MA 374 - Financial Engineering Lab05

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Calculations for BSE (Sensex)

Daily data of BSE (Sensex) from January 1, 2018 to December 31, 2022 are taken for this lab and also in the same duration data of 10 indexed companies and 10 non-indexed companies are taken.

Indexed Companies:

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'ADANIPORTS.BO','RELIANCE.BO', 'BAJFINANCE.BO','HDFCBANK.BO',
'TATAMOTORS.BO', 'TCS.BO', 'ITC.BO', 'ICICIBANK.BO', 'SBIN.BO', 'TECHM.BO'
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Non-Indexed Companies:

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'FEDERALBNK.BO', 'DLF.BO', 'BHARATFORG.BO', 'VOLTAS.BO', 'GAIL.BO',
'ACC.BO', 'NAUKRI.BO', 'TATAPOWER.BO', 'BANKBARODA.BO', 'AMBUJACEM.BO'
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The minimum variance line is constructed using the following steps:

i) Obtain the required weights $\boldsymbol{w}$ using the following relation -

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

where, $\mu_v =$ return,

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

Minimum variance portfolio has weights:

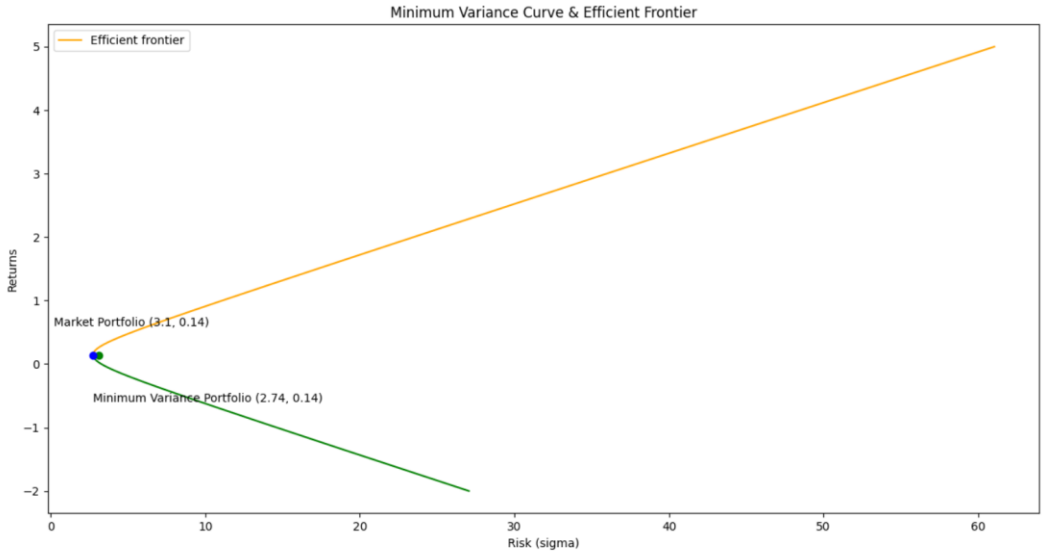
$$w = \frac{uC^{-1}}{uC^{-1}u^T}$$

using which the corresponding point was calculated.

The efficient frontier is a concept in finance that refers to the portfolio with the highest expected return for a given level of risk, as measured by standard deviation. The efficient frontier is represented on a graph as a curve with points that have a higher return than the minimum variance portfolio, indicating a trade-off between risk and reward.

Here M, C and σ are the mean return, Covariance Matrix and risk (volatility) of each of the 20 stocks and is calculate from the data obtained.

The Markowitz efficient frontier is as follows :

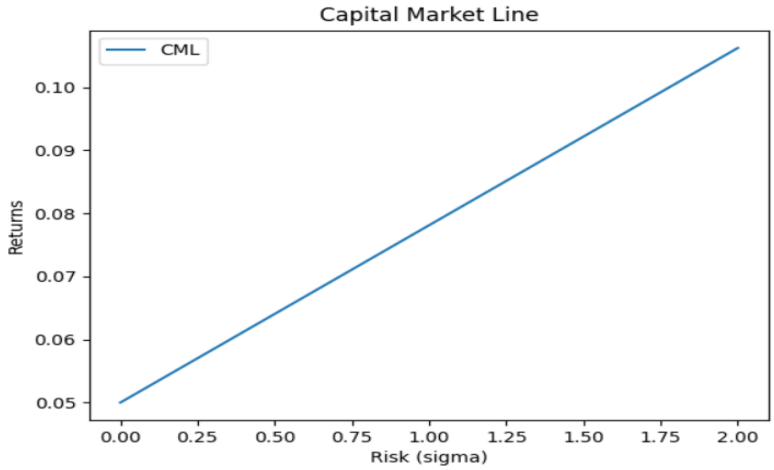


b) Market Portfolio:

Return = 0.13730084360173597

Risk = 3.104875027916485

c) Equation of Capital Market Line comes out as: *y = 0.03 x + 0.05*



d) Equation of Security Market Line comes out as: μ (mu) = 0.09β + 0.05 The Security market line is obtained using the following formula:

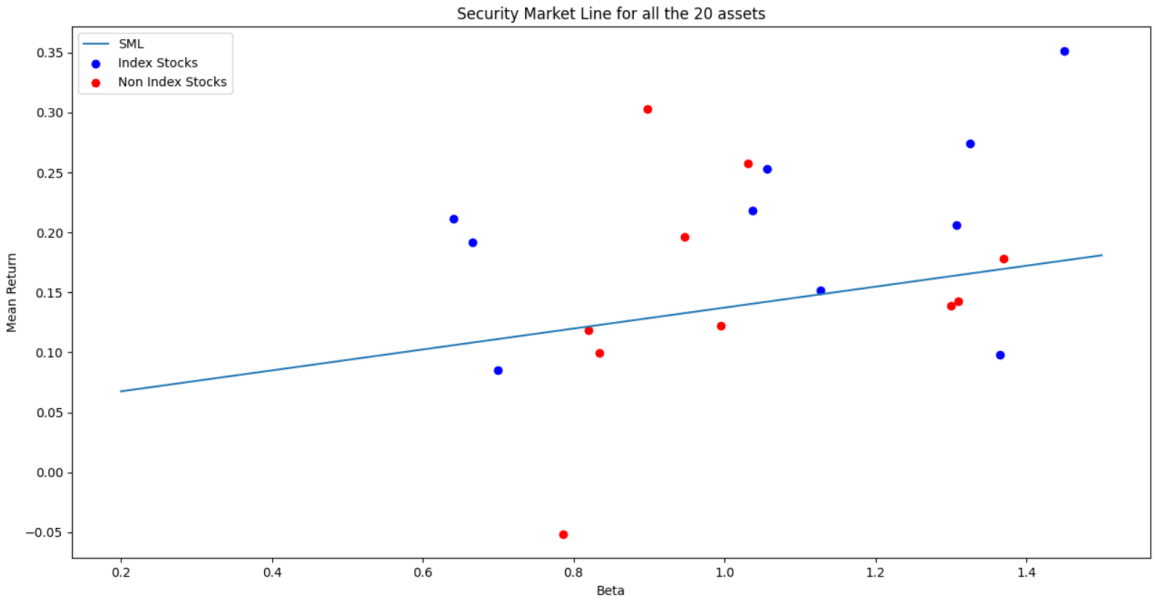
$$\mu = (\mu_M - \mu_{rf})\beta + \mu_{rf}$$

where,

μ_M = return corresponding to market portfolio
μ_{rf} = risk free return $= 0.05$

In the plot below SML equation is plotted. Also, there are 2 types of markers plotted. Blue one represents the stocks included in the BSE index and the red ones are those which are not included. For each point we have plotted $(\beta, E[R])$, where β is the calculated beta value for that stock and E[R] is the expected return calculated.

We can see that most of the indexed stocks have higher return than average and opposite is the case for stocks not included in the BSE index. SML thus divides stocks into over and undervalued stocks.



Below screenshot shows the expected return value, actual return value and expected beta value for all the stocks taken, and we can see that the expected return value is quite close to the actual return value.

We can observer that the beta values for the stocks indexed is mostly greater than 1 which is not the case with the stocks not in BSE index.

Stocks Name	Actual Return	Expected Return	Expected Beta Value
ADANIPORTS.BO	0.21830279930301025	0.14052362625594977	1.036915824879265
RELIANCE.BO	0.2528174168476714	0.1421807588509384	1.0558976872143921
BAJFINANCE.BO	0.3514369382036928	0.17665101364310665	1.450742151139857
HDFCBANK.BO	0.15163208084307003	0.1483633206330849	1.1267167254627648
TATAMOTORS.BO	0.09788723783682808	0.16915859299538583	1.3649191471617848
TCS.BO	0.2114542799283542	0.10595748980272493	0.6409730707529178
ITC.BO	0.08487410154251504	0.11110288528502782	0.6999117392699833
ICICIBANK.BO	0.2744746614381945	0.16567892540890983	1.3250607970827164
SBIN.BO	0.20613689432255583	0.1641785365954156	1.307874378812362
TECHM.BO	0.19171433567550122	0.10808829342789372	0.6653806656541706
FEDERALBNK.BO	0.14251918731618615	0.16430839007565134	1.3093618040751478
DLF.BO	0.178533162456638	0.16960264753799242	1.3700056334348425
BHARATFORG.BO	0.12205353220149602	0.13689938663680812	0.9954014537733531
VOLTAS.BO	0.09942807221494242	0.12280329341119973	0.8339357377040518
GAIL.BO	-0.05146182569167067	0.11867471875880767	0.7866443888228598
ACC.BO	0.11847547754523385	0.12159087183232928	0.8200478813117185
NAUKRI.BO	0.3029795006356896	0.1283610978325198	0.897598403401472
TATAPOWER.BO	0.2577474096967618	0.1400197043965401	1.0311435798628417
BANKBARODA.BO	0.13902101919029056	0.16354749347639955	1.3006460051451514
AMBUJACEM.BO	0.19608317708182915	0.132673743395344	0.9469982188545543

Stock Name	Expected Beta Value	Actual Beta Value (Long Term Beta)
ADANIPORTS.BO	1.036915824879265	1.30
RELIANCE.BO	1.0558976872143921	1.08
BAJFINANCE.BO	1.450742151139857	1.76
HDFCBANK.BO	1.1267167254627648	1.06
TATAMOTORS.BO	1.3649191471617848	2.36
TCS.BO	0.6409730707529178	0.824
ITC.BO	0.6999117392699833	0.868
ICICIBANK.BO	1.3250607970827164	1.25
SBIN.BO	1.307874378812362	1.43
TECHM.BO	0.6653806656541706	1.03
FEDERALBNK.BO	1.3093618040751478	1.23
DLF.BO	1.3700056334348425	1.65
BHARATFORG.BO	0.9954014537733531	1.20
VOLTAS.BO	0.8339357377040518	1.05
GAIL.BO	0.7866443888228598	1.08
ACC.BO	0.8200478813117185	0.791
NAUKRI.BO	0.897598403401472	0.97
TATAPOWER.BO	1.0311435798628417	1.30
BANKBARODA.BO	1.3006460051451514	1.29
AMBUJACEM.BO	0.9469982188545543	0.777

Calculations for NSE (Nifty)

Daily data of NSE (Nifty) from January 1, 2018 to December 31, 2022 are taken for this lab and also in the same duration data of 10 indexed companies and 10 non-indexed companies are taken.

Indexed Companies:

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'ICICIBANK.NS', 'INFY.NS', 'AXISBANK.NS', 'WIPRO.NS', 'HDFCBANK.NS',
'BHARTIARTL.NS', 'CIPLA.NS', 'TCS.NS', 'BRITANNIA.NS', 'NESTLEIND.NS'
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Non-Indexed Companies:

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'INDUSTOWER.NS', 'BANKBARODA.NS', 'NAUKRI.NS', 'HAVELLS.NS',
'GODREJCP.NS', 'ACC.NS', 'DMART.NS', 'GAIL.NS', 'INDIGO.NS', 'DLF.NS'
```

The minimum variance line is constructed using the following steps:

i) Obtain the required weights $\boldsymbol{w}$ using the following relation -

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

where, $\mu_v =$ return,

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

Minimum variance portfolio has weights:

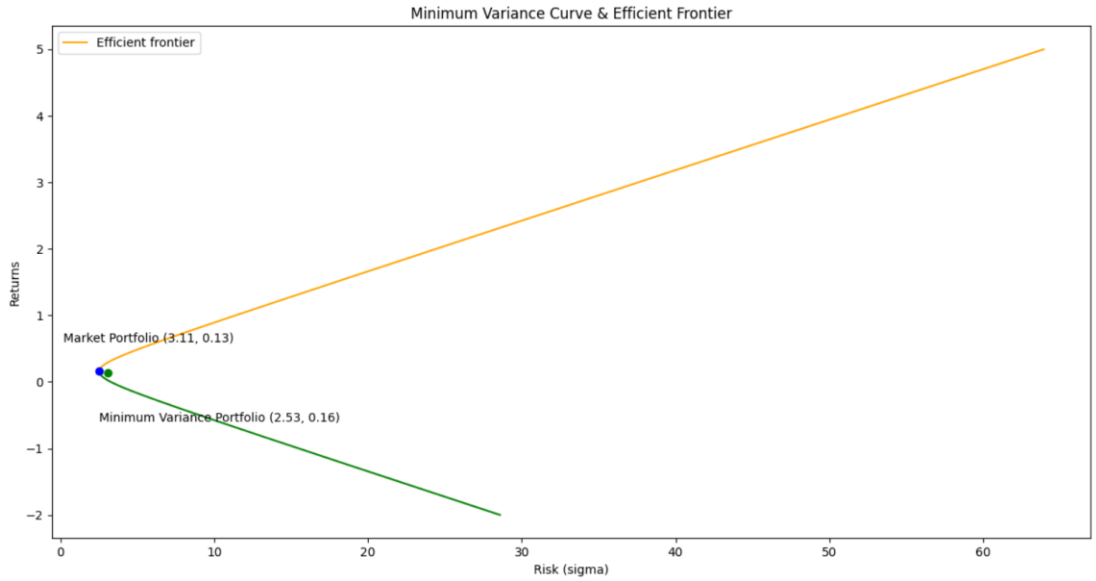
$$w = \frac{uC^{-1}}{uC^{-1}u^T}$$

using which the corresponding point was calculated.

The efficient frontier is a concept in finance that refers to the portfolio with the highest expected return for a given level of risk, as measured by standard deviation. The efficient frontier is represented on a graph as a curve with points that have a higher return than the minimum variance portfolio, indicating a trade-off between risk and reward.

Here M, C and σ are the mean return, Covariance Matrix and risk (volatility) of each of the 20 stocks and is calculate from the data obtained.

The Markowitz efficient frontier is as follows:

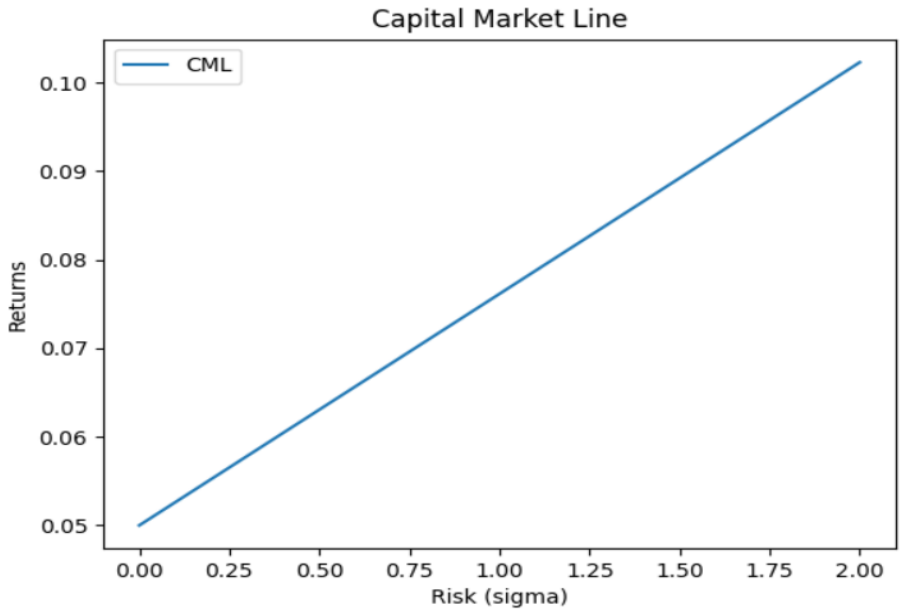


b) Market Portfolio:

Return = 0.1312238417183743

Risk = 3.106646443812293

c) Equation of Capital Market Line comes out as: *y = 0.03 x + 0.05*



d) Equation of Security Market Line comes out as: μ (mu) = 0.08β + 0.05 The Security market line is obtained using the following formula:

$$\mu = (\mu_M - \mu_{rf})\beta + \mu_{rf}$$

where,

μ_M = return corresponding to market portfolio
μ_{rf} = risk free return $= 0.05$

In the plot below SML equation is plotted. Also, there are 2 types of markers plotted. Blue one represents the stocks included in the NSE index and the red ones are those which are not included. For each point we have plotted $(\beta, E[R])$, where β is the calculated beta value for that stock and E[R] is the expected return calculated.

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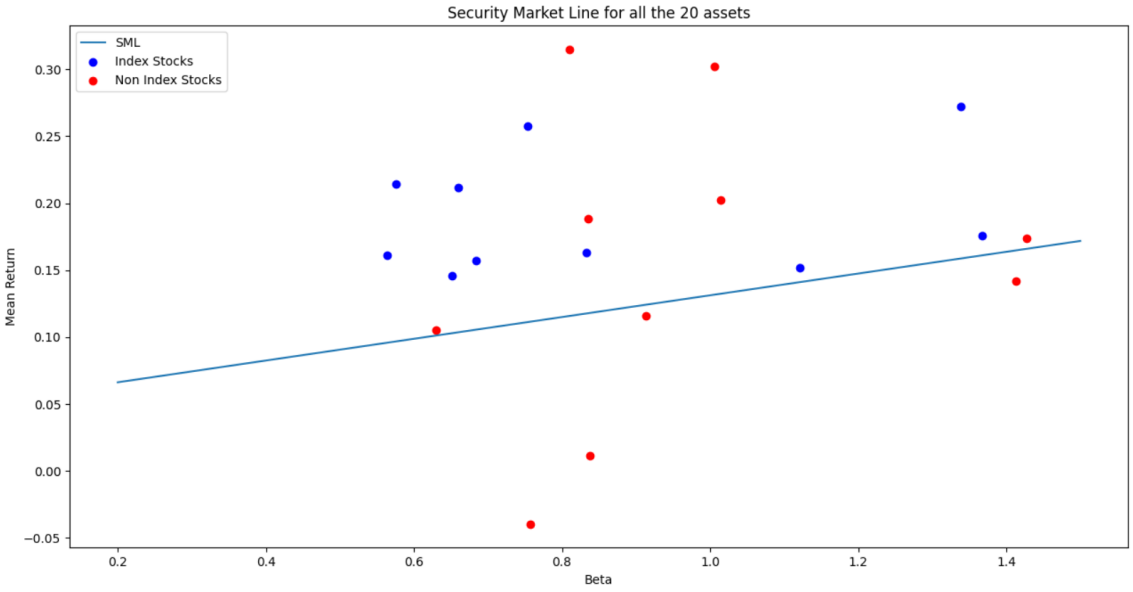

Below screenshot shows the expected return value, actual return value and expected beta value for all the stocks taken, and we can see that the expected return value is quite close to the actual return value.

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Stocks Name	Actual Return	Expected Return	Expected Beta Value
ICICIBANK.NS	0.2721701064117296	0.15876790514466	1.3391130343451205
INFY.NS	0.2575673011246697	0.11123330208647833	0.7538833523633522
AXISBANK.NS	0.17591994480721668	0.16103693880387432	1.3670485962590926
WIPRO.NS	0.145612825951569	0.1029417514039031	0.6518006324727522
HDFCBANK.NS	0.15205114056316615	0.1411094853990622	1.1217086445500102
BHARTIARTL.NS	0.16328766991933508	0.11761294798298576	0.8324273581815878
CIPLA.NS	0.16111358953340923	0.09583763210003547	0.564337159266208
TCS.NS	0.2120623402610804	0.10359561033482584	0.6598507187170085
BRITANNIA.NS	0.15741823073810457	0.1055163559621089	0.683498278185358
NESTLEIND.NS	0.21430272791533442	0.0967941434615292	0.5761133981297946
INDUSTOWER.NS	-0.03957236809112856	0.11146191824663197	0.7566979958881724
BANKBARODA.NS	0.14200437178793457	0.16474955220798132	1.412757015432119
NAUKRI.NS	0.30243387082195095	0.13170839612409924	1.005965667167099
HAVELLS.NS	0.1886676768166903	0.11783687272138627	0.8351842425355305
GODREJCP.NS	0.10536490511212931	0.10113051596659801	0.6295013247942859
ACC.NS	0.11605967772072266	0.12418453071599957	0.9133344243087885
DMART.NS	0.3149068776831594	0.11581379090261604	0.8102767550790172
GAIL.NS	0.011168314016704189	0.1180506484957958	0.8378161763358394
INDIGO.NS	0.20223602391178822	0.13237839588188444	1.014214473719592
DLF.NS	0.17360684076051547	0.16597145364194518	1.4278006455795396

Stock Name	Expected Beta Value	Actual Beta Value (Long Term Beta)
ICICIBANK.NS	1.3391130343451205	1.25
INFY.NS	0.7538833523633522	0.884
AXISBANK.NS	1.3670485962590926	1.37
WIPRO.NS	0.6518006324727522	1.17
HDFCBANK.NS	1.1217086445500102	0.954
BHARTIARTL.NS	0.8324273581815878	0.728
CIPLA.NS	0.564337159266208	0.264
TCS.NS	0.6598507187170085	0.824
BRITANNIA.NS	0.683498278185358	0.495
NESTLEIND.NS	0.5761133981297946	0.489
INDUSTOWER.NS	0.7566979958881724	0.70
BANKBARODA.NS	1.412757015432119	1.29
NAUKRI.NS	1.005965667167099	1.02
HAVELLS.NS	0.8351842425355305	0.872
GODREJCP.NS	0.6295013247942859	0.755
ACC.NS	0.9133344243087885	0.891
DMART.NS	0.8102767550790172	0.793
GAIL.NS	0.8378161763358394	1.08
INDIGO.NS	1.014214473719592	1.06
DLF.NS	1.4278006455795396	1.65