Portfolio Selection In BSE : Expected Return And Risk Analysis Through Markowitz Theorem

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INTRODUCTION

As the economy grows, and grows more complex, the financial sector needs to keep pace. In comparison with the developed industrialized countries, the financial sector development of our country is relatively less, and there is a lot of scope for the growth of the financial sector in India. The market capitalization is considerably lower than US and Australian economies. The financial assets in the total assets in India was only 16.7 per cent in 2006-07. The proportion of shares and debentures in total assets declined from 1.7 in 1993-94 to 0.8 per cent in 2006-07. It clearly indicates that investment in financial assets tends to move towards fewer risky portfolios like bank deposits, government bonds and insurance funds. This vividly manifests that the investors tend to be risk averters. The attitudes towards risk and returns tends to play an increasingly critical role in selecting a portfolio. Thus, there is a need to comprehend the investors' attitudes towards different portfolio choices. Diversification always reduces the non-systematic risk within financial assets' portfolio significantly. The common objective of financial investors is to achieve an optimal risk-return combination. It can be achieved either by maximizing return with an accepted level of risk, or by minimizing risk with an acceptable rate of return. Diversification influences the risk component of the portfolio, in particular. It implies a spread of investments and allows a middle road through the highs and lows of market performance. In other words, diversification allows an opportunity for investments to grow with minimum volatility. Securities behave differently from one another within the same market based on its own performance, industry/sector conditions, national and international factors and so on. Literature suggests that much of the market volatility can be attributed to substantial increase in the sector specific and sub- sector specific risks (Black et al., 2002).

SECURITIES MARKET IN INDIA

In the last three decades, a large number of countries have initiated financial reforms processes to open up their economies and to integrat into the global economy. India is one of the late entrants – the reform process officially started in 1991 only. The Indian stock market is possibly one of the oldest in Asia, but remained at a small scale and was largely outside the global integration process until the late 1980s (Rajan and Zingales, 2005). The major stock market in India located in Mumbai (formerly known as Bombay) has always played a dominant role in the equity market in India. It has been traditionally governed by brokers, leading to conflict of interest situation between the interest of common investors and those of brokers/owners of stock exchanges (Acharya and Richardson, 2009). Reforms in equity market in India commenced slightly earlier than the overall reforms – in mid-1980s. With the establishment of the National Stock Exchange (NSE), a new institutional structure was introduced in India that could ensure the smooth functioning of the market through a combination of new technology and efficient market design. The Securities Exchange Board of India (SEBI) was set up in 1992 as a market regulator, with statutory powers to control and supervise operations of all participants in the capital market viz. stock exchanges, stock brokers, mutual funds and rating agencies. Accordingly, stocks from different sectors and sub-sectors also performed differently during the period and need to be viewed with proper care. Each sector is unique in its own way, and so are the companies operating in each sector. Thus, changing pattern of correlations between sectors is vital for portfolio optimization purpose. The efficient frontier is defined as the set of portfolios that exhibit the minimum amount of risk for a given level of return or the highest return for a given level of risk, and lies above the global minimum variance portfolio.

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Elton, Gruber and Padberg (1976) showed that one is able to use a simple decision criterion to reach an optimal solution to the portfolio problem by assuming that a risk-free asset exists, and either the single index model adequately describes the variance covariance structure, or that a good estimate of pair wise correlations is a single figure. This simple criterion not only allows one to determine which stocks to include, but how much to invest in each.

MODERN PORTFOLIO THEORY

Markowitz mean-variance portfolio theory is one of the most widely used approaches in portfolio selection. It reflects market conditions, which are no longer valid by assigning equal weights to the most recent and the most distant observations. To express the dynamic structure of the market, one can use exponentially weighted variances. Exponentially weighted data gives greater weight to the most-recent observations. Thus, current market conditions are taken into consideration more accurately. The most important contribution of Markowitz was the use of standard deviation of returns as a measure of risk. Optimum allocation of wealth of an investor was determined by maximizing the expected return at a certain level of risk or by minimizing the risk at a certain level of expected return. Both models are an ex-ante model of portfolio analysis. In other words, to use Markowitz's approach, an estimate of expected returns, variances and covariances must be calculated.

Modern portfolio theory is based on the idea that investors seek high investment returns and wish to minimize their risk. Expecting higher returns with a lower level of risk is contradictory; therefore, constructing a portfolio requires a trade-off between risk and return. Thus, investors must allocate their wealth among different securities. This is known as diversification. Mean-variance optimization developed by Markowitz (1952) can be used in order to determine how an investor allocates his wealth among securities. The proportion of securities in a portfolio depends not only on their means and variances, but on the interrelationships or covariance. Thus, covariance between securities as well as returns and variances are calculated as input in portfolio optimization. Markowitz portfolio theory uses an equally weighted scheme for calculating the parameters listed above. Once the input parameters are obtained, both the risk and the return on any portfolio consisting of security combinations are calculated. The goal of portfolio optimization is to find a combination of assets that minimize the standard deviation of the portfolio return for any given level of expected return or, in other words, a combination of assets that maximizes the expected return of the portfolio for any given level of risk.

METHODOLOGY

The general objective of the study is to assess the optimality of the portfolios in the Bombay Stock Exchange (BSE). The specific objectives of the study are :

1. To analyze the expected return of different portfolios in the BSE in relation to the Sensex;

2. To assess the risk level of different portfolios in the BSE;

3. To assess the Beta value of different portfolios;

4. To analyze the optimality of the portfolios in the BSE;

5. To examine the application of Efficient Market Hypothesis and Modern Portfolio Theory.

The research methodology followed in the study is exploratory empirical research. Only time series secondary data was used .The data for the study was collected from the BSE website and published data of RBI and SEBI. The data for all the portfolios and the benchmark indexes such as Sensex 30, BSE 500, Midcap index were collected from the BSE archives. The data were collected in three sets such as daily closure index, monthly closures and the Annual average. The analysis was done from three dimensions. The data was collected from January 1, 2007 to November 30, 2010. The analysis of the collected data has been done within the above conceptual framework. The analysis done in the study includes the expected returns from different portfolios and their respective risk levels. The expected return has been computed through the calculation of the average increase in the returns and their skewness. The risk level has been analyzed through variance, standard deviation, covariance and correlation matrix.

PORTFOLIO OPTIMIZATION: ANALYSIS AND INTERPRETATION

Optimum portfolio selection within a capital market is primarily based on the best risk-return trade-off among the industry sectors. Literature suggests that much of the market volatility can be attributed to substantial increase in the

sector specific and sub sector specific risks. Performance of the economy influences industry sector returns differently, and changes over time periods. Thus, changing pattern of correlations between sectors is vital for portfolio optimization purpose. Common objective of financial investors is to achieve an optimal risk-return combination. Thus, analysis of all the risks and returns for all the sectors in the form of portfolio has been done to assess the optimization choice of the portfolio.

❁Expected Risk And Returns - Mean, Standard Deviation And Portfolio Choice : Expected returns and risk of portfolios have been analyzed with the help of arithmetic mean, standard deviation and the ratio between these two. The ratio was computed with the help of the formula used by Markowitz :

$$R = (\mu - d)/\sigma$$

Here, μ denotes the arithmetic mean of the rate of return of the daily data;
σ denotes the standard deviation of the set of the data;
d refers to the disaster level, which refers to the lowest value of the returns;
and *R* is the risk adjusted ratio between the mean and standard deviation of returns.
These three results explicate the relationship between the expected returns and the risk of all portfolios including the indices.

The results shown in Table 1 vividly explain that the lowest return was noticed in the IT (Information Technology) portfolio in comparison with all the major portfolios during the last four years. This indicates that the worst performing shares during the global economic crisis were the IT shares. The standard deviation also tends to be high. This indicates that risk is also relatively high. The portfolio choice ratio indicates that the least priority portfolio remains to be IT. The ratio among the benchmark indices indicates that the midcap portfolio shares were the most preferable to other shares. The returns of bank and metal portfolio tend to be the highest among the other portfolios, but the portfolio choice ratio indicates negative results to exhibit resistance to the portfolios. This could be due to very high risks in these two portfolios, as they have reported the highest standard deviation values. The ratios manifest that the Auto, FMCG and Oil &Gas portfolios tend to have more promises than other portfolios. The lowest risk levels are noticed in the Auto, FMCG and PSU portfolios. Understandably, these sectors did not get much affected during the period under study.

Table 1 : Mean, Standard Deviation And Their Ratio For The Daily Data From 2007 To 2010

	Mean	STD	Min	Max	$R = (\mu - d)/\sigma$
BSE	0.06	2.05	-10.96	17.34	5.38
MID Cap	0.05	1.85	-11.38	11.75	6.19
Small Cap	0.05	1.83	-10.27	9.05	5.65
Auto	0.08	1.80	-10.43	11.21	5.82
Bank	0.10	2.60	-12.62	19.18	4.89
BSECD	0.08	2.22	-11.01	13.29	5.01
BSECG	0.08	2.39	-9.22	21.90	3.89
FMCG	0.08	1.54	-7.96	7.21	5.21
IT	0.04	2.17	-10.10	11.39	4.67
PSU	0.06	1.98	-10.67	16.42	5.43
Metal	0.10	2.85	-13.30	16.10	4.71
OILGAS	0.08	2.35	-14.97	19.11	6.41
Power	0.06	2.29	-11.43	18.33	5.02

Thus, the Table 1 clearly indicates that the most preferable shares were the midcap shares in comparison with the other shares in the Sensex and the small cap. The most supportable portfolios tend to be Auto, FMCG and Oil & Gas. The returns and risk level support these portfolios. The results tend to discourage the support of portfolios like IT, capital goods, metal and bank. Though the last two have high returns, the risk level is very high. Hence, the portfolio choice ratio indicates a resistance to these portfolios.

Table 2 : Mean, Standard Deviation And Their Ratio For The Monthly Data From 2007 to 2010					
	Mean	STD	Min	Max	R = (μ - d)/σ
BSE500	1.31	10.05	-26.36	32.36	2.75
BSE30	1.13	9.26	-23.89	28.26	2.70
Midcap	1.26	12.03	-33.31	43.91	2.87
IT	0.69	9.17	-21.97	20.53	2.47
Bank	2.09	12.75	-23.69	45.26	2.02
PSU	1.44	11.43	-26.91	43.73	2.48
FMCG	1.58	6.39	-16.70	21.01	2.86
Oil &Gas	1.48	10.78	-31.46	28.12	3.06
Power	1.36	11.72	-29.95	36.38	2.67
Auto	1.81	10.11	-26.92	31.80	2.84
CD	2.09	14.15	-29.23	56.92	2.21
CG	1.85	13.39	-33.68	50.74	2.65
Metal	2.43	16.32	-40.31	57.98	2.62
Realty	0.23	21.81	-43.62	79.30	2.01

The analysis results of monthly average closing data shown in the Table 2 confirm the results of the previous table. The Bank and Metal portfolios performed very well, while the IT and Realty portfolios showed a very poor performance. The portfolio choice ratio does not substantiate the same. The ratio value is very low in the case of bank, realty and capital goods. It shows that in the case of bank and capital goods, the risk level is very high. Unlike the daily data results, the monthly data shows more stability. The minimum level of returns is very high due to the stock market crash in December 2008. The monthly data results also encourage the support of Midcap portfolios for higher returns and minimum risk. In the case of IT, though the returns are low, the risk is also considerably low. Hence, the portfolio choice ratio supports the investment in the IT shares.

❁ **Correlation and Covariance Matrices :** The correlation coefficient reveals the magnitude and direction of the relationships. The magnitude is the degree to which variables move in unison or opposition. The coefficient's sign signifies the direction of the relationships. Direction tells whether large values on one variable are associated with large values on the other (and small values correspond with other small values). When the values correspond in this way, the two variables have a positive relationship and vice versa. The correlation coefficient value varies over a range of +1 through 0 to -1. The designation *r* symbolizes the coefficient's estimate of linear association based on sampling data. The coefficient ρ represents the population correlation.

$$r = (\sum(X-\ddot{X})\ (Y-\bar{Y})) \ /\ ((n-1)\sigma_x\sigma_y)$$

The correlation matrix was computed for all the portfolios and for the benchmark indices to understand the relationship between the returns. Similarly, the relationship between the risks of all portfolios was assessed through Covariance. Covariance is the statistical measure that indicates the interactive risk of a security relative to others in a portfolio of securities. In other words, the way security returns vary with each other affects the overall risk of the portfolio. The covariance between two portfolios A and B was calculated by using the following formula :

$$Cov_{ab} = \sum(X_a-\ddot{X}_a)\ (X_b-\ddot{X}_b)/N$$

Where,

Cov_{ab} – denotes the covariance between the portfolios *a* and *b*;

Xa – denotes the return of portfolio *a* ;

Xb– denotes the return of portfolio *b* ;

Ẍa and b – denotes the mean return of the portfolios *a* and *b* respectively.

The covariance is a measure of how deviations in the returns of two portfolios move together. If the returns of the two portfolios move in the same direction consistently, the covariance would be positive and vice versa. If the movements of returns are independent of each other, covariance would be close to zero. Thus, the covariance indicates the

direction and the interactive risk relationship between the two portfolios.

The correlation matrix of all the portfolios, along with the benchmark indices was computed to understand the relationship between the portfolios. The Table 3 shows the correlation matrix of the daily returns data of all the portfolios. It shows that the BSE Sensex index has a very high positive correlation with all the portfolios. Other benchmark indices also have a high correlation with most of the portfolios. Only FMCG and IT portfolios have displayed a very low positive correlation in comparison with others. This indicates that these two portfolios are relatively independent of others. Oil & gas and Power portfolios have high correlation with PSU and metal portfolios. Since these are largely government-owned shares, understandably, there is a high correlation among these portfolios. Thus, the correlation coefficients of all the portfolios have shown high positive correlation on the daily data, indicating that there is more systematic risk, and diversification has little effect in averting the risk. This clearly manifests that there is more scope for systematic market risks than non-systematic risks in the BSE market on a daily basis.

Table 3 : Correlation Matrix Of Daily Data Of All The Portfolios And Benchmark Indices

	BSE	MIDCAP	Smallcap	Auto	Bank	BSECD	BSECG	FMCG	IT	PSU	Metal	OILGAS	Power
BSE	1.000												
MIDCAP	0.965	1.000											
Smallcap	0.949	0.994	1.000										
Auto	0.801	0.722	0.718	1.000									
Bank	0.938	0.882	0.879	0.905	1.000								
BSECD	0.910	0.958	0.963	0.748	0.884	1.000							
BSECG	0.950	0.936	0.922	0.629	0.856	0.858	1.000						
FMCG	0.671	0.533	0.537	0.880	0.823	0.582	0.520	1.000					
IT	0.758	0.768	0.754	0.860	0.750	0.780	0.574	0.585	1.000				
PSU	0.937	0.852	0.842	0.842	0.943	0.785	0.895	0.783	0.658	1.000			
Metal	0.946	0.902	0.894	0.733	0.864	0.814	0.909	0.655	0.677	0.910	1.000		
OILGAS	0.877	0.804	0.795	0.551	0.773	0.706	0.905	0.587	0.406	0.867	0.907	1.000	
Power	0.890	0.868	0.858	0.510	0.775	0.757	0.970	0.445	0.422	0.862	0.880	0.929	1.000

Similar to the daily data, monthly data analysis also shows that all the benchmark indexes have a very high positive correlation with all the portfolios (Table 3) . The Realty portfolio has shown a very low correlation with all the portfolios, including the benchmark indices. This indicates that the Realty portfolio is independent of all the other portfolios. Only FMCG and Realty have shown negative correlation, indicating the risk dispersion among them. Diversification of risk is possible only in these portfolios.

Thus, the correlation analysis indicates that there is high scope for systematic market risk in the Indian financial market, particularly in the BSE market. The portfolios are highly correlated to the benchmark indices of the BSE. IT and FMCG have shown very low correlation with other portfolios, indicating the possibility for diversification of risk in the case of daily data. In the case of monthly average closure, the Realty sector has shown very low correlation with all the portfolios and indices. Only FMCG and Realty have shown negative correlation, indicating the possibility for risk diversification. Hence, correlation analysis has indicated the existence of high scope for systematic market. This also manifests that there is little scope for diversification of risk, for all the portfolios have high positive correlation except Realty and FMCG.

The covariance results of the daily data have been presented in the Table 4. It shows that the covariance of the Auto and FMCG sectors has been very low against all the indices. This shows that these two sectors are highly independent. The positive covariance in all the portfolios substantiates the positive correlation among all the portfolios. Among the indices, the covariance of all the portfolios is higher in the BSE Sensex Index. The Midcap comes next to the Sensex. The Smallcap index has also shown very low covariance values for all the portfolios. This indicates that there is very less risk premium for all the portfolios in the daily data.

The covariance values for all the portfolios in the monthly data have been positive, and have been considerably higher

Table 4 : Covariance In Relation To The Benchmark Indices For The Daily Data			
	BSE	MIDCAP	Smallcap
Auto	2.997	2.697	2.476
Bank	4.857	3.803	3.334
BSECD	3.186	3.349	3.250
BSECG	4.350	3.698	3.355
FMCG	2.132	1.829	1.666
IT	3.326	2.299	2.036
PSU	3.567	3.208	2.961
Metal	4.947	4.427	4.078
OILGAS	4.331	3.416	3.056
Power	4.214	3.684	3.340

than the daily data. The IT, FMCG, Auto and HC portfolios have displayed a very low covariance asset value. The low covariance values indicate the lower-risk level. These portfolios have a very low risk level in comparison with other portfolios in the BSE. Unlike the covariance values of the daily data, where the benchmark indices have shown some trend, the monthly data midcap indices have shown very high covariance values. Metals and Realty have shown very high covariance values, indicating the high risk nature of these portfolios. The covariance results of daily and monthly data exhibit different pictures. While the covariance of the Sensex index to all the portfolios tends to be higher in the daily data, it is the midcap index value which is higher in the monthly data. Among the portfolios, FMCG and IT showed very low risk levels. Thus, the covariance analysis manifests the prevalence of very high systematic risk.

❁ **Beta Values of Portfolios In Relation To Benchmark Indices :** The characteristic regression line or CRL is a simple linear regression model estimated for a particular stock against the market index return to measure its diversifiable and un-diversifiable risks. The model is :

$$R_i = \alpha_i + \beta_i R_m + e_i$$

Where,

R_i= Return of the i^{th} portfolio;

α_i = intercept;

β_i= slope of the i^{th} portfolio;

R_m= Return of the market index;

e_i= The error term

❁ **Beta:** Beta is the slope of the characteristic regression line. Beta describes the relationship between the stock's return and the index returns. It indicates that one percentage change in BSE index return would cause the Beta value to change in the particular stock return.

❁ **Beta = +1** indicates that one percentage change in the market index return causes exactly one percentage change in the stock return. It indicates that the stock moves in tandem with the market.

❁ **Beta = +0.5** indicates that one per cent change in the market index return causes 0.5 per cent change in the stock return. The stock is less volatile as compared to the market.

❁ **Beta = -1** indicates that stock return moves in the opposite direction to the market return, i.e. one per cent increase in the index return in index would cause one per cent decline in the return of the share.

Stocks with negative Beta resist the decline in the market return, but stocks with negative returns in the long run are very rare. It enables the risk diversification.

❁ **Alpha (α) :** The intercept of the characteristic regression line is Alpha i.e. the distance between the intersection and the horizontal axis. It indicates that the stock return is independent of the market index return. A positive value of alpha is a healthy sign. Positive alpha values would yield profitable returns. According to the portfolio theory, in a well-diversified portfolio, the average value of alpha of all stocks turns out to be zero.

Beta values of the portfolios in relation to the benchmark indexes such as Sensex, Midcap and Smallcap have been computed and are presented in the Table 5. The Beta values of the portfolios in relation to the Sensex indicate that all the beta values except CD (consumer durables) exhibited a very high positive value. The Beta value is low in the case of IT and Oil & Gas. In the case of Midcap index as the independent variable, most of the portfolios exhibited negative signs, indicating that there is a resistance to risk. Even those portfolios which have shown positive values displayed very low values. In the case of Smallcap index as an independent variable, all the portfolios exhibited similar beta values. Thus, it clearly manifests that Sensex and Smallcap have a positive influence on the portfolios in the BSE, whereas the Midcap index has a negative impact on the portfolios. This shows the resistance level of the portfolios. The R^2 value is above 0.9, indicating the above 90 per cent fitness of the model. This indicates that the Midcap shares are being used to diversify risks.

Table 5: Beta Values Of The Portfolios In Relation To Benchmark Indexes Based On Daily Data

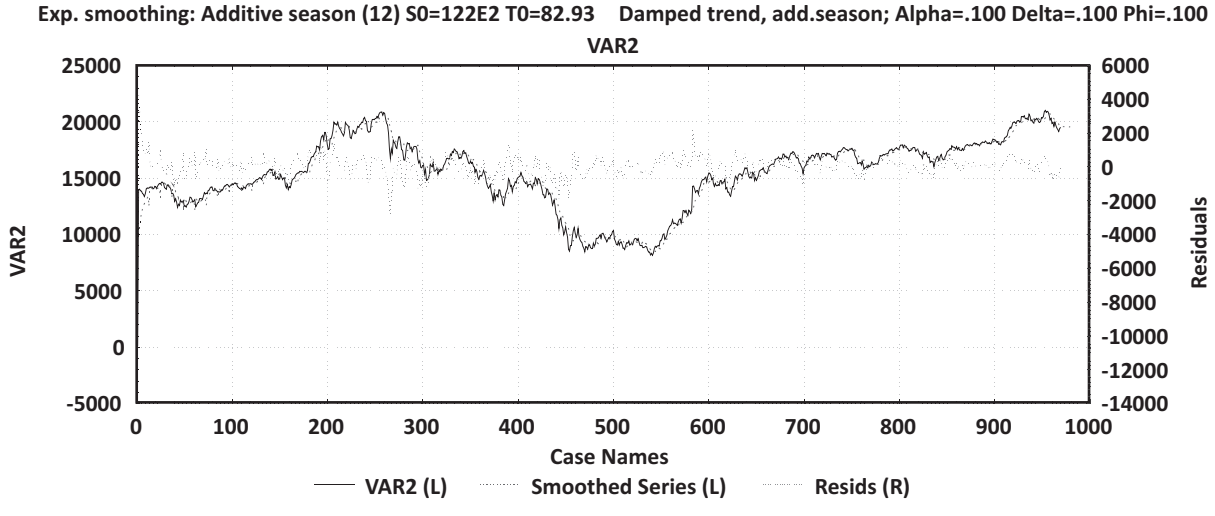
	Auto	Bank	BSECD	BSECG	FMCG	IT	PSU	Metal	OILGAS	Power
Sensex	1.662	1.437	-0.076	0.661	2.595	0.165	1.778	1.195	0.057	0.787
Midcap	-2.141	-1.823	0.166	0.486	-4.501	1.202	-1.800	-0.981	0.163	-0.103
Smallcap	1.268	1.327	0.870	-0.190	2.547	-0.597	0.944	0.736	0.137	0.214
R^2	0.694	0.907	0.928	0.909	0.710	0.596	0.926	0.903	0.801	0.793

The Beta values of the returns of the portfolios in relation to the returns of the index of the BSE on monthly data have been computed and are presented in the Table 6. It shows that the Beta values of most of the portfolios against the Sensex 30 are negative, which is a very rare phenomenon. This could be attributed to the economic slowdown at the global and domestic level, and the consequent decline in the value of shares frequently. This could be substantiated with the negative skewness values. Only IT, Oil & Gas and Realty portfolios showed positive Beta values, indicating

Table 6: Beta Values Of The Returns Of The Portfolios In Relation To The Index Based On The Monthly Data

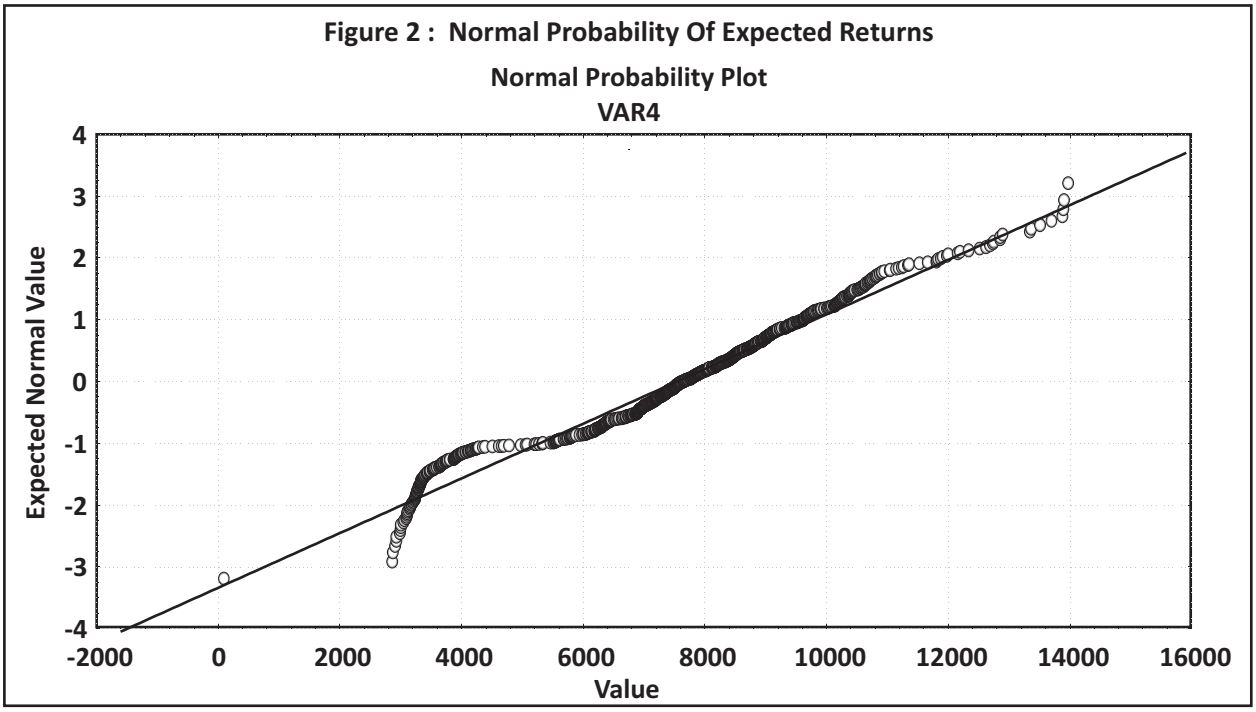
	IT	Bank	PSU	FMCG	Oil &Gas	Power	Auto	CD	CG	HC	Metal	Realty
BSE 500	-1.368	2.780	2.202	3.475	1.153	0.829	3.211	0.868	0.743	2.347	2.551	-4.643
BSE Sensex 30	1.667	-1.262	-0.348	-0.662	0.414	-0.027	-1.390	-1.008	-0.099	-0.479	-1.446	2.212
Midcap	0.551	-0.584	-0.921	-2.110	-0.667	0.122	-1.027	1.089	0.328	-1.051	-0.163	3.051
R^2	0.719	0.937	0.963	0.817	0.867	0.851	0.749	0.929	0.933	0.776	0.923	0.78

Figure 1 : Trend Line Including The Alpha And Error Term Through Exponential Smoothing



high risky nature of these portfolios. Midcap index, as independent variable, brought out negative Beta values in majority of the portfolios. This also supports the Arbitrage Pricing Theory of buying the shares when the prices decline and sell when the prices are high. The Beta values of majority of the portfolios against the independent variable BSE 500 index returns have shown positive signs, excluding IT and Realty portfolios. The R^2 values of majority of the portfolios have been more than 0.9, indicating the 90 percent goodness of fit of the model. Thus, the regression results as presented in the previous tables have shown the Beta values, goodness of fit of the model, and risk elements. The alpha or intercept and residuals or error terms of the regression line have been explained in the Figure 1 . The intercept and error terms of the Portfolios in relation to the Sensex index has been shown in the Figure 1. The intercepts concentrate around 14000 and goes upto 21000. The normal course is followed around the 15000 range. The error ranges from -4000 to +2000. This could be one of the reasons for the high negative skewness. Thus, the figure clearly shows the movement of the portfolios for every one per cent change in the index. The normal probability plot has been calculated and plotted as a graph (Figure 2). This shows that when the value of the index increases from 2000 to 16000, the expected normal returns of the portfolios increases upto 4 per cent. The normal trend line has the intercept in the negative, which is not a good sign for the portfolio.

Figure 2 : Normal Probability Of Expected Returns



Thus, the regression analysis has shown that the Sensex index has a positive role in determining the expected returns of different portfolios. The regression results have shown the risk level of different portfolios. The expected returns of the portfolios in relation to the increase in the Sensex have also been computed.

CONCLUDING OBSERVATIONS

The findings of the study vividly indicate that the share market in India does not support the efficient market theory, though the market responds quickly to the domestic and global glues. The size of assets in the financial market is also less than one percent of the total assets. It is also dwindling consistently. The expected returns remain to be meager, and the prevalent risk is an increasingly systematic risk. This manifests that there is a financial instability in the economy. It necessitates the attention of the financial regulation mechanisms. The trend also shows that the ideal value of Sensex is around 16000. Anything above and below are risky situations and market fluctuations. Market correction brings the index value closure to this range. Thus, the portfolio choice should be made looking at the beta values and correlation values to beat the market.

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