MA 374 – Financial Engineering Lab

Lab – 5

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1 QUESTION - 1:

Theoretical Explanations and Formulae used

A. The minimum variance line is constructed using the following steps:

i) Obtain the required weights ***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, μ_v = return,

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

ii) Obtain the risk using following relation –

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

and then take square root to obtain the risk in terms of std. deviation.

Now, the minimum variance portfolio has weights:

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

Using this, we find the corresponding point on the minimum variance curve.

Now, 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 ***(denoted by yellow)***.

B. The equation of CML 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

C. 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

D. The value of β can be evaluated by using following relation:

$$\beta_k = \frac{Cov(R_k, R_M)}{\sigma_M^2}$$

where, β_k = beta of the asset k

R_k = return of the asset k

R_M = return of the entire market portfolio

σ_M^2 = variance of the market portfolio

Observations

1. Basic BSE and NSE Index values

i) Market portfolio for BSE:

Market return = 0.27364953648430085

Market risk = 0.74283537151186 %

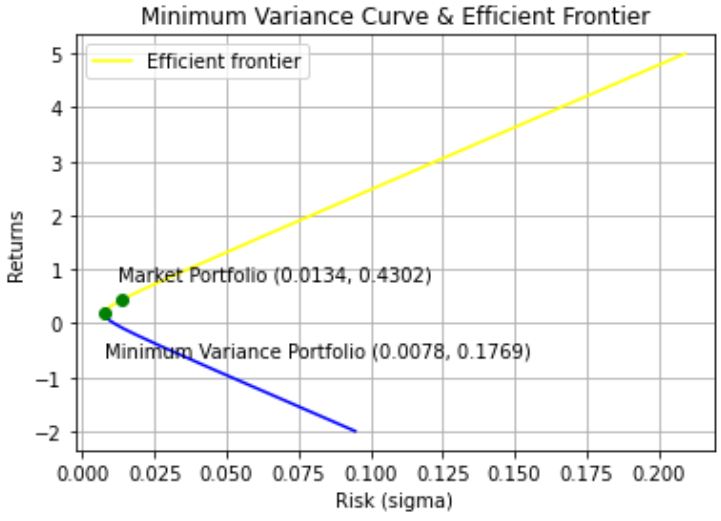
ii) Market portfolio for NSE:

Market return = 0.1732608095477732

Market risk = 0.7341924576360469 %

2. 10 stocks included in the BSE Index

i) The plot for Markowitz efficient frontier is:



ii) The market portfolio is as follows:

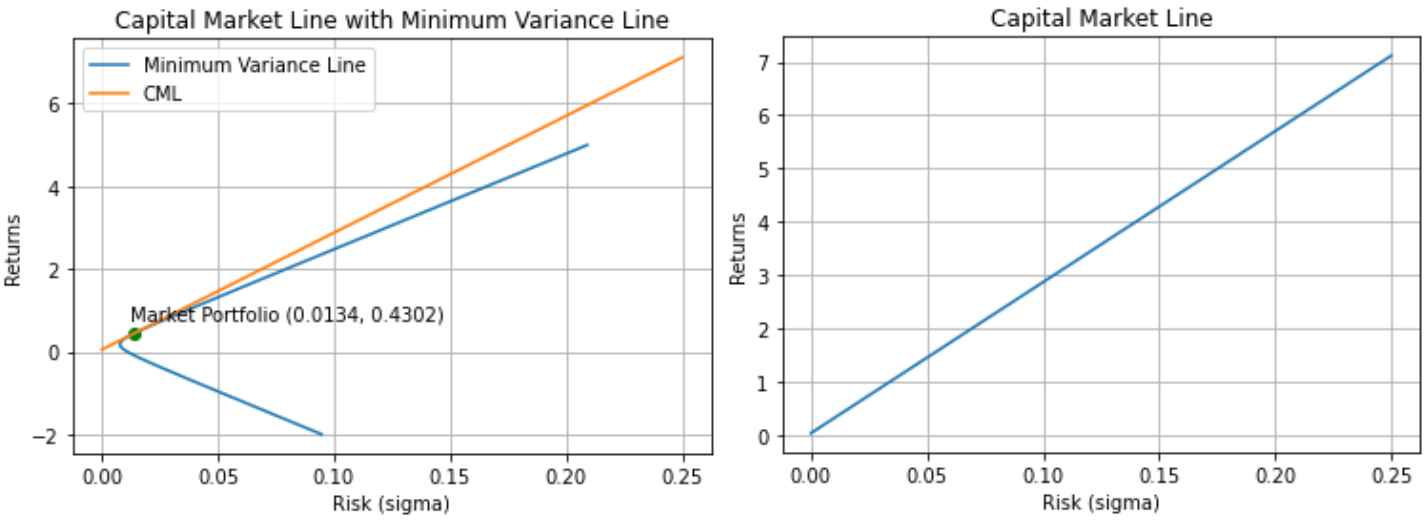
Market Portfolio Weights = [-0.09778546, -0.05895216, 0.62221465, -0.04761012, 0.07000287, 0.05848755, 0.18695924, 0.52896376, 0.1343937, -0.39667403]

Return = 0.43018900349935396

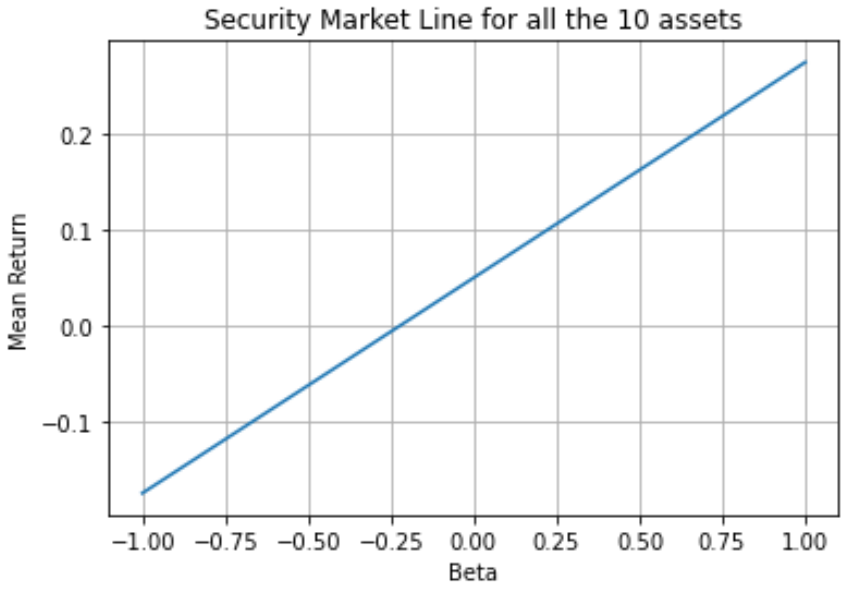
Risk = 1.344916150769783 %

Note: *The market portfolio shown in the plot above is calculated from the values of the 10 stocks, and not taken from the market portfolio found from the index values.*

iii) The equation of Capital Market Line (CML) is: y = 28.2686 x + 0.0500



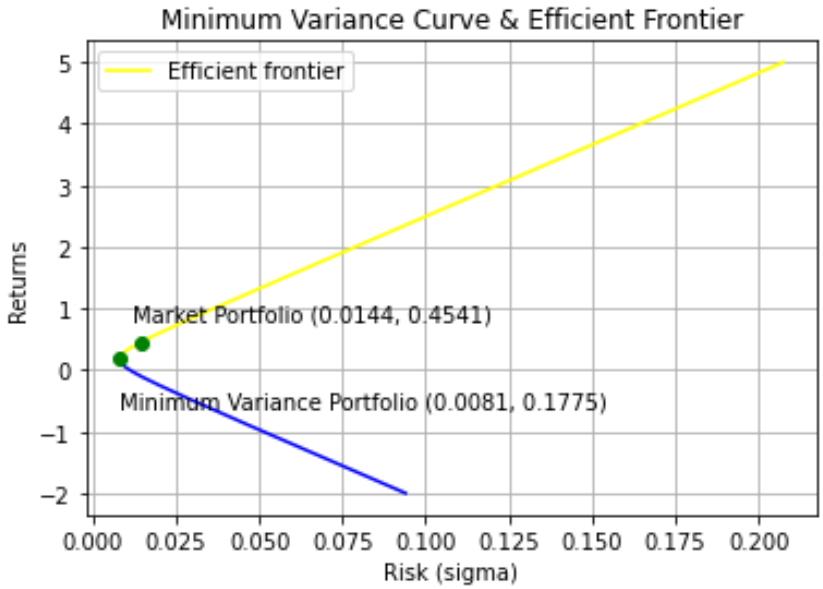
iv) The equation of Security Market Line (SML) is: mu = 0.22 beta + 0.05



Note: *The market portfolio mean used in calculating the SML equation is that value which was calculated from the corresponding index values.*

3. 10 stocks included in the NSE Index

i) The plot for Markowitz efficient frontier is:



ii) The market portfolio is as follows:

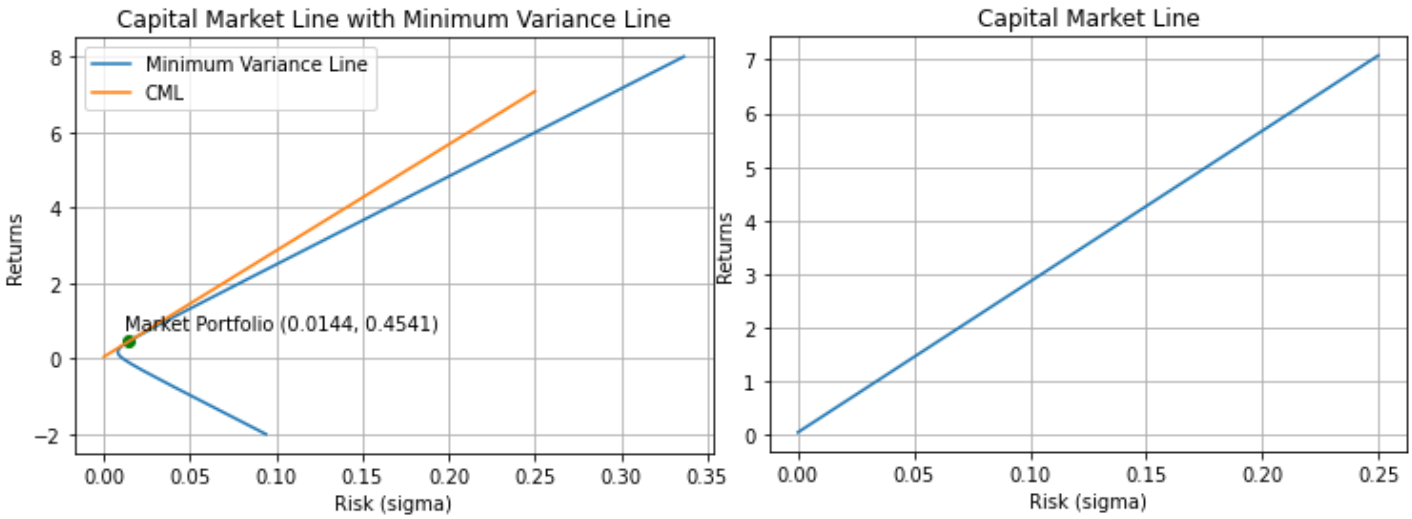
Market Portfolio Weights = [-0.14454129, -0.0483015, 0.65928498, -0.12139159, 0.17519582, 0.03725495 0.19239421, 0.54239391, 0.16354953, -0.45583902]

Return = 0.4540820076978107

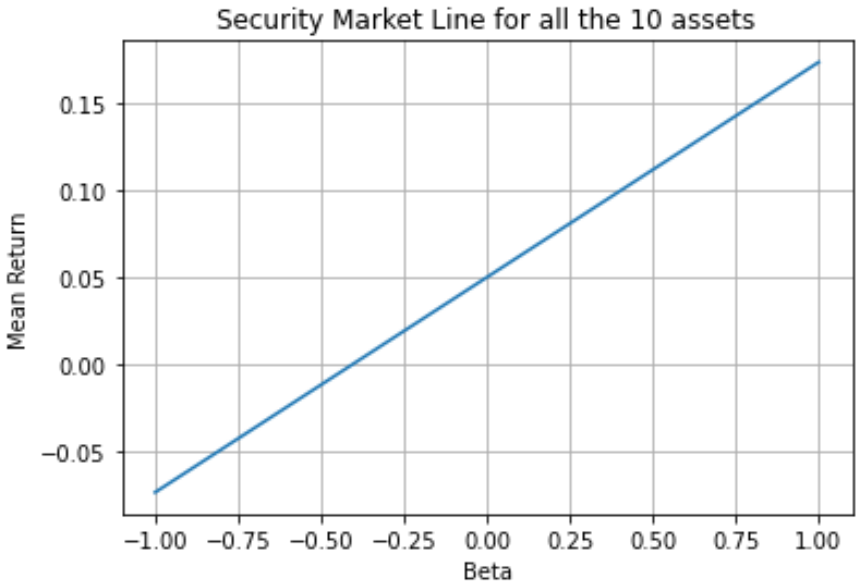
Risk = 1.4369800628277307 %

Note: *The market portfolio shown in the plot above is calculated from the values of the 10 stocks, and not taken from the market portfolio found from the index values.*

iii) The equation of Capital Market Line (CML) is: y = 28.1202 x + 0.0500



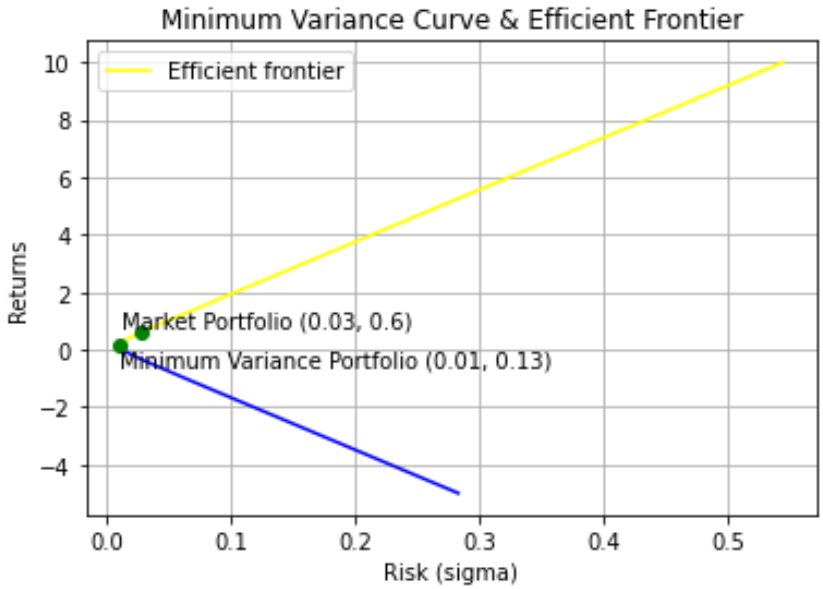
iv) The equation of Security Market Line (SML) is: mu = 0.12 beta + 0.05



Note: *The market portfolio mean used in calculating the SML equation is that value which was calculated from the corresponding index values.*

4. 10 stocks not included in any of the Index

i) The plot for Markowitz efficient frontier is:



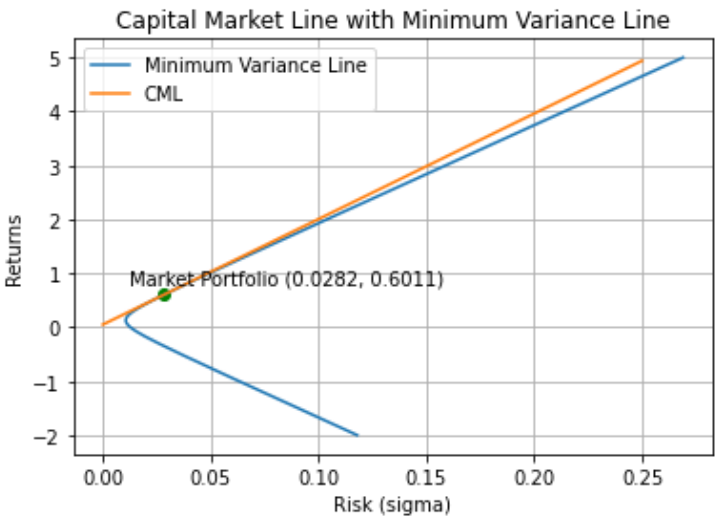
ii) The market portfolio is as follows:

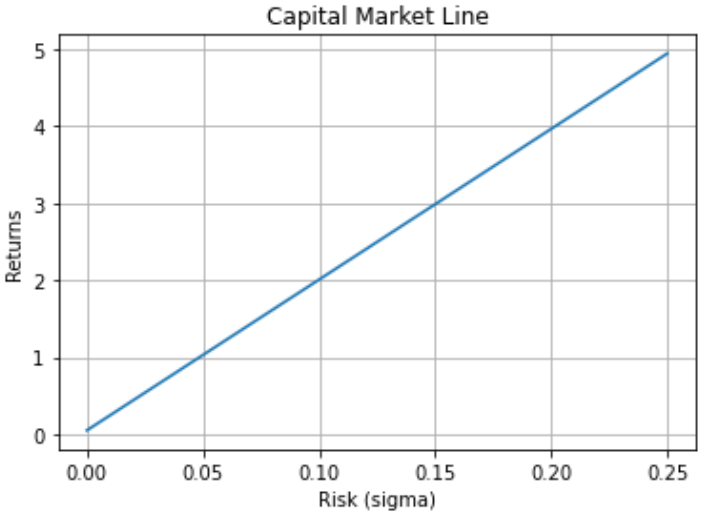
Market Portfolio Weights = [-0.2264015, 0.27564927, 0.1728615, 0.22604924, 0.57215133, -0.34637823, -0.63231141, -0.16328817, 0.67427171, 0.44739627]

Return = 0.6011103380600903

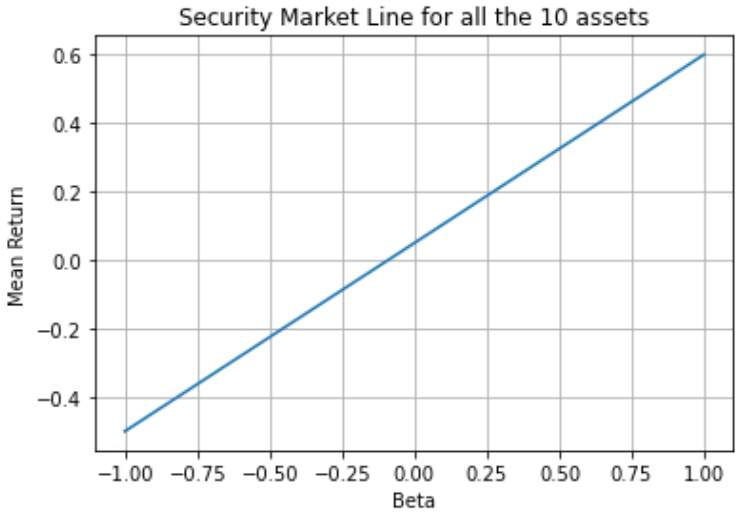
Risk = 2.8170610494024144 %

iii) The equation of Capital Market Line (CML) is: y = 19.5633 x + 0.0500





iv) The equation of Security Market Line (SML) is: mu = 0.55 beta + 0.05



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

2 QUESTION - 2:

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

SI No.	Stocks (from BSE)	Actual Return	Expected Return
1.	WIPRO.BO	0.05834656604726833	0.16010053324335904
2.	BAJAJ-AUTO.BO	0.10082665809967288	0.23231448593814746
3.	HDFCBANK.BO	0.2468099062488282	0.236278247841469
4.	HEROMOTOCO.BO	0.11608437332541395	0.2472150490591789
5.	TCS.BO	0.2403456112424333	0.1604806222641466
6.	INFY.BO	0.1134417966755598	0.20145722838809466
7.	NESTLEIND.BO	0.17428995233002792	0.13326324238113818
8.	MARUTI.BO	0.3213774900690883	0.27996660463395273
9.	RELIANCE.BO	0.21535728356261533	0.3018613005250232
10.	TATAMOTORS.BO	-0.097843085497585	0.35827605881695257

SI No.	Stocks (from NSE)	Actual Return	Expected Return
1.	WIPRO.NS	0.05638530858102343	0.11099717685263587
2.	BAJAJ-AUTO.NS	0.10336556135885959	0.1572097962469069
3.	HDFCBANK. NS	0.24720097411281733	0.15567258223082564
4.	HEROMOTOCO. NS	0.11468528075015236	0.16127964024199454
5.	TCS. NS	0.1398166252696079	0.11169680084720165
6.	INFY. NS	0.11331270587416957	0.1314301254921425
7.	NESTLEIND. NS	0.17540528828427132	0.10951324007671887
8.	MARUTI. NS	0.32308648075282076	0.1796900982669387
9.	RELIANCE. NS	0.21574703957701297	0.18637862779339687
10.	TATAMOTORS. NS	-0.09911720477619501	0.2203237618975057

SI No.	Stocks (non-index)	Actual Return	Expected Return (using BSE Index)
1.	ACC.NS	0.08796898452201496	0.2600762237094524
2.	CUMMINSIND.NS	0.15870471290435634	0.20941575927845135
3.	EMAMILTD.NS	0.15837211632914333	0.17942671592467196
4.	GODREJIND.NS	0.18407153504266563	0.3150128927484521
5.	IBULHSGFIN.NS	0.3351676335124816	0.28653365084112736
6.	LUPIN.NS	0.02760435159200274	0.2046348206279115
7.	MAHABANK.NS	-0.10146972260122855	0.23683202177000662
8.	PNB.NS	0.014312162228859875	0.3999012346997433
9.	TATACHEM.NS	0.2314497659054188	0.27194896361233883
10.	ZYDUSWELL.NS	0.24185626734016913	0.1598149671718492

SI No.	Stocks (non-index)	Actual Return	Expected Return (using NSE Index)
1.	ACC.NS	0.08796898452201496	0.174161735772821
2.	CUMMINSIND.NS	0.15870471290435634	0.1407609219907971
3.	EMAMILTD.NS	0.15837211632914333	0.12558029352521521
4.	GODREJIND.NS	0.18407153504266563	0.2020922713453741
5.	IBULHSGFIN.NS	0.3351676335124816	0.18943255660118963
6.	LUPIN.NS	0.02760435159200274	0.1430405822860521
7.	MAHABANK.NS	-0.10146972260122855	0.16259727755683812
8.	PNB.NS	0.014312162228859875	0.25859875792569487
9.	TATACHEM.NS	0.2314497659054188	0.1786470597890344
10.	ZYDUSWELL.NS	0.24185626734016913	0.11530732849197871

Explanation:

1. The market portfolio return is taken as the corresponding value calculated using the index values.
2. The dependence between actual return and expected return depends on the value of beta. *(which is discussed in detail in the next question)*
3. If the value of beta is close to 1, the expected return is very close to the market portfolio return, otherwise if it is close to 0, them the expected return is around the risk-free return.
4. Also, since the market portfolio mean is calculated from the index values, and not from the combined asset of 10 chosen stocks, there can be some deviations in the observed values.
5. For the non-index stocks, the comparison was made twice, first by considering the market portfolio constructed using BSE index and then using NSE index.

3 QUESTION – 3 :

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

SI No.	Company name (Stocks)	Beta
1.	WIPRO.BO	0.49229046021782197
2.	BAJAJ-AUTO.BO	0.8151793596538265
3.	HDFCBANK.BO	0.83290245430285
4.	HEROMOTOCO.BO	0.8818039695468918
5.	TCS.BO	0.4939899451653987
6.	INFY.BO	0.6772078796538271
7.	NESTLEIND.BO	0.37229338227125214
8.	MARUTI.BO	1.028245388964154
9.	RELIANCE.BO	1.1261427342269617
10.	TATAMOTORS.BO	1.3783889904846376

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

SI No.	Company Name (Stocks)	Beta
1.	WIPRO.NS	0.49486269866655946
2.	BAJAJ-AUTO.NS	0.8697800755994121
3.	HDFCBANK. NS	0.8573088447051715
4.	HEROMOTOCO. NS	0.9027982263808267
5.	TCS. NS	0.500538663290941
6.	INFY. NS	0.6606327330714307
7.	NESTLEIND. NS	0.4828236995608311
8.	MARUTI. NS	1.0521600396975623
9.	RELIANCE. NS	1.1064232686265094
10.	TATAMOTORS. NS	1.3818160250804772

The betas of the securities for the stocks from non-index using market portfolio from BSE index are:

SI No.	Company Name (Stocks)	Beta
1.	ACC.NS	0.9393098998181858
2.	CUMMINSIND.NS	0.7127927103468044
3.	EMAMILTD.NS	0.5787032602849014
4.	GODREJIND.NS	1.1849472031749761
5.	IBULHSGFIN.NS	1.0576085001532336
6.	LUPIN.NS	0.6914157885534723
7.	MAHABANK.NS	0.8353785333381244

8.	PNB.NS	1.5645068628358398
9.	TATACHEM.NS	0.992396260244065
10.	ZYDUSWELL.NS	0.49101361396989823

The betas of the securities for the stocks from non-index using market portfolio from NSE index are:

SI No.	Company Name (Stocks)	Beta
1.	ACC.NS	1.0073091052083247
2.	CUMMINSIND.NS	0.7363323535176057
3.	EMAMILTD.NS	0.6131737557339507
4.	GODREJIND.NS	1.2339061531672533
5.	IBULHSGFIN.NS	1.131199422693624
6.	LUPIN.NS	0.7548269610381855
7.	MAHABANK.NS	0.9134880581260341
8.	PNB.NS	1.6923364262413574
9.	TATACHEM.NS	1.0436979950157939
10.	ZYDUSWELL.NS	0.5298304362236651

Explanation:

1. The beta of a security is a measure of its systematic risk, which cannot be eliminated by diversification.
2. A beta value of one is considered as the overall market average. A beta value which is greater than one represents a risk level greater than the market average, and a beta value of less than one represents a risk level that is less than the market average.
3. From the above tables, is clear that for the stocks from **MARUTI, RELIANCE** and, **TATAMOTORS**, the value of beta is greater than 1 for both the indices, while for the stocks of the rest of the companies, the value of beta is less than 1.
4. Beta less than 1 can also occur when the asset price goes opposite to the market.