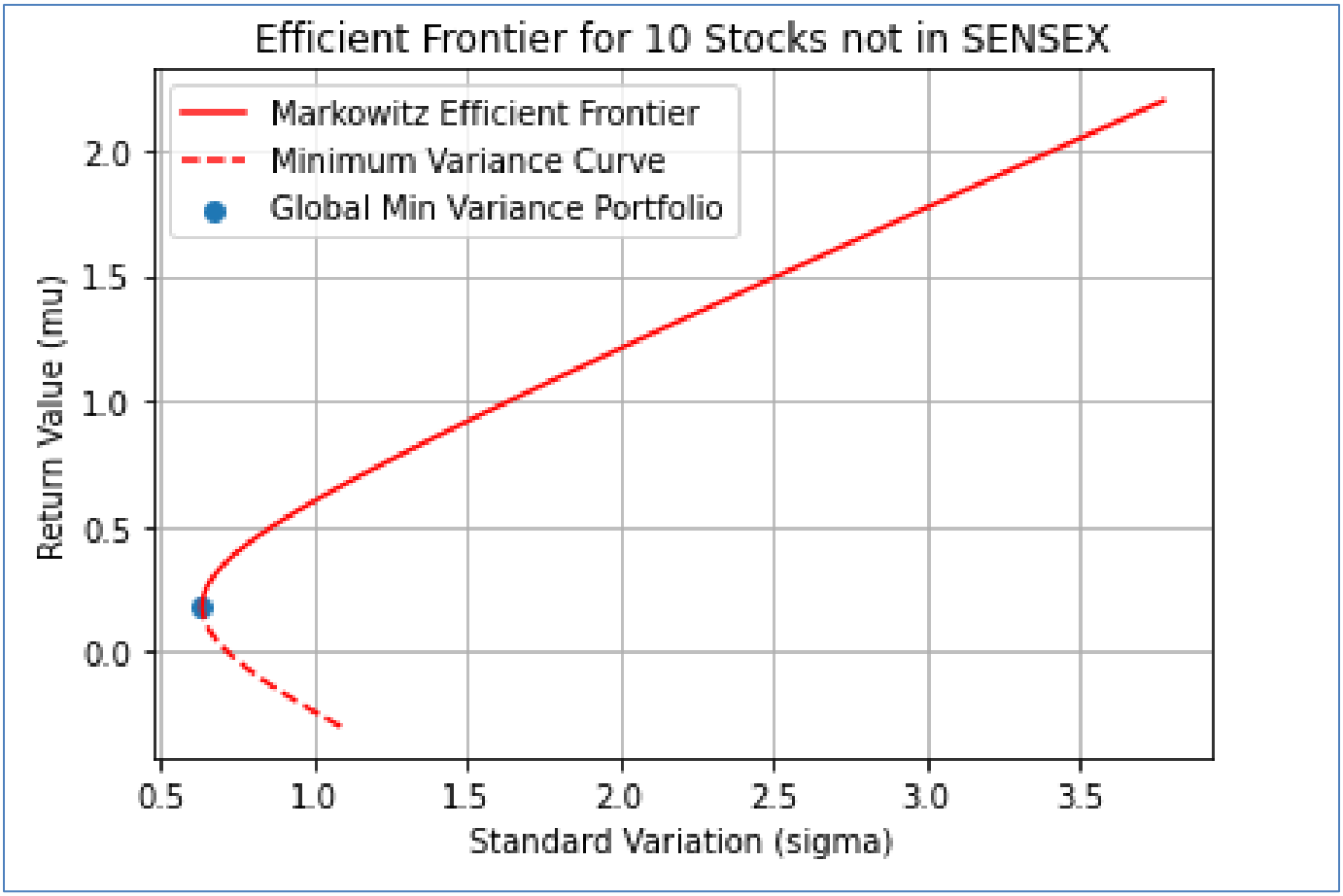
Mean Return for SENSEX is: 0.12437255087912862
Standard Variation (Risk) for SENSEX is: 46.905846609383175 %
```

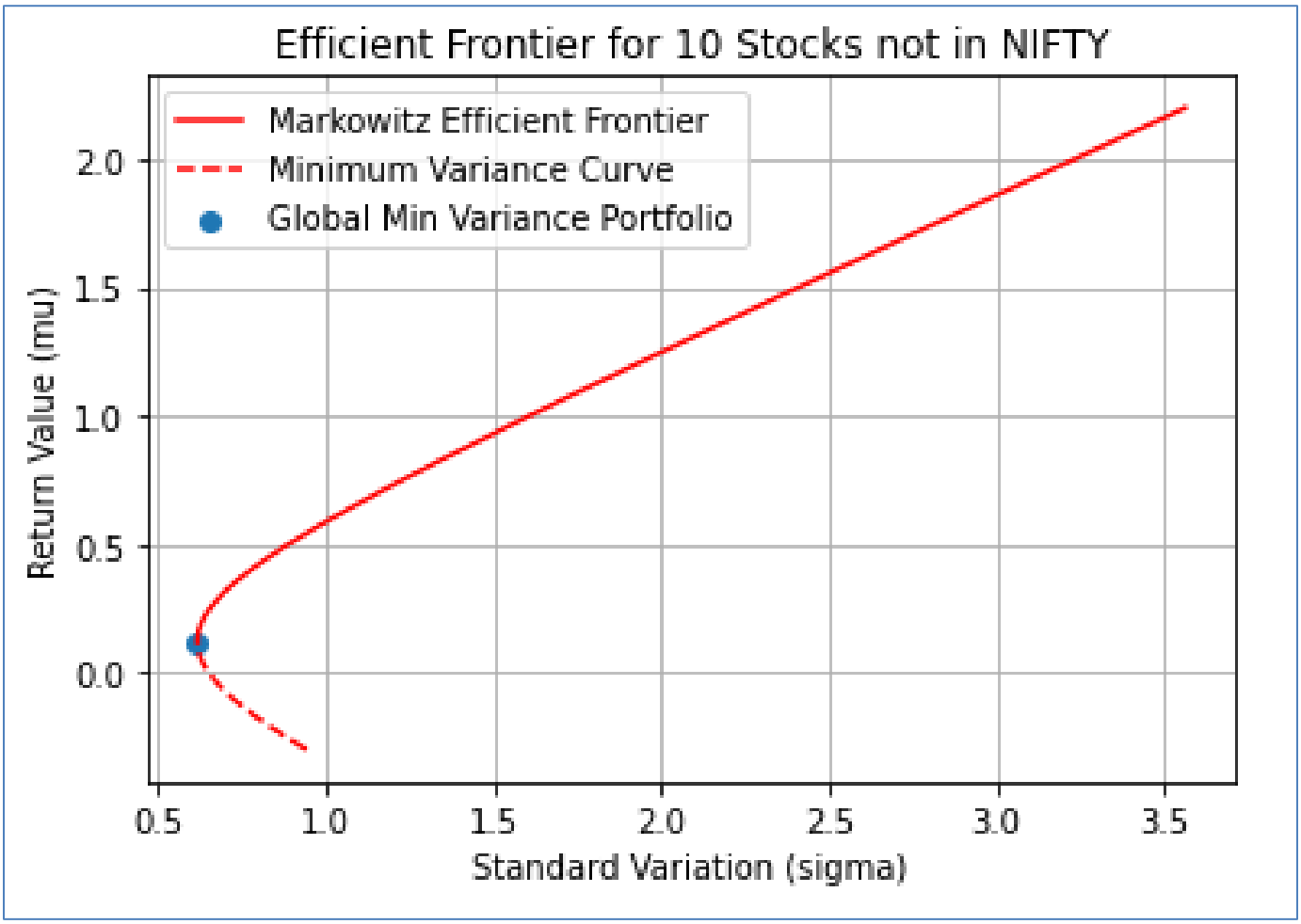
Now, for **each csv data file**, procedure used in **Question3** of **Lab4** was repeated.

The **Markowitz Efficient Frontiers** (and the **Minimum Variance Curves**) are as follows:






Efficient Frontier for 10 Stocks not in SENSEX
Markowitz Efficient Frontier
Minimum Variance Curve
Global Min Variance Portfolio
Return Value (mu)
Standard Variation (sigma)
0.0
0.5
1.0
1.5
2.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5


Efficient Frontier for 10 Stocks not in NIFTY
Markowitz Efficient Frontier
Minimum Variance Curve
Global Min Variance Portfolio
Return Value (mu)
Standard Variation (sigma)
0.0
0.5
1.0
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2.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

For Constructing the **CML**, same procedure was followed as in **Q3** of **Lab4**. The **risk-free** rate was considered to be **0.05 (per annum)**. The corresponding **Market Portfolio** was found using the **risk-free rate**. Subsequently, the CML was plotted out.
Also, the Market portfolio corresponding to the index (NIFTY/SENSEX) value was also marked. It is important to note that index Market Portfolio **may not lie on/inside the Efficient Frontier**, **as the index and the 10 Stocks do not represent same set of companies.**
The **CMLs** are as follows:

(SENSEX)

```
The risk-free rate = 0.05 = 5% (Yearly)
The return on market portfolio is 0.4739
The risk on market portfolio is 1.2053 ( 120.5276 % )
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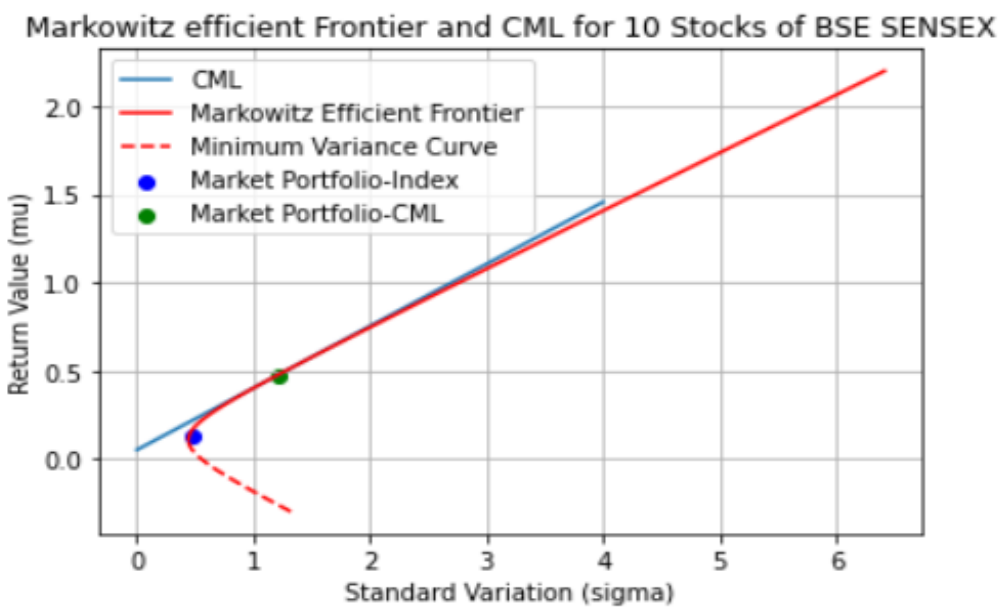
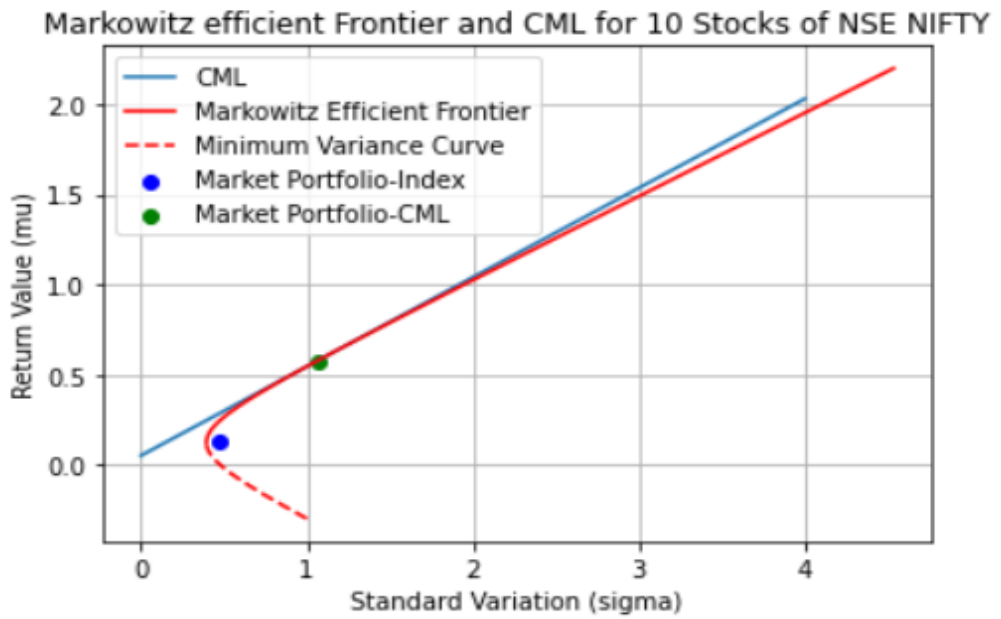
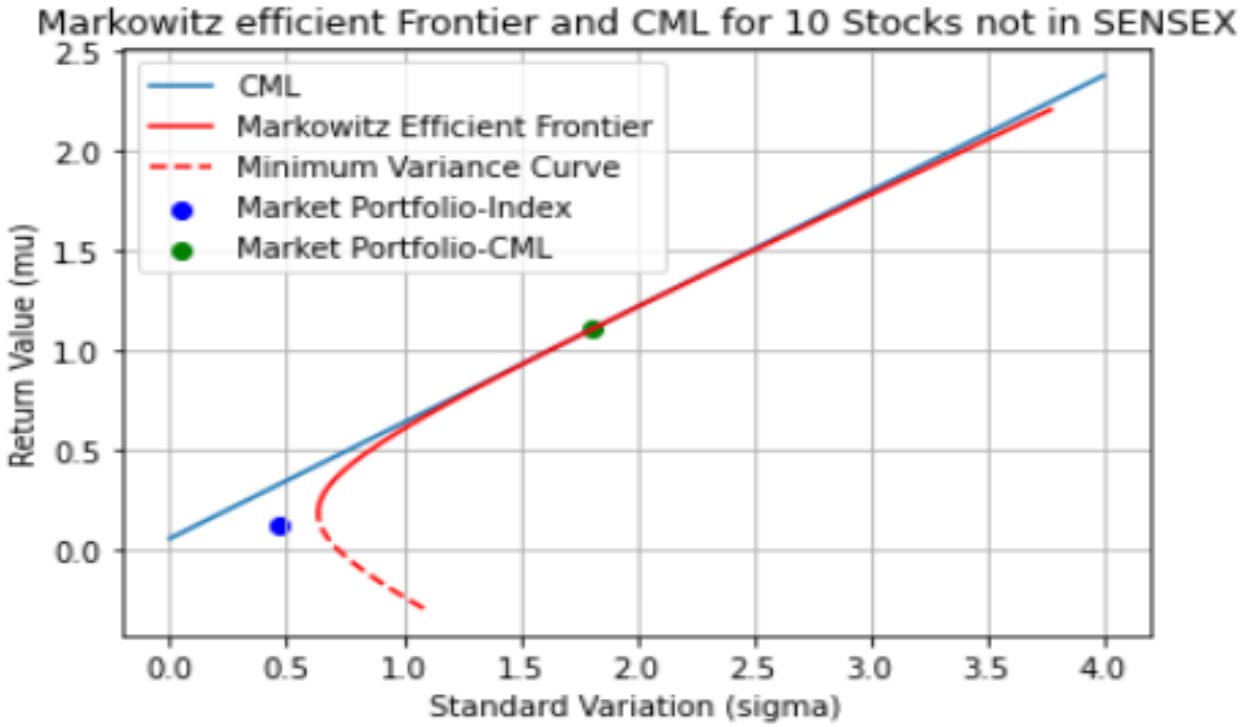


(NIFTY)

```
The risk-free rate = 0.05 = 5% (Yearly)
The return on market portfolio is 0.5752
The risk on market portfolio is 1.0606 ( 106.0581 % )
```

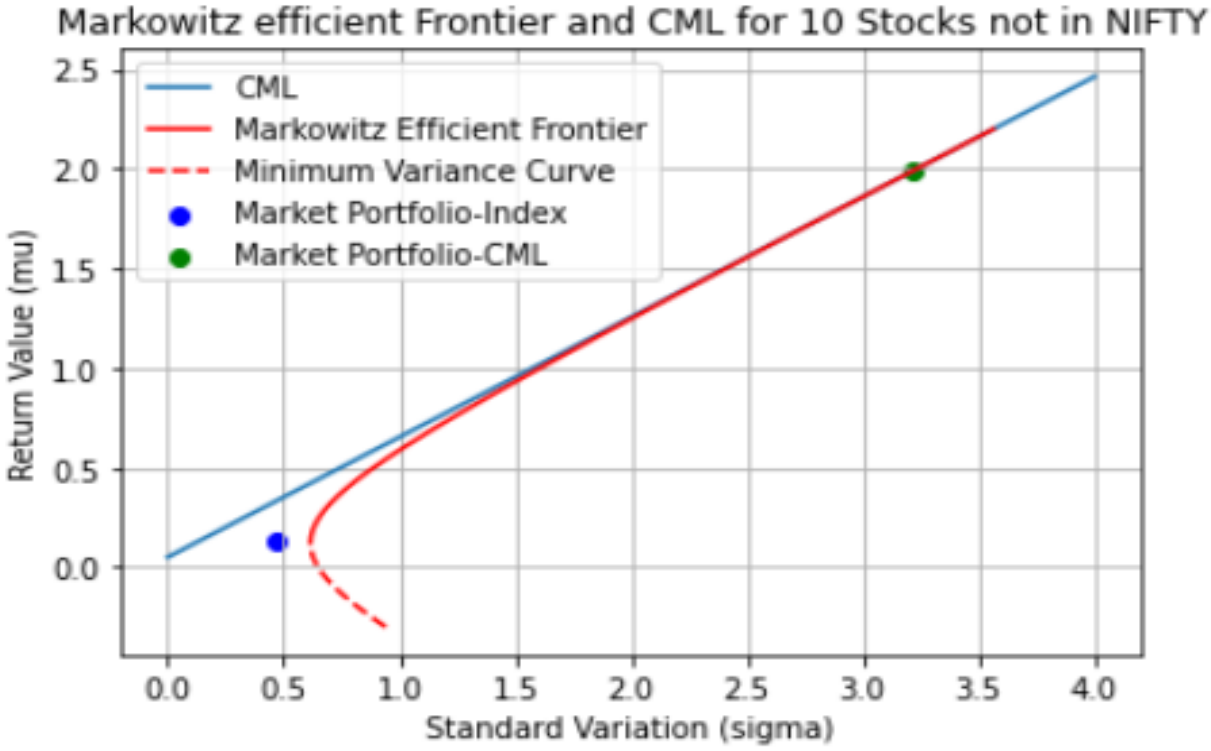


The risk-free rate = 0.05 = 5% (Yearly)
The return on market portfolio is 1.101
The risk on market portfolio is 1.8116 (181.1558 %)



BSE NON_INDEX

The risk-free rate = 0.05 = 5% (Yearly)
The return on market portfolio is 1.9936
The risk on market portfolio is 3.2208 (322.0814 %)

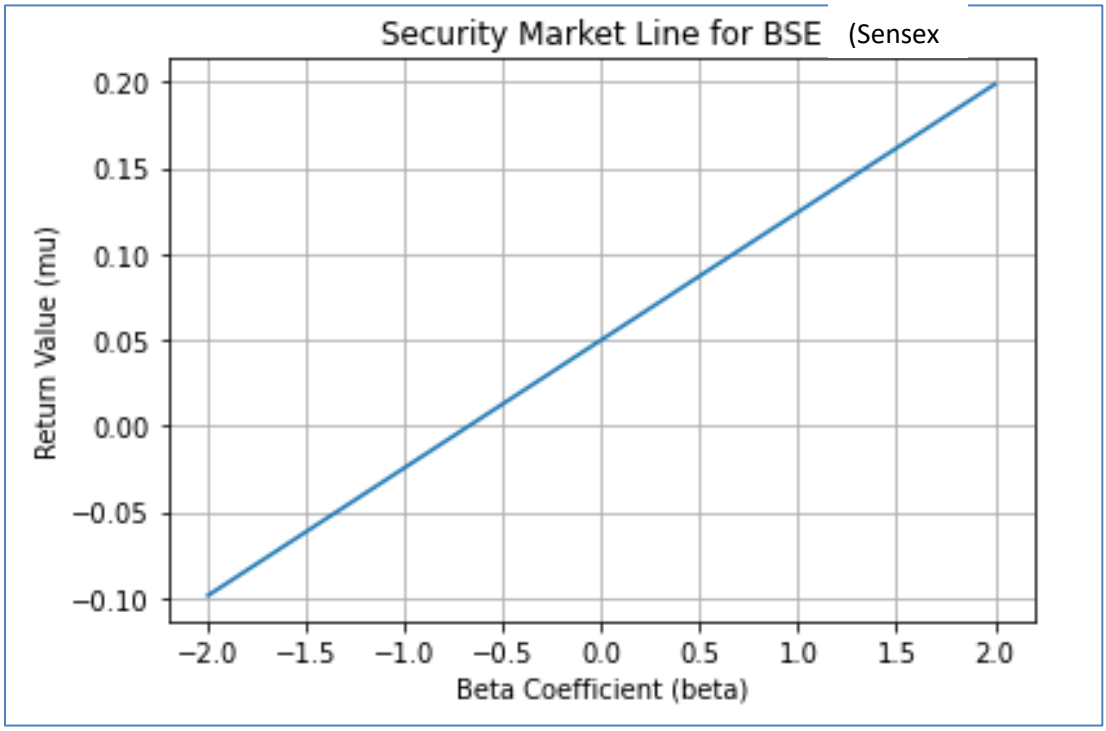


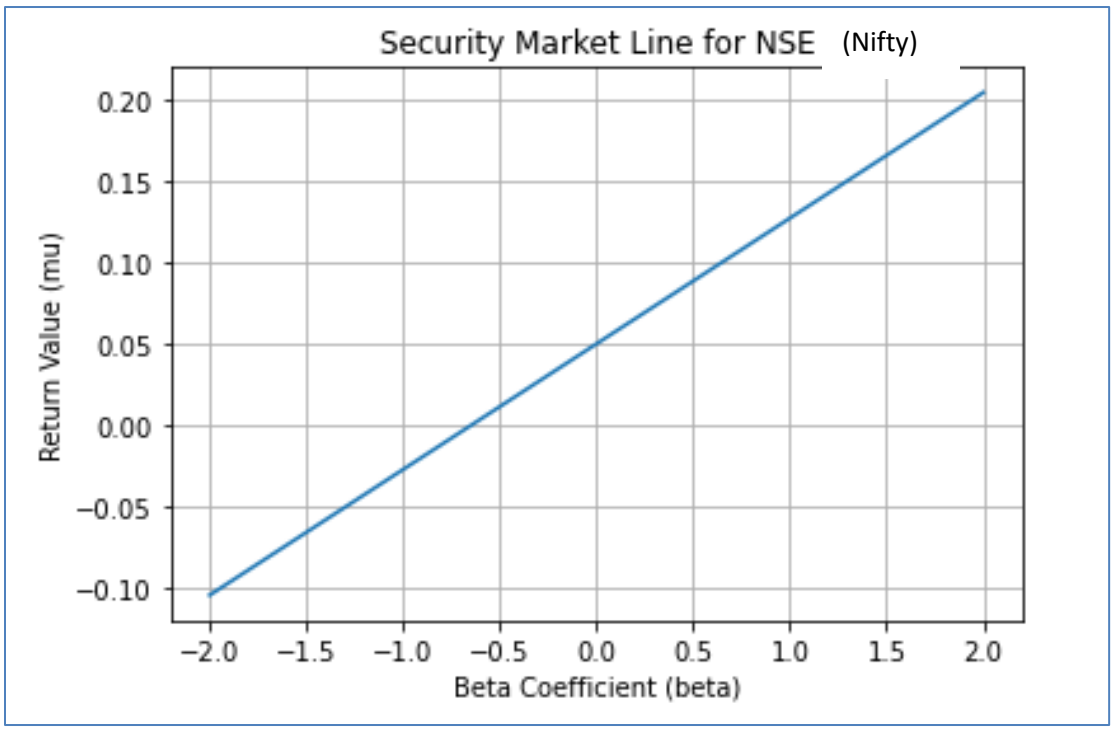
NSE NON_INDEX

Using the below formula, μ_V vs β_V (Beta Coefficient) for each index was plotted out.

$$\mu_V = r_F + (\mu_M - r_F)\beta_V.$$

β_V was varied between **-2 to 2**.
μ_M = Mean of the **corresponding index return value**
The plot of **Security Market Lines** (for **NIFTY** and **SENSEX**) are as follows:





It can be seen that **SMLs** for **NSE (NIFTY)** and **BSE (SENSEX)** are almost the same, with **insignificant diffirence**. Since the **SMLs** have **positive** slopes in both cases, this implies that the market return is **greater** than the **risk free rate**.

Q2.

In this question, **beta values** for each stock were calculated (Procedure explained in Q3). Using these **calculated values of beta** (**risk premium**), the actual values of returns were calculated for each stock, using the below formula.

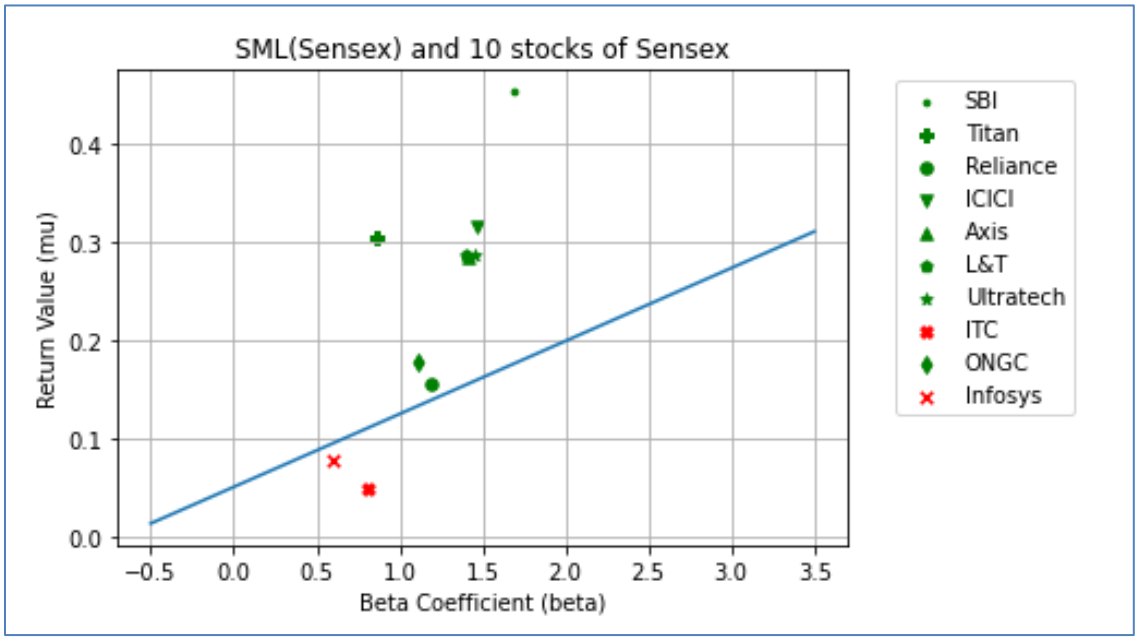
$$\mu_V = r_F + (\mu_M - r_F)\beta_V.$$

where μ_M is the **mean stock return**, β_V is the **calculated beta value**, r_F is the **risk-free rate (0.05)**
Here, μ_V is the **actual return**.

This **actual return** value was then compared with the corresponding **CAPM** return value (using **mean market index** return as μ_M) to determine whether the stock is **overvalued**, or **undervalued**. All stocks whose values **lie above the security market line are undervalued** (as they give **more** returns relative to market, represented as green), and stocks which **lie below the security market line are overvalued**, (as they give **less** return relative to market, represented as red).

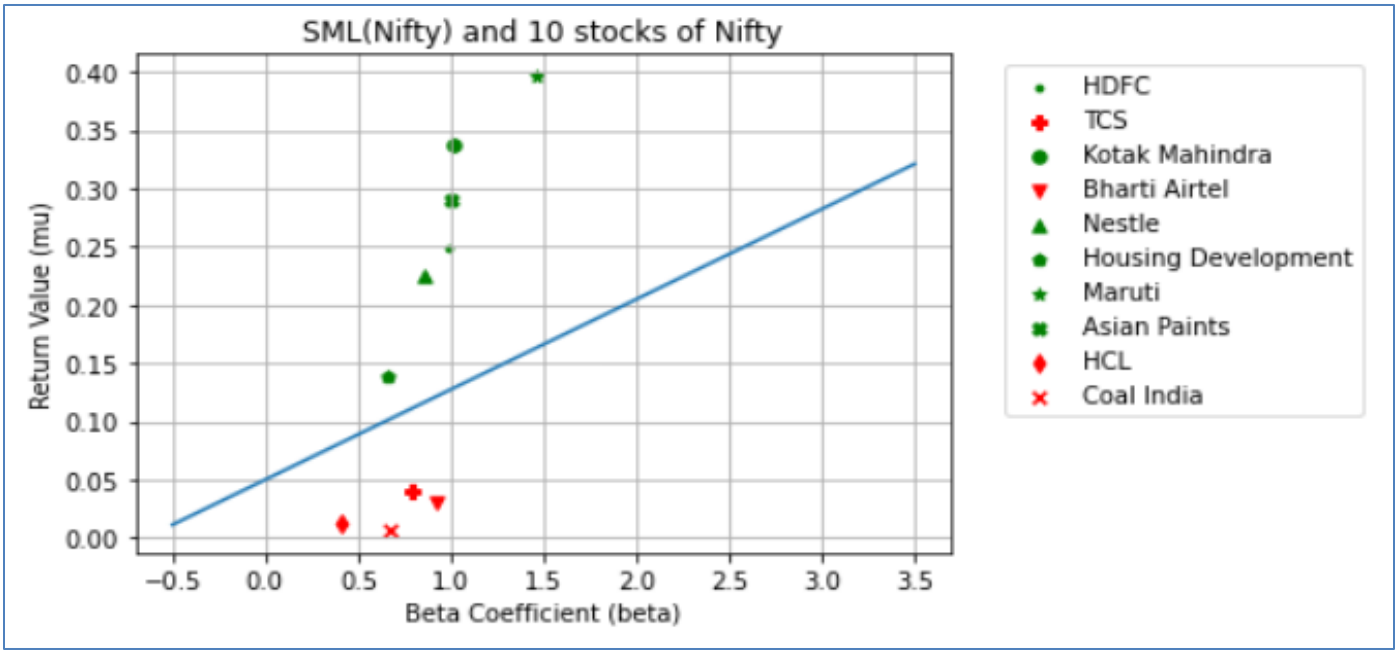
Stocks in Sensex (BSE):

Stock Name	Calculated Beta	Actual Return	Expected (CAPM) Return	Quality
SBI	1.687	0.40283	0.12544	Undervalued
Titan	0.861	0.25372	0.06405	Undervalued
Reliance	1.189	0.10478	0.08842	Undervalued
ICICI	1.465	0.26526	0.10893	Undervalued
Axis	1.419	0.23439	0.10556	Undervalued
L&T	1.4	0.23669	0.10414	Undervalued
Ultratech	1.456	0.23699	0.10829	Undervalued
ITC	0.808	-0.00078	0.06008	Overvalued
ONGC	1.111	0.12787	0.08265	Undervalued
Infosys	0.603	0.02706	0.04488	Overvalued



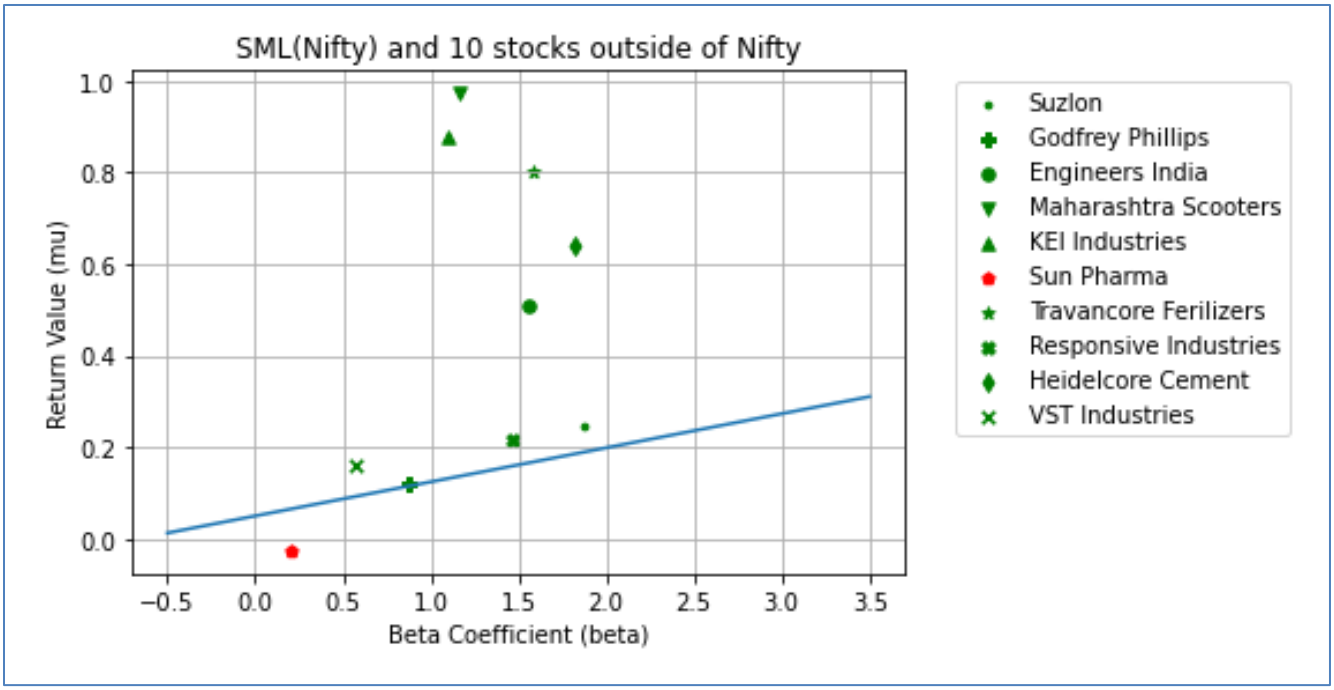
Stocks in NIFTY (NSE):

Stock Name	Calculated Beta	Actual Return	Expected (CAPM) Return	Quality
HDFC	0.983	0.19847	0.07607	Undervalued
TCS	0.793	-0.00972	0.06137	Overvalued
Kotak Mahindra	1.018	0.28784	0.07879	Undervalued
Bharti Airtel	0.916	-0.0198	0.07093	Overvalued
Nestle	0.859	0.174523	0.06646	Undervalued
Housing Dev.	0.655	0.08934	0.0507	Undervalued
Maruti Suzuki	1.466	0.34586	0.11351	Undervalued
Asian Paints	1.005	0.23975	0.0778	Undervalued
HCL	0.414	-0.03813	0.03205	Overvalued
Coal India	0.673	-0.04314	0.05206	Overvalued



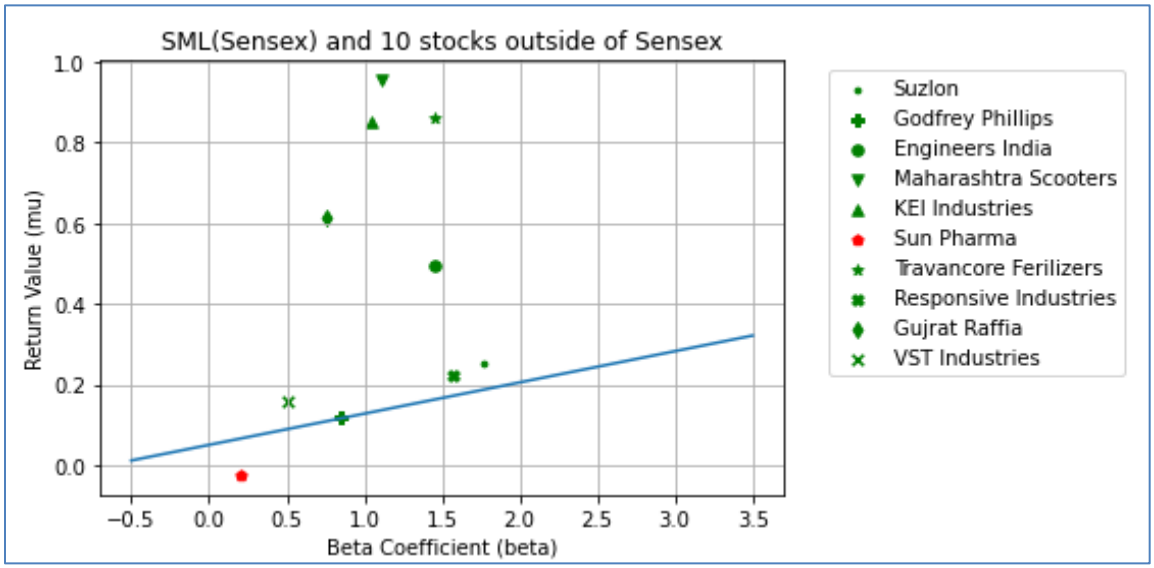
Stocks not included in Nifty (but still listed in NSE):

Stock Name	Calculated Beta	Actual Return	Expected (CAPM) Return	Quality
Suzlon	1.86	0.19682	0.14396	Undervalued
Godfrey Phillips	0.873	0.06875	0.06756	Undervalued
Engineers India	1.544	0.45488	0.11955	Undervalued
Maharashtra Scooters	1.159	0.91401	0.08968	Undervalued
KEI Industries	1.091	0.81944	0.08443	Undervalued
Sun Pharmaceuticals	0.204	-0.07513	0.01575	Overvalued
Travancore Fertilizers	1.574	0.74502	0.12180	Undervalued
Responsive Industries	1.449	0.16315	0.11218	Undervalued
Heide-core Cement	1.809	0.58655	0.14005	Undervalued
VST Industries	0.565	0.11118	0.04377	Undervalued



Stocks not included in Sensex (but still listed in BSE):

Stock Name	Calculated Beta	Actual Return	Expected (CAPM) Return	Quality
Suzlon	1.785	0.20238	0.13272	Undervalued
Godfrey Phillips	0.861	0.06725	0.06406	Undervalued
Engineers India	1.466	0.44888	0.10902	Undervalued
Maharashtra Scooters	1.117	0.91143	0.08311	Undervalued
KEI Industries	1.060	0.80622	0.07880	Undervalued
Sun Pharmaceuticals	0.205	-0.07532	0.01525	Overvalued
Travancore Fertilizers	1.465	0.81612	0.10899	Undervalued
Responsive Industries	1.579	0.17292	0.11743	Undervalued
Gujrat Raffia	0.765	0.56936	0.05690	Undervalued
VST Industries	0.508	0.10843	0.03775	Undervalued



Q3.

First, the **beta values** of each stock were calculated using the below formula.

$$\beta_V = \frac{\mathrm{Cov}(K_V, K_M)}{\sigma_M^2}$$

Here, the K_V and K_M represents the **returns of that particular stock** and **the mean return of the corresponding index portfolio (NIFTY/SENSEX)**. σ_M represents the **SD (risk)** of the **corresponding index portfolio (NIFTY/SENSEX)**.

Also, the **long-term beta** values **(actual value)** for the stocks were also collected from online sources (www.topstockresearch.com). The data has been stored in 4 files, **bse_beta.csv, nse_beta.csv, non_bse_beta.csv, and non_nse_beta.csv**.

The comparison between **actual** and **calculated beta** values are as follows:

Stocks included in **Sensex (BSE)**

Stock Name	Calculated Beta	Actual Beta
SBI	1.687	1.75
Titan	0.861	1.10
Reliance	1.189	0.95
ICICI	1.465	1.7
Axis	1.419	1.42
L&T	1.4	1.34
Ultratech	1.456	1.57
ITC	0.808	1.01
ONGC	1.111	1.04
Infosys	0.603	0.62

Stocks included in **NIFTY (NSE)**:

Stock Name	Calculated Beta	Actual Beta
HDFC	0.983	0.85
TCS	0.793	0.69
Kotak Mahindra	1.018	0.799
Bharti Airtel	0.916	0.972
Nestle	0.859	0.742
Housing Dev.	0.655	0.84
Maruti Suzuki	1.466	1.01

Asian Paints	1.005	0.728
HCL	0.414	0.7
Coal India	0.673	0.875

Stocks **not included in Sensex (but still listed in the BSE):**

Stock Name	Calculated Beta	Actual Beta
Suzlon	1.785	1.28
Godfrey Phillips	0.861	0.55
Engineers India	1.466	0.936
Maharashtra Scooters	1.117	0.99
KEI Industries	1.060	1.61
Sun Pharmaceuticals	0.205	0.349
Travancore Fertilizers	1.465	1.34
Responsive Industries	1.579	N/A
Gujrat Raffia	0.765	N/A
VST Industries	0.508	0.47

Stocks **not included in Nifty (but still listed in the NSE):**

Stock Name	Calculated Beta	Actual Beta
Suzlon	1.86	1.28
Godfrey Phillips	0.873	0.55
Engineers India	1.544	0.936
Maharashtra Scooters	1.159	0.99
KEI Industries	1.091	1.61
Sun Pharmaceuticals	0.204	0.349
Travancore Fertilizers	1.574	1.34
Responsive Industries	1.449	N/A
Heidelcore Cement	1.809	1.87
VST Industries	0.565	0.47

We can say that the calculated beta values and the actual beta values are **similar**. The **similarity** is much stronger in case of Stocks included in **Nifty/Sensex**, (because large companies have **credible** (and **stable**) datasets of beta values). **Actual** Beta values for **smaller** companies vary very **large** (due to high volatility), and hence the similarity between the actual and calculated beta values is **less strong**.

Beta Value:

The **Market Portfolio** has **beta value** as **1**.
If the **Beta value is above 1**, it implies that the particular stock is **highly correlated** with the market, and **moves according to the market volatility**.
If the **Beta value is below 1**, it implies that the particular stock is **lowly correlated** with the market, and moves with **small magnitude in response to the market volatility.**
A **Beta value** of **0** represents **zero correlation** with the market, and occurs when the **stock return equals the risk-free return.**
A **negative Beta value** suggests that the stock moves in **opposite** direction to the market flow, and is **negatively correlated**.