APPLICATION OF MARKOWITZ MODEL IN INDIAN STOCK MARKET - REFERENCE TO BOMBAY STOCK EXCHANGE

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ABSTRACT:

This Research has been carried out to test whether the Markowitz Framework of Construction of Portfolio offers the improved Investment alternative to Investors of Indian Stock Market. This research has applied Markowitz Model on 30 Listed Securities of Bombay Stock Exchange. It can be found that this model provides better insights to the investors for investment purpose. To evaluate the performance of Portfolio Sharpe and Treynor's measure has been used.

Key words: Portfolio Selection, Portfolio Evaluation, Markowitz Model. Bombay Stock Exchange

1. THEORETICAL FRAMEWORK:

1.1 Tradition Portfolio Theory:

According to traditional portfolio theory return is appreciation in price or dividend declared by a firm over a period of time. But it is must for the forecaster or an investor to approximate future return of an enterprise to predict future return of a stock.

The analyst is likely to think about risk as the possible down side price expectation. Each shareholder assumes a roughly channel return and risk on their funds. That does not mean that the decade old traditional portfolio theory is not successful. It is just not useful or in terms of its main purpose of earning higher returns.

1.2 Modern Portfolio Theory

Harry Markowitz, Developed Modern Portfolio theory in the year of 1952. He received Nobel Prize for this invention. According to him any investors who invest in stock market or anywhere else, want to minimize the risk and maximize. It is nothing but an optimization of Risk Return ratio to Stock Investors.
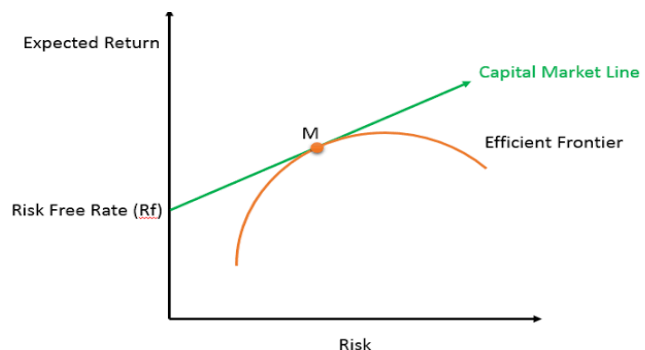
Figure 1 Efficient Frontier

Modern Portfolio Theory specifies that it is not enough to look at individual security for its market risk and company specific risk. An investor can take advantage of diversification by investing in different security by that minimizing risk of a investing in single security and can reduce volatility of portfolio (Markowitz-1952)[1].

1.3 Introduction to Indian Stock Market:

The Bombay Stock Exchange is considered Asia's Oldest Stock Exchange. Its head quarter is in Mumbai India. It was established in a year 1875. Initially it was a broker's association known as Native shares and Stock Brokers Association. Before that all the share brokers were used to gather under banyan tree to carry on transactions.

BSE Ltd, the first ever stock exchange in Asia established in 1875 and the first in the country to be granted permanent recognition under the Securities Contract Regulation Act, 1956, has had an interesting rise to prominence over the past 143 years.

The Bombay Stock Exchange deals with trading in derivatives, equity and other debt instruments, the Bombay Stock Exchange introduces the first Exchange Traded Index Derivative Contract in 2000. The Index Options started to be traded from 2001 whereas the single stock futures were traded from 2002. The weekly options were introduced in 2004[2]

2. LITERATURE REVIEW:

Rita Ambrozaite, undertook study on," Danish Mortgage Bond Portfolio Optimization Using the Mean-Variance Approach'. Objective of this portfolio was to construct portfolio with highest possible return in Danish Mortgage Market. In other word how to maximize Sharpe Ratio? To achieve an objective Markowitz mean variance methods has been applied to data available from Danish mortgage bond Market. Author proved that the sensitivity of the value of the optimal portfolio to market interest rate fluctuations was not markedly different.

Ioana Coralia Zavera in his paper titled, "Application of Markowitz Model on Romanian Stock Market", tested application of Markowitz model in Romanian market by creating a portfolio comprised of three securities. Author calculated efficient frontier and Minimum Variance Portfolio for the stock in Romanian Market.

M. Ivanova and L. Dospatliev conducted research titled, "Application of Markowitz portfolio optimization on Bulgarian stock market from 2013 to 2016". This paper was conducted with object to offer realistic study and application of Markowitz model on the Bulgarian Stock market for the period three years period. Author created efficient frontier by simulating various weight option and created Minimum Variance Portfolio.

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[1] Markowitz, H. M. (1976). Markowitz revisited. *Financial Analysts Journal*, *32*(5), 47-52.
[2]https://www.google.com/search?ei=DHUyXtaZNG1mgewz53oBg&q=bombay+stock+exchange&oq=Bombay+Stock+&gs_l=psyab.1.0.0i131j0l9.2699759.2702458...2706358...0.1..0.252.2413.0j8j5......0....1..gwswiz.......0i71j0i273j0i67j0i131i67j0i10.FQ241gh35Ig

Another researcher Raghavendra S Bendigeri[3] wrote research paper titled," Optimal Portfolio Construction Using N – Assets Mean –Variance Portfolio Model: Study of Four Etfs of BSE" with objective of to create an optimum portfolio comprised of exchange traded fund using N – Asset Mean variance Portfolio model. A Variance – covariance matrix and Correlation matrix has been calculated to further employ the model. Researcher used GRG – Non Linear Optimization Method to calculate optimum weight for portfolio.

3. RESEARCH METHODOLOGY

The process used to collect information and data for the purpose of making business decisions. The methodology may include publication research, interviews, surveys and other research techniques, and could include both present and historical information.

Research Objectives:
1. To Understand Markowitz Model and Its Applicability in Bombay Stock Exchange
2. To Know Markowitz Framework of Construction of Portfolio offers the improved Investment alternative to Investors of Indian Stock Market
3. To Identify the efficient Portfolio with the help of Efficient Frontier

Sample Size and Sample Selection:

Below mentioned stocks have been selected on following criteria-

- Only those stocks has been selected which gave return more than RFR
- The research period is from the year January 2008 to December 2016. Hence only that Stock selected which has been listed on BSE since last ten years.

This study is based on risk and return data of 75 selected stocks listed on Bombay Stock exchange has been shown in Annexure. Refer Annexure 1 for the same. The List has been given below:

Table 1 List of Selected Security

ACC	BOMBAY BUMRAH	EICHER
ADANI	BOSCH	FINOLEX
AIA ENGINEERING	BPCL	GLAXO PHARMA
AMBUJA	BRITANNIA	GLAXO CONSUMER
ASHOK LAYLAND	BUTTERFLY	HEVELLS
AUROBINDO	CADILA	HAWKINS
AXIS	CIPLA	HDFC
BAJAJ FIN.	CUMMINS	HERO MOTO
BIOCON	DIVIS	HIND ZINC
BLUE STAR	DR REDDY	HINDALCO
HITACHI	LEEL	NESTLE
IFB	LUPIN	ORACLE
INDIABULLS REALESTATE	M & M	PETRONET

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[3] Raghavendra S Bendigeri, Optimal Portfolio Construction Using N – Assets Mean – Variance Portfolio Model: Study of Four Etfs of BSE, IOSR Journal of Business and Management (IOSR-JBM), e-ISSN: 2278-487X, p-ISSN: 2319-7668,PP 24-29

INDRAPRASTAH	MARUTI	PIRAMAL
INDUSIND	MIND TREE	RAIN
ITI	MOTHERSON SUMI	RAMCO
JSW	MPHASIS	SHREE
KAJARIA	MRF	SOBHA
KOTAK MAHINDRA	MRPL	STERLITE
KRBL	NCC	SIMPHONY
TATA COMM	THERMAX	UNITED SPIRIT
TATA STEEL	TORRENT	VEKARANGEE
TATA	TTK PRESTIGE	VEDANTA
TCS	ULTRATECH	WELSPUN
TECH MAHINDRA	UNITED BEVE	WHIRLPOOL

The data for the study have been collected from the publications and website of BSE. After collection of data following procedure have been applied to create a two stock portfolio based on Markowitz Model

1. Mean Return, Standard Deviation and Beta of each stock has been calculated for the period of 10 Years that is From January 2008 to December 2017.
2. Total two Thousand eight hundred and Fifty - Two stock portfolio can be formulated and correlation of this portfolio Correlation of these thirty stocks has been calculated.
3. Out of these 2850 pair of Portfolio 50 Portfolio has been selected which has the least Correlation as per Markowitz.
4. After that Minimizing Weight, Portfolio Return and Portfolio Risk have been calculated for this 50 Portfolio based on the Monthly return of last ten years available.
5. After than an Efficient Frontier of each Portfolio has been developed on the basis of Mean Return and Risk of the portfolio which is derived by researcher.
6. To check the Portfolio Performance and Evaluation of Portfolio Sharpe's Measure and Taynors Measure calculated on the portfolio and then Ranking has been given to these portfolios.

4. ANALYSIS AND DISCUSSION:

4.1 Risk and Return of individual Security:

If we look at the mean return and SD data of Sample Company, Every company is providing Return more than 0.62% which is RFR.

Ambuja Cement has registered mean return of Monthly average is 0.86%. The highest return earned by Symphony 5.28% monthly return followed by Eicher (4.38%) and Butterfly (4.31%) The lowest return earned Tata Communication that is 0.68% Followed by Divis Lab that is 0.

The highest Risk confront by stock Nestle that is -5.93% followed by Glaxo Pharma (-7.17%) and Cipla (-7.18%). The stock of Butterfly and Bombay Bumrah Registered the Lowest risk that is -0.1883 and -0.19677 respectively.

4.2 Selection of Stocks for Two-Stock Portfolio:

Table 3: Least Correlation Portfolios:

As per Markowitz a portfolio constructed from the Group of those securities which is negatively Correlated should be selected to reduce risk. This argument is very valid as negatively correlated security will move in opposite to each other and in any case of Boom or bull of stock market one will go up and another will reduce and balance will be maintained between these two securities.

From 75 selected sample total 2850 Pair of Two stock portfolio can be Created out of these 2850 portfolios total 50 Portfolio selected which has correlation Coefficient less than 0.01. The portfolios total summary of correlation has been given in following table.

Table: 2 - Summary of Least Correlated Portfolio Set

Less than 0.1	180
0.100 to 0.199	474
0.200 to 0.399	669
0.400 to 0.599	655
0.600 to 0.699	484
0.700 to 0.799	237
0.800 to 0.899	62
0.900 to 0.999	14
Greater than or equals to 1	75

4.3 Calculation of Weight, Expected Return and risk of 50 Portfolio:
Appling Markowitz Model Minimum weight of each 50 portfolio obtained and risk and return of the each portfolio Calculated. When calculated, Minimum Weight, Its Expected Return and Expected risk for these 50 Portfolios. Following results were obtained.

The Total 50 pair of portfolios has been compared here and the maximum expected profit earned by Portfolio no 31 that is VEKARANGEE and TCS pair which is followed by Portfolio no. 23 which is comprised of VEKARNGEE and BRITANNIA this portfolio earned return of 2.45% Monthly return with 0.05 of Risk. The return of the portfolio ranges between 2.45% monthly to 0.05%. The Pair no. 31 earned the highest return and pair no. 4 earned the least return of 0.02% which is comprised of TTK PRESTIGE and BRITANNIA.

4.4 Identification of Efficient set:
An Efficient Frontier has been developed using Return and Risk data of given Portfolios. The best pair of 5 Portfolio has been identified from the given Efficient Frontier.

Fig. 2 below shows the Return and risk Pattern of fifty two stocks Portfolio. In the figure the lowest point has been shown denoting the lowest return earning portfolio but it is not providing lowest Risk and hence not considered in Minimum variance Portfolio. The line here shown in orange is an Efficient Frontier.

According to Markowitz the Portfolio Makes this line are efficient Portfolios. This portfolio provides Minimum risk among all the portfolios with maximum Return.

The five portfolios have been identified as Efficient Portfolio in this Research all those portfolio Shown in Table Below.
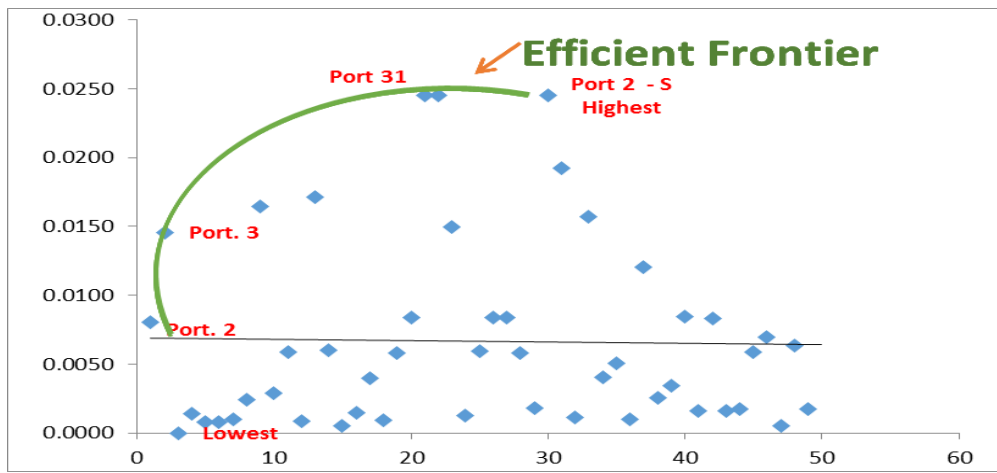
Figure: 2 Efficient Frontiers and Set of Efficient Portfolio

Table: 3 - Set of Efficient Portfolio

Port No.	Security 1	Security 2	Return R(p)
2	MINDTREE	IGL	0.0081
21	MINDTREE	BPCL	0.0084
3	KRBL	BRITANNIA	0.0146
31	VAKRANGEE	TCS	0.0245
22	VAKRANGEE	NESTLEIND	0.0245

Portfolio set no. 2, 21, 3, 31, and 22 are identified as an Efficient Portfolio according to Markowitz Efficient Frontier. Now to check the performance Evaluation of a Portfolio Shape and Taynors Ratio has been calculated.

Applying the Markowitz to twos asset portfolio, It can be found that five portfolio are efficient portfolio out of all the 50 Portfolios. Even though, it is necessary to found the better portfolio from the given portfolio. For this purpose Sharpe and Treynor gave two different methods to rank the performance of the portfolio.

Sharpe ratio is the quantifying of risk-adjusted return of a portfolio. A portfolio with a higher Sharpe ratio is considered better relative to other portfolio with lower Sharpe ratio. . The measure was named after William F Sharpe, a Nobel laureate and professor of finance.

Table: 4 - Ranking of Efficient Portfolio as per Sharpe's ranking

Sr. No.	Sharpe = Rp-Rf/ SDp	RANK
PORT22	0.58	1
PORT3	0.13	2

PORT2	0.13	3
PORT31	0.07	4
PORT21	0.06	5

As stated in above table if you calculate Sharpe the ranking of Sharpe is given the best portfolio is Portfolio 22 as it has the highest Sharpe ranking whereas the same result can be shown from Treynor's ranking as well.

Treynor Ratio gauges how efficiently the fund manager achieves the balance between return and risk of the portfolio. Unlike Sharpe Ratio, it makes use of beta in the denominator.

Table: - 5 Ranking of Efficient Portfolio as per Treynor Ranking

Sr. No.	Treynor's Ratio	RANK
PORT22	0.86%	1
PORT3	0.86%	2
PORT2	0.83%	3
PORT31	0.48%	4
PORT21	-0.34%	5

5. CONCLUSION:

Here, it can be found that from the Markowitz Selection of Portfolio criteria the best portfolio can be selected. These calculations show that an investor in Indian stock market can reduce risk for Indian Investors. Here limitation of secondary data should be considered investment by applying simple models of portfolio selection developed some five decades ago. Moreover this technique here is used only for 50 Portfolios. The result can be different if applied to Different number of portfolio.

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Annexure 1 Risk return profile of Sample Company

Sr. No.	Security	Mean Return (%)	Standard Deviation (%)	CV	Beta
1	ACC	0.84%	-8.31%	-9.90%	0.84
2	ADANI	0.75%	-14.16%	-18.86%	1.12
3	AIA Engineering	1.53%	-13.18%	-8.63%	1.40
4	AMBUJA	0.86%	-8.83%	-10.24%	0.90
5	ASHOK LEYLAND	2.28%	-14.37%	-6.29%	1.45
6	Aurobindo	2.71%	-17.65%	-6.52%	1.65
7	Axis	0.76%	-13.91%	-18.31%	1.51
8	BAJAJ FIN.	3.31%	-15.66%	-4.73%	1.49
9	BIOCON	1.53%	-13.40%	-8.78%	1.06
10	BLUE STAR	1.08%	-12.31%	-11.44%	1.35
11	BOMBAY BUMRAH	2.91%	-19.68%	-6.76%	1.68
12	BOSCH	1.58%	-7.47%	-4.72%	0.63
13	BPCL	0.95%	-12.75%	-13.39%	0.80
14	BRITANNIA	1.99%	-10.48%	-5.27%	0.23
15	BUTTERFLY	4.31%	-18.83%	-4.37%	0.96
16	CADILA	1.43%	-11.35%	-7.96%	0.45
17	CIPLA	1.16%	-7.18%	-6.19%	0.34
18	CUMMINS	1.15%	-9.88%	-8.58%	0.96
19	DIVIS	0.69%	-11.77%	-17.00%	0.44
20	DR REDDY	1.41%	-8.23%	-5.84%	0.47
21	EICHER	4.38%	-10.47%	-2.39%	0.82
22	FINOLEX	2.36%	-12.88%	-5.46%	1.42
23	GLAXO PHARMA	1.13%	-7.17%	-6.37%	0.23
24	GLAXO CONSUMER	2.13%	-7.78%	-3.65%	0.45
25	HEVELLS	1.50%	-15.73%	-10.49%	1.48
26	HAWKINS	2.93%	-12.22%	-4.16%	0.70
27	HDFC	1.15%	-10.54%	-9.16%	1.08
28	HERO MOTO	1.68%	-8.02%	-4.77%	0.68
29	HIND ZINC	1.00%	-13.02%	-12.96%	0.81
30	HINDALCO	1.20%	-13.69%	-11.38%	1.52
31	HITACHI	3.68%	-16.13%	-4.38%	1.58
32	IFB	4.01%	-16.99%	-4.23%	1.40
33	INDIABULLS REAL ESTATE	0.78%	-19.52%	-25.12%	2.19
34	INDRAPRASTAH	1.59%	-11.17%	-7.03%	0.46
35	INDUSIND	3.09%	-12.22%	-3.95%	1.57
36	ITI	2.31%	-19.89%	-8.62%	1.89
37	JSW	1.10%	-16.53%	-14.96%	1.61
38	KAJARIA	3.29%	-11.89%	-3.62%	0.84
39	KOTAK MAHINDRA	1.06%	-13.25%	-12.45%	1.43
40	KRBL	3.15%	-17.55%	-5.57%	1.39

41	LEEL	1.74%	-17.48%	-10.03%	1.75
42	LUPIN	1.26%	-11.08%	-8.81%	0.38
43	M & M	0.88%	-11.02%	-12.59%	0.93
44	MARUTI	2.39%	-10.18%	-4.25%	0.98
45	MIND TREE	1.80%	-13.14%	-7.31%	0.70
46	MOTHERSON SUMI	1.79%	-11.65%	-6.50%	0.77
47	MPHASIS	1.78%	-10.92%	-6.12%	0.97
48	MRF	2.89%	-11.86%	-4.10%	1.20
49	MRPL	0.99%	-12.57%	-12.72%	1.36
50	NCC	1.31%	-21.10%	-16.12%	2.17
51	NESTLE	1.73%	-5.93%	-3.43%	0.38
52	ORACLE	1.73%	-10.52%	-6.08%	0.86
53	PETRONET	1.51%	-10.91%	-7.23%	0.85
54	PIRAMAL	2.10%	-9.04%	-4.31%	0.62
55	RAIN	2.06%	-18.45%	-8.94%	1.29
56	RAMCO	1.25%	-13.42%	-10.74%	1.32
57	SHREE	2.63%	-10.94%	-4.16%	1.12
58	SOBHA	0.87%	-15.65%	-18.03%	1.93
59	STERLITE	2.49%	-19.41%	-7.80%	2.04
60	SIMPHONY	5.29%	-17.94%	-3.39%	1.16
61	TATA COMM	0.68%	-10.26%	-15.00%	0.48
62	TATA STEEL	0.91%	-14.91%	-16.43%	1.74
63	TATA	0.99%	-15.67%	-15.87%	1.72
64	TCS	1.54%	-9.06%	-5.87%	0.66
65	TECH MAHINDRA	1.29%	-14.06%	-10.89%	1.21
66	THERMAX	1.16%	-11.42%	-9.85%	1.25
67	TORRENT	2.21%	-9.36%	-4.24%	0.61
68	TTK PRESTIGE	3.79%	-12.97%	-3.42%	0.83
69	ULTRATECH	1.76%	-10.09%	-5.72%	1.01
70	UNITED BEVE	1.85%	-12.91%	-6.99%	1.13
71	UNITED SPIRIT	1.37%	-13.52%	-9.84%	1.05
72	VEKARANGEE	3.02%	-22.46%	-7.45%	1.53
73	VEDANTA	0.77%	-17.02%	-21.97%	1.40
74	WELSPUN	0.77%	-18.96%	-24.56%	1.79
75	WHIRLPOOL	4.00%	-14.38%	-3.59%	1.35
					0.99

Annexure 2 – Selected 50 least correlated Portfolio

Port. No.	S1	S2	corel	SD1	SD2	E(r) 1	E(r) 2	P12	W1	W2	Rp
1	TCS	HAWKINCOOK	-0.1547	0.1222	0.0906	0.0293	0.0154	-0.1534	0.8314	0.1686	0.0069
2	MINDTREE	IGL	-0.1115	0.1314	0.1117	0.0180	0.0159	-0.1106	0.7747	0.2253	0.0081
3	KRBL	BRITANNIA	-0.1020	0.1755	0.1048	0.0315	0.0199	-0.1011	0.5848	0.4152	0.0146
4	TTKPRESTIGE	BRITANNIA	-0.0936	0.1297	0.1048	0.0379	0.0199	-0.0928	0.7825	0.2175	-0.0002
5	KOTAKBANK	GLAXO	-0.0883	0.1325	0.0717	0.0106	0.0113	-0.0876	0.0000	1.0000	0.0014
6	TAT COMM	GLAXO	-0.0841	0.1026	0.0717	0.0068	0.0113	-0.0834	0.0000	1.0000	0.0008
7	TAT COMM	OFSS	-0.0799	0.1026	0.1052	0.0068	0.0173	-0.0793	0.9790	0.0210	0.0008
8	IGL	GSKCONS	-0.0778	0.1117	0.0778	0.0159	0.0213	-0.0771	0.0000	1.0000	0.0010
9	GLAXO	ADANIENT	-0.0501	0.0717	0.1416	0.0113	0.0075	-0.0497	1.0000	0.0000	0.0024
10	RAIN	GLAXO	-0.0423	0.1845	0.0717	0.0206	0.0113	-0.0420	0.5480	0.4520	0.0164
11	GSKCONS	DIVISLAB	-0.0337	0.0778	0.1177	0.0213	0.0069	-0.0334	1.0000	0.0000	0.0029
12	LUPIN	BPCL	-0.0298	0.1108	0.1275	0.0126	0.0095	-0.0296	0.9077	0.0923	0.0059
13	TAT COMM	BUTTERFLY	-0.0253	0.1026	0.1883	0.0068	0.0431	-0.0251	0.0000	1.0000	0.0008
14	BUTTERFLY	BRITANNIA	-0.0238	0.1883	0.1048	0.0431	0.0199	-0.0236	0.5361	0.4639	0.0171
15	IGL	DIVISLAB	-0.0197	0.1117	0.1177	0.0159	0.0069	-0.0195	0.9000	0.1000	0.0060
16	GLAXO	BRITANNIA	-0.0174	0.0717	0.1048	0.0113	0.0199	0.0461	0.0000	1.0000	0.0005
17	MINDTREE	MARUTI	-0.0159	0.1314	0.1018	0.0180	0.0239	-0.0157	0.0000	1.0000	0.0015
18	TCS	TAT COMM	-0.0134	0.0906	0.1026	0.0154	0.0068	-0.0133	1.0000	0.0000	0.0040
19	TAT COMM	MINDTREE	-0.0132	0.1026	0.1314	0.0068	0.0180	-0.0131	0.0000	1.0000	0.0009
20	PETRONET	GLAXO	-0.0095	0.1091	0.0717	0.0151	0.0113	-0.0094	0.9202	0.0798	0.0058
21	MINDTREE	BPCL	-0.0060	0.1314	0.1275	0.0180	0.0095	-0.0060	0.7647	0.2353	0.0084
22	VAKRANGEE	NESTLEIND	-0.0055	0.2246	0.0593	0.0302	0.0173	-0.0055	0.4474	0.5526	0.0245
23	VAKRANGEE	BRITANNIA	-0.0018	0.2246	0.1048	0.0302	0.0199	-0.0018	0.4473	0.5527	0.0245
24	KRBL	CADILAHC	-0.0017	0.1755	0.1135	0.0315	0.0143	-0.0017	0.5723	0.4277	0.0150
25	DIVISLAB	ACC	0.0007	0.1177	0.0831	0.0069	0.0084	0.0007	0.0000	1.0000	0.0012
26	M&M	DIVISLAB	0.0016	0.1102	0.1177	0.0088	0.0069	0.0016	0.9109	0.0891	0.0059
27	MINDTREE	ACC	0.0034	0.1314	0.0831	0.0180	0.0084	0.0034	0.7638	0.2362	0.0084
28	MINDTREE	AMBUJACEM	0.0035	0.1314	0.0883	0.0180	0.0086	0.0035	0.7637	0.2363	0.0084
29	SHREECEM	DIVISLAB	0.0040	0.1094	0.1177	0.0263	0.0069	0.0040	0.9176	0.0824	0.0058
30	TECHM	BRITANNIA	0.0054	0.1406	0.1048	0.0129	0.0199	0.0054	0.0000	1.0000	0.0018
31	VAKRANGEE	TCS	0.0065	0.2246	0.0906	0.0302	0.0154	0.0064	0.4463	0.5537	0.0245
32	ITI	GLAXO	0.0077	0.1989	0.0717	0.0231	0.0113	0.0076	0.5041	0.4959	0.0192
33	IGL	BUTTERFLY	0.0096	0.1117	0.1883	0.0159	0.0431	0.0095	0.0000	1.0000	0.0012
34	SYMPHONY	BRITANNIA	0.0111	0.1794	0.1048	0.0529	0.0199	0.0110	0.0530	0.9470	0.0157
35	TCS	DIVISLAB	0.0116	0.0906	0.1177	0.0154	0.0069	0.0115	0.1043	0.8957	0.0040
36	MARUTI	DIVISLAB	0.0125	0.1018	0.1177	0.0239	0.0069	0.0124	0.9860	0.0140	0.0051
37	TAT COMM	CIPLA	0.0129	0.1026	0.0718	0.0068	0.0116	0.0128	0.0000	1.0000	0.0010
38	HAVELLS	GLAXO	0.0136	0.1573	0.0717	0.0150	0.0113	0.0135	0.6371	0.3629	0.0121
39	GLAXO	DIVISLAB	0.0145	0.0717	0.1177	0.0113	0.0069	0.0144	1.0000	0.0000	0.0025
40	IBREALEST	GLAXO	0.0170	0.1952	0.0717	0.0078	0.0113	0.0168	0.0000	1.0000	0.0035

41	MINDTREE	BOSCHLTD	0.0170	0.1314	0.0747	0.0180	0.0158	0.0169	0.0000	1.0000	0.0084
42	KOTAKBANK	CIPLA	0.0176	0.1325	0.0718	0.0106	0.0116	0.0174	0.0000	1.0000	0.0016
43	HINDZINC	DIVISLAB	0.0182	0.1302	0.1177	0.0100	0.0069	0.0180	0.0000	1.0000	0.0083
44	HINDZINC	CADILAHC	0.0221	0.1302	0.1135	0.0100	0.0143	0.0219	0.0000	1.0000	0.0016
45	NESTLEIND	DIVISLAB	0.0230	0.0593	0.1177	0.0173	0.0069	0.0228	0.0000	1.0000	0.0017
46	SHREECEM	MINDTREE	0.0239	0.1094	0.1314	0.0263	0.0180	0.0237	0.0000	1.0000	0.0059
47	KAJARIACR	CADILAHC	0.0243	0.1189	0.1135	0.0329	0.0143	0.0241	0.8425	0.1575	0.0069
48	GLAXO	FINCABLES	0.0244	0.0717	0.1288	0.0113	0.0236	0.0242	0.0000	1.0000	0.0005
49	CADILAHC	BPCL	0.0271	0.1135	0.1275	0.0143	0.0095	0.0269	0.8826	0.1174	0.0063
50	NESTLEIND	IGL	0.0279	0.0593	0.1117	0.0173	0.0159	0.0277	1.0000	0.0000	0.0018

Annexure 3 – Correlation among Securities

1.0																			
0.3	1.0																		
0.3	0.4	1.0																	
0.8	0.4	0.4	1.0																
0.5	0.4	0.5	0.5	1.0															
0.4	0.4	0.6	0.4	0.5	1.0														
0.5	0.4	0.5	0.5	0.6	0.5	1.0													
0.4	0.2	0.4	0.5	0.5	0.4	0.5	1.0												
0.3	0.2	0.5	0.3	0.2	0.4	0.3	0.3	1.0											
0.5	0.4	0.5	0.5	0.6	0.5	0.5	0.5	0.4	1.0										
0.3	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.5	1.0									
0.5	0.3	0.4	0.5	0.6	0.3	0.5	0.4	0.2	0.5	0.4	1.0								
0.4	0.2	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.2	0.2	0.3	1.0							
0.1	0.5	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.3	0.2	0.1	1.0						
0.2	0.2	0.3	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.0	1.0					
0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.0	0.1	0.1	1.0				
0.2	0.0	0.2	0.2	0.2	0.3	0.1	0.2	0.3	0.2	0.1	0.2	0.1	0.1	0.2	0.1	1.0			
0.4	0.4	0.6	0.4	0.5	0.5	0.5	0.4	0.4	0.6	0.5	0.5	0.4	0.1	0.2	0.3	0.2	1.0		
0.0	0.2	0.3	0.0	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	1.0	
0.1	0.1	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.3	0.2	0.1	0.1	0.2	0.3	0.4	0.3	0.3	1.0

0.3	0.3	0.4	0.3	0.4	0.5	0.3	0.4	0.3	0.5	0.3	0.5	0.3	0.3	0.1	0.2	0.2	0.4	0.2	0.3	1.0									
0.5	0.4	0.6	0.5	0.5	0.6	0.4	0.5	0.4	0.6	0.4	0.5	0.3	0.2	0.3	0.1	0.1	0.5	0.2	0.2	0.5	1.0								
-0.1	0.1	0.3	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.3	0.2	0.0	1.0							
0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.2	0.3	0.1	0.3	0.0	0.2	0.3	0.1	0.1	0.2	0.0	0.3	0.3	0.2	0.3	1.0						
0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.4	0.3	0.2	0.2	0.3	0.1	0.0	0.4	0.2	0.2	0.4	0.6	0.0	0.2	1.0					
0.2	0.2	0.4	0.2	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.0	0.4	0.1	0.3	0.3	0.2	0.3	0.3	0.2	0.2	0.4	0.2	1.0				
0.4	0.4	0.4	0.4	0.4	0.3	0.5	0.4	0.2	0.5	0.3	0.3	0.2	0.1	0.1	0.2	0.2	0.5	0.2	0.1	0.3	0.4	0.1	0.3	0.4	0.2	1.0			
0.4	0.3	0.3	0.5	0.3	0.3	0.3	0.2	0.2	0.4	0.3	0.4	0.4	0.2	0.1	0.2	0.3	0.3	0.1	0.2	0.3	0.3	0.3	0.2	0.3	0.2	0.4	1.0		
0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.2	0.0	0.2	0.3	0.0	0.2	0.1	0.3	0.1	0.1	0.2	0.3	0.2	0.3	1.0	
0.5	0.4	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.6	0.4	0.4	0.3	0.1	0.2	0.1	0.2	0.5	0.2	0.3	0.4	0.7	0.1	0.2	0.6	0.2	0.4	0.5	0.5	0.1

Annexure 4 Least correlated Portfolio pair – 50 Portfolios

Sr. No.	Weight 1	Weight 2	Correlation
PORT1	TCS	HAWKINCOOK	-0.155
PORT2	MINDTREE	IGL	-0.111
PORT3	KRBL	BRITANNIA	-0.102
PORT4	TTKPRESTIGE	BRITANNIA	-0.094
PORT5	KOTAKBANK	GLAXO	-0.088
PORT6	TAT COMM	GLAXO	-0.084
PORT7	TAT COMM	OFSS	-0.080
PORT8	IGL	GSKCONS	-0.078
PORT9	GLAXO	ADANIENT	-0.050
PORT10	RAIN	GLAXO	-0.042
PORT11	GSKCONS	DIVISLAB	-0.034
PORT12	LUPIN	BPCL	-0.030
PORT13	TAT COMM	BUTTERFLY	-0.025
PORT14	BUTTERFLY	BRITANNIA	-0.024
PORT15	IGL	DIVISLAB	-0.020
PORT16	GLAXO	BRITANNIA	-0.017
PORT17	MINDTREE	MARUTI	-0.016

PORT18	TCS	TAT COMM	-0.013
PORT19	TAT COMM	MINDTREE	-0.013
PORT20	PETRONET	GLAXO	-0.009
PORT21	MINDTREE	BPCL	-0.006
PORT22	VAKRANGEE	NESTLEIND	-0.006
PORT23	VAKRANGEE	BRITANNIA	-0.002
PORT24	KRBL	CADILAHC	-0.002
PORT25	DIVISLAB	ACC	0.001
PORT26	M&M	DIVISLAB	0.002
PORT27	MINDTREE	ACC	0.003
PORT28	MINDTREE	AMBUJACEM	0.004
PORT29	SHREECEM	DIVISLAB	0.004
PORT30	TECHM	BRITANNIA	0.005
PORT31	VAKRANGEE	TCS	0.006
PORT32	ITI	GLAXO	0.008
PORT33	IGL	BUTTERFLY	0.010
PORT34	SYMPHONY	BRITANNIA	0.011
PORT35	TCS	DIVISLAB	0.012
PORT36	MARUTI	DIVISLAB	0.013
PORT37	TAT COMM	CIPLA	0.013
PORT38	HAVELLS	GLAXO	0.014
PORT39	GLAXO	DIVISLAB	0.015
PORT40	IBREALEST	GLAXO	0.017
PORT41	MINDTREE	BOSCHLTD	0.017
PORT42	KOTAKBANK	CIPLA	0.018
PORT43	HINDZINC	DIVISLAB	0.018
PORT44	HINDZINC	CADILAHC	0.022
PORT45	NESTLEIND	DIVISLAB	0.023
PORT46	SHREECEM	MINDTREE	0.024
PORT47	KAJARIACR	CADILAHC	0.024
PORT48	GLAXO	FINCABLES	0.024
PORT49	CADILAHC	BPCL	0.027
PORT50	NESTLEIND	IGL	0.028

Annexure 5 - Calculation of Sharpe and Treynor's Ratio

Sr. No.	CO 1	Co 2	Correlation	VARp	SDp	Rp	Rf	Rp-Rf	Sharpe = Rp-Rf/ SDp	RANK
PORT22	GLAXO	FINCABLES	0.024	0.051%	2.249%	1.99%	0.68%	1.31%	0.58	1
PORT3	BRITANNIA	ACC	0.085	0.0055	7.410%	1.64%	0.68%	0.96%	0.13	2
PORT2	BRITANNIA	AXISBANK	0.081	0.00558	7.471%	1.62%	0.68%	0.94%	0.13	3
PORT31	HAVELLS	CIPLA	0.036	1.212%	11.007%	1.40%	0.68%	0.72%	0.07	4
PORT21	GLAXO	DIVISLAB	0.015	0.253%	5.025%	1.00%	0.68%	0.32%	0.06	5
Sr. No.	CO 1	Co 2	Correlation	VARp	SDp	Rp	Rf	Bp	Treynor Ratio	RANK
PORT22	GLAXO	FINCABLES	0.024	0.051%	2.249%	1.99%	0.68%	0.59	0.86%	1
PORT3	BRITANNIA	ACC	0.085	0.0055	7.410%	1.64%	0.68%	0.87	0.86%	2
PORT2	BRITANNIA	AXISBANK	0.081	0.00558	7.471%	1.62%	0.68%	0.86	0.83%	3
PORT31	HAVELLS	CIPLA	0.036	1.212%	11.007%	1.40%	0.68%	0.74	0.48%	4
PORT21	GLAXO	DIVISLAB	0.015	0.253%	5.025%	1.00%	0.6	0.5	-0.34%	5