An Empirical Study on the Utility of Sharpe's Single Index Model in Optimal Portfolio Construction

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Abstract

While investors take investment decisions, they expect high returns at minimum risk, and they also do not want to block their entire investment in a single security. So, they aim at creating optimal portfolios through diversification. The present study examined the impact of a single market index on the different companies' stocks included in the index. By using Sharpe's single index model (SIM), analysis of risk and return is made easy. The study aimed at applying Sharpe's single index model for constructing an optimal portfolio and understanding the effect of diversification of investments. The study is empirical in nature and is based on secondary data. All the 30 companies listed in the BSE were included in the study. Sensex was used as the benchmark index. Data for a 7- year period (2005-2012) were used for portfolio construction. The study showed that by using this model, the investors can minimize their overall risk and maximize the returns over any period of time. It was found that even companies with high rates of return were not included in the portfolio as the risk involved in such companies was high. It was also proved that SIM has been useful to create an optimal portfolio by diversifying almost all the unsystematic risks.

Keywords: **beta, cut-off rate, diversification, excess return to beta ratio, systematic risk, unsystematic risk, portfolio optimization, Sharpe's single index model**

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Individual securities have risk-return characteristics of their own. The return expected from a security is variable, and this variability of returns is termed as 'risk'. Investors do not invest their entire wealth in a single security. If the price of that security falls, the investor may have to incur heavy losses. Investors vary depending upon their risk bearing ability, and can be categorized as high risk bearing, moderate risk bearing, and low risk bearing investors. The portfolios are created depending upon the risk bearing potential of the investors. The process of creating a portfolio is called diversification. While creating a portfolio, investors do not invest in securities belonging to only one industry. However, they invest in different types of industries to spread their risk. This results in diversification of risk. If one of the industry's share prices fall, and the returns from those securities are affected, it may be compensated through the returns from the securities belonging to other sectors. Another important question pertains to how many portfolios may be constructed. From a given set of securities, any number of portfolios can be constructed, and the investor has to decide about the portfolio that needs to be selected.

Rational investors search for the most efficient of these portfolios. This leads to the construction of optimal portfolios. The major objective of optimal portfolio construction is to design a portfolio that provides the highest return with the lowest risk. Such a portfolio is known as an 'optimal portfolio'. The conceptual framework (and analytical tools) for determining the optimal portfolio is disciplined, and the same has been provided by Harry Markowitz in his pioneering work on portfolio analysis (Markowitz, 1952, 1959) . His method of portfolio selection came to be known as the Markowitz model. Markowitz's works mark the beginning of today's modern portfolio theory. Markowitz showed that for a given level of expected return and for a given security universe,

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finding a specific portfolio that dominates the others requires knowledge of the co-variance or correlation matrix between all possible security combinations. Subsequent to the publication of his paper, numerous investment firms and portfolio managers began to program "Markowitz Algorithms," which prescribed portfolio proportions so as to minimize portfolio variance. Even today, the term Markowitz diversification refers to portfolio construction accomplished using security covariances. According to Strong (2003), "portfolio management primary involves reducing risk rather than increasing return" (p.1) and, "the whole point of investment management is to get more of what you like and to get rid of what you dislike" (p. 6).

When the number of securities considered for portfolio construction increase, the required number of covariances to be computed also increase. This is the major disadvantage of the Markowitz (full covariance) model. So, in order to overcome the disadvantage associated with the Markowitz model, the Single index model was developed by William J. Sharpe. His model is computationally easy as it compares securities' performances with a benchmark, rather than with one another. It requires only one beta statistics per security rather than numerous pair wise comparisons. Thus, Sharpe's single index model is very useful for optimal portfolio construction. The present study is aimed at studying the utility of Sharpe's single index model in optimal portfolio construction.

Scope of the Study

The present study would help an investor in selecting the securities for constructing an optimal portfolio that earns the maximum return at a minimum level of risk. It considers the impact of a single market index on the different companies' stock included in the index. By using Sharpe's single index model, analysis of risk and return is made easy. Security screening, a practice that most professional investors follow to find the best stocks to form a portfolio for investment is experienced through the study. The study explains how the theoretical framework of portfolio management is applied in the real-world scenario. In order to form a well balanced optimized and diversified portfolio of stocks, the study would be useful, and the investors would be benefitted by knowing the criteria for the selection of companies to form a portfolio. The effect of diversification of investment is well understood through this study.

In order to take advantage of diversification, it is necessary for an investor to hold a portfolio of securities by constructing a portfolio either by using fundamental techniques or by using the technique of Sharpe's single index model. Sharpe's single index model was constructed to know the utility of this model in portfolio construction.

Review of Literature

The review of literature examines a few studies conducted in the area of optimal portfolio construction and also examines the utility of Sharpe's single index model in optimal portfolio construction in the long run. Literature suggests that much of market volatility can be attributed to substantial increase in sector specific and sub- sector specific risks (Black, Buckland, & Fraser, 2002). India's stock market is one of the oldest in Asia, but remained at a small scale and largely outside the integration process until the late 1980s (Wong, Agarwal, & Du, 2005). The SEBI controls and supervises operations of all participants in the Indian stock market. NSE and BSE ranked 3rd and 6th among the stocks in the world in 2006 in terms of the number of transactions (Ministry of Finance, Government of India, 2007).

Studies on benefits of diversification in the Indian stock markets are limited. In order to reap the benefits of diversification, the correlation between two securities must be less than perfect and should be considered in a dynamic setting. Gupta and Basu (2008) found that using asymmetric DCC GARCH model for estimating correlations in the portfolio optimization process helps to enhance portfolio returns of the domestically diversified portfolio.

Varadharajan (2011) attempted to construct an optimal portfolio using Sharpe's single index model with the stocks selected from the automobile and infrastructure sector, which would maximize the returns and diversify the

risk associated with the stocks. The study found that by using the short selling strategy, 10 securities with negative returns yielded profits to an individual. The author found that the stock prices over a period of years revealed that most of the stock prices move in line with the market index . The study concluded that this model (Sharpe's single index model) helps investors to take decisions about their portfolio creation and maintenance.

Varadharajan and Vikkraman (2011a) also applied Sharpe's single index model to construct an equity portfolio of stocks chosen from oil, IT, steel, and banking sectors ; 25 companies were chosen from these sectors. They proved that even if some of the sectors do not perform well (as expected) during a period, it will be compensated by the excess returns from other sectors that exceed expectations. The authors found the existence of the cut off rate to be extremely useful, and the study found that the optimal portfolio developed proved to be the best investment option in the NSE. The study concluded that the portfolio arrived at was well diversified as the stocks belonged to different types of companies. The excess return to beta was positive for all the stocks included in the portfolio, and the stocks with beta more than one were not included in the study. The study found that steel stocks had higher beta and yielded higher returns as compared to the other stocks.

Varadharajan and Vikkraman (2011b) made an attempt to apply Sharpe's single index model in 15 scrips of companies in the banking industry to : (a) find the best stocks to form a portfolio; (b) know the proportions to be invested in each security, and (c) to take decisions about short sales. The study found that the returns of stocks selected were better than the other stocks, and the risk associated with the stocks also varied from time to time. The study made an attempt to answer questions regarding shares having high returns not taken for portfolio construction because of higher risk associated with the same. Taneja and Bansal (2011) attempted to identify efficient securities using Sharpe and Treynor models in order to reach an optimal portfolio. The study found that there existed a consistency pattern between Sharpe and Treynor's models for efficient securities identification. It was also found that Sharpe's single index model was successful in identifying the optimal portfolio by diversifying almost all the unsystematic risks.

Saravanan and Natarajan (2012) gave an analytical prescription for investors on Nifty stocks in constructing an optimal portfolio. The authors considered all the 50 stocks listed on NIFTY to construct the optimal portfolio and collected data from CMIE Prowess. The authors found that returns on either individual securities or a portfolio comprised of securities of different companies listed on the NIFTY ; the examined 50 stocks listed under various sectors were asymmetrical and heterogeneous. It was also concluded that every security depends, to some extent, on overall performance of the market. The study concluded that Sharpe's single index model holds good for the Indian stock market.

Varadharajan and Ganesh (2012) applied Sharpe's single index model for the construction of equity portfolio of large caps of companies of selected sectors in India ; 18 stocks from three different large caps sectors were chosen for the study. The three sectors considered were the power sector, shipping sector, and textiles sector as the government has made huge investments in these companies as they are consistently performing well, thereby enabling the economy to grow. The authors opined that factors like general economic factors and macro-economic factors governing the share price movements are also considered while making investment decisions. Thus, investment decisions must be made only after considering all the factors affecting the securities, including general economic factors that govern the movement of these securities in the market.

Karmarkar, Ramchandani, and Patel (2013) revisited the Sharpe ratio for portfolio creation using data from the Indian stock market. In this study, the authors compared the risk and return of portfolio constructed using Sharpe's single index model, with the risk and return of another portfolio constructed using the generalized Sharpe single index model. They attempted to identify the better model among these two, the one which was a better tool for portfolio construction in the Indian stock market. It was assumed that Sharpe's ratio limited the utility as far as securities were concerned. The authors assumed that only those securities which were uncorrelated could form a part of the optimal portfolio. It eliminated the inclusion of many potential securities. The generalized Sharpe ratio, however, extends the utility of the Sharpe ratio to all those securities which are correlated with the portfolio. The findings of this study revealed that the level of risk and return of all the three portfolios remained the same in both the cases, that is, if the portfolio was selected by using the traditional Sharpe ratio or the generalized Sharpe ratio. The replacement of either high correlated securities or low correlated securities did not affect the level of risk and

return for the portfolios. The authors suggested that the generalized Sharpe ratio model was applicable to the Indian stock markets for portfolio creation.

Khurana, Bagga, and Singh (2013) studied the role of Sharpe's single index model in constructing an optimal portfolio with NSE's S&P CNX Nifty Scrips. Daily closing prices of 44 companies were chosen for the study, of which 19 scrips were found to qualify for the construction of the portfolio. It was found that there existed a significant relationship amongst the scrips returns; also, there existed strong causal explanations to the variations in S&P CNX index. The authors concluded that the model constructed for predicting the index using the 19 scrips fairly estimated the reality.

The preset study is unique as it considers all the 30 scrips in the BSE and would be helpful for the investors to decide upon their portfolio's diversification.

Objectives of the Study

The major objectives of this study are:

(1) To apply Sharpe's single index model in constructing an optimal portfolio;

(2) To understand the effect of diversification of investments.

Methodology

The present study is empirical in nature. The data required for this study was collected from secondary sources. Data relating to closing prices of shares were collected from the BSE website as the sample companies chosen for the study belonged to those listed on the BSE. The website used for data collection is www.bseindia.com. All the 30 companies listed on the BSE have been included in the study. The data so collected was used for the selection of optimal portfolio. Data for a 7- year period (2005-2012) was used for portfolio construction. Sensex was used as the benchmark index. The data relating to Sensex points were also collected from the website of BSE. The risk free rate has been assumed to be 8%. The popular Sharpe's single index model was used to test its utility in optimal portfolio construction. The basic equation underlying the Sharpe's single index model is:

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

where,

R_i = Expected return on security *i*,

α_i = Intercept of the straight line or Alpha co-efficient,

R_m = Rate of return on market index,

β_i = Slope of straight line or Beta co-efficient,

e_i = is the error term.

This model assumes co-movement of share prices and index.

↳ **Return :** The total gain or loss experienced on an investment over a given period of time is calculated by dividing the asset's cash distributions during the period plus change in value by its beginning of period investment value is termed as return.

$$\text{Stock Return} = \frac{\text{(Today's price - Yesterday's price)}}{\text{(Yesterday's price)}} \times 100$$

↳ **Market Return :** Market return is the return on the market portfolio of all traded securities.

$$\text{Market Return} = \frac{(\text{Today's Index} - \text{Yesterday's Index})}{(\text{Yesterday's Index})} \times 100$$

In the present study, Sensex is chosen as the benchmark index and market return is calculated for the Sensex.

↳ **Arithmetic Mean Return (AM) :** Statistics useful in portfolio construction deal with a series of holding period returns. It is important that all the holding periods be of equal length. The arithmetic average of these is called arithmetic mean return.

$$AM = \left[\frac{\Sigma R_i}{N} \right]$$

where,
n = number of years,
R_i = Return of stock or market index

↳ **Risk :** According to Sharpe's single index model, risk is divided into two, that is, systematic risk and unsystematic risk. Systematic risk is $\beta_i^2 \times \sigma_m^2$ and unsystematic risk is σ_{ei}^2 The stock variance includes both systematic and unsystematic risk.

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_{ei}^2$$

The unsystematic risk can found out as follows:

$$\sigma_{ei}^2 = \sigma_i^2 - \beta_i^2 \times \sigma_m^2$$

↳ **Beta and its Interpretation :** Beta is the relative measure of non-diversifiable risk. It is an index of degree of movement of an assets return in response to a change in the market return. In the present study, the following formula was used to compute beta :

$$\beta = \left[\frac{(\Sigma R_i - \bar{R}_i)(\Sigma R_m - \bar{R}_m)}{(\Sigma R_m - \bar{R}_m)^2} \right]$$

↳ **Risk-free Rate of Return *(R_f)* :** Risk free rate of return is the required return on a risk–free asset. For the study, the risk free rate of return is assumed as 8% , which is the rate on a 10 year bond in India.

↳ **Sharpe's Single Index Model :** The essence of Sharpe's single index model is that stocks vary together because of the common movement in the stock market. The co-movement of stocks with a market index may be studied with the help of a simple linear regression analysis, taking the returns on an individual security as the dependent variable *(R_i)* and the returns on the market index *(R_m)* as the independent variable.

↳ **Excess Return to Beta Ratio :** Excess return to beta ratio shows the return from the investment in excess to the risk taken by the investor.

$$\text{Excess return to beta} = \left[\frac{R_i - R_f}{\beta_i} \right]$$

where,
R_i = the expected return on stock 'i',
R_f = The return on a riskless asset,
β_i = systematic risk of stock 'i'.

The individual returns are calculated and excess return to beta is found using the above formula. Then, the stocks are ranked according to the excess return to beta ratio while selecting securities for constructing a portfolio.

↳ **Steps Pertaining to the Computation of Cut-off Point (C^*):** First, compute excess return to beta ratio of each company. As a next step, rank them according to the highest return to beta ratio to lowest return to beta ratio and arrange them according to the ranks so assigned. In the next step, find out C^* , which is considered as the cut-off rate, using the following formula:

$$C_i = \left[\frac{\sigma_m^2 \sum_{i=1}^{N} \frac{(R_i - R_f)\beta_i}{\sigma^2_{ei}}}{1 + \sigma_m^2 \sum_{i=1}^{N} \frac{\beta_i^2}{\sigma^2_{ei}}} \right]$$

C_i is the cumulative risk-adjusted return upon cumulative estimated risk.

↳ **Computation of Percentage of Investment in Each Security :** After finding C^* , the top companies that come within C^* are considered. Such companies have C^* more than the cut-off rate. In the present study, five companies' C^* was above the cut off rate. These companies were thus selected for construction of optimal portfolio and as a next step, the proportion of investment to be invested made in them was computed. The proportion of investment to be made was computed using the following formula:

$$X_i = \left[\frac{\mathbf{Z_i}}{\sum_{i=1}^{N} Z_i} \right]$$

$$Z_i = \left[\frac{\beta_i}{\sigma^2_{ei}} \right] \left\{ \left[\frac{R_i - R_f}{\beta_i} \right] - C^* \right\}$$

In the present study, five companies fall within the C^* and thus, an optimal portfolio will be the one which has these securities in its portfolio.

Data Analysis and Interpretation

This part of the study deals with data analysis and interpretation done for 30 companies (listed in the BSE Sensex).

Table 1 gives the information about companies qualified for the optimal portfolio construction and ranks assigned to each company. The Table 1 shows in detail about the companies that were qualified for the optimal portfolio construction. From this table, it may be observed that each company is assigned a rank on the basis of its excess return to beta ratio.

The Table 2 shows the C_i of sample companies . The data in the Table 2 has been arranged in the order of ranks assigned to sample companies based on excess return to beta ratio. It may be understood from the Table 2 that

ICICI Bank Ltd., with C_i of 17.71, is the cut-off point (C^*) for taking decisions as to which companies are to be included in the optimal portfolio.

↳ **Computation of Proportion of Investment to be Made:** The next part of the analysis is about the computation of the proportion of funds to be invested in each of the company's stocks that had been selected for portfolio construction. The proportion of funds to be invested was ascertained by using the following formula :

Table 1. Companies Qualified for the Optimal Portfolio Construction and their Assigned Ranks

Sl. No	Name of the Scrip	R_i	β (beta)	$\frac{R_i - R_f}{\beta_i}$	RANK
1	Housing Development Finance Corp. Ltd.	18.08	1.015	9.931	15
2	Cipla Ltd.	9.347	0.433	3.111	22
3	Bharat Heavy Electricals Ltd.	11.26	1.219	2.674	23
4	State Bank Of India	28.231	1.065	18.996	6
5	HDFC Bank Ltd.	24.051	1.128	14.230	11
6	Hero Motocorp Ltd.	21.325	0.468	28.472	3
7	Infosys Ltd.	11.221	0.85	3.789	20
8	Oil And Natural Gas Corporation Ltd.	2.957	1.003	-5.028	26
9	Reliance Industries Ltd.	18.902	0.835	13.056	12
10	Tata Power Co. Ltd.	21.222	1.394	9.485	17
11	Hindalco industries Ltd.	12.881	1.521	3.209	21
12	Tata Steel Ltd.	26.797	1.695	11.090	13
13	Larsen&Toubro Ltd.	40.011	1.64	19.519	5
14	Mahindra &Mahindra Ltd.	35.885	1.909	14.607	10
15	Tata Motors Ltd.	52.864	2.644	16.968	8
16	Hindustan Unilever Ltd.	18.251	-0.115	-89.139	27
17	ITC Ltd.	-97.3	-0.922	114.208	1
18	Sterlite Industries (India) Ltd.	20.855	1.894	6.787	19
19	Wipro Ltd.	8.384	1.241	0.309	24
20	SunPharmaceutical Industries Ltd.	12.843	0.454	10.667	14
21	Gail (India) Ltd.	18.869	1.118	9.722	16
22	ICICI Bank Ltd.	29.593	1.207	17.890	7
23	Jindal Steel &Power Ltd.	67.94	1.862	32.191	2
24	Bharti Airtel Ltd.	14.419	0.283	22.682	4
25	Maruti Suzuki India Ltd.	32.568	1.481	16.589	9
26	Tata Consultancy Services Ltd.	6.544	0.531	-2.742	25
27	NTPC Ltd.	12.315	0.617	6.994	18
28	DLF Ltd.	-15.235	0.777	-29.903	Not Valid
29	Bajaj Auto Ltd.	93.738	3.467	24.730	Not Valid
30	Coal India Ltd.	6.838	0.444	-2.617	Not valid

Source: Computed from closing prices available at
http://www.bseindia.com/indices/IndexArchieveData.aspx?expandable=3

Table 2. Table showing C_i of Sample Companies

Securities	RANK	R_i	BETA	$\frac{R_i - R_f}{\beta_i}$	$\frac{(R_i - R_f)\beta}{\sigma_{ei}^2}$	Cumulative of [Col 6]	$\frac{\beta_i^2}{\sigma_{ei}^2}$	Cumulative of [Col 8]	C_i
1	2	3	4	5	6	7	8	9	10
Jindal Steel and Power Ltd.	1	67.94	1.862	32.191	0.0004133	0.0004133	0.000013	0.000013	4.56
Hero Motocorp Ltd.	2	21.325	0.468	28.472	0.0006491	0.0010625	0.000023	0.000036	9.35
Bharti Airtel Ltd.	3	14.419	0.283	22.682	0.0001219	0.0011843	0.000005	0.000041	9.99
Larsen and Toubro Ltd.	4	40.011	1.64	19.519	0.0022523	0.0035998	0.000115	0.000158	14.69
State Bank of India	5	28.231	1.065	18.996	0.0083891	0.0118258	0.000442	0.000598	17.50
ICICI Bank Ltd.	6	29.593	1.207	17.890	0.0143677	0.026194	0.000803	0.001401	17.71 C*
Tata Motars Ltd.	7	52.864	2.644	16.968	0.0016414	0.027835	0.000097	0.001498	17.66
Maruti Suzuki India Ltd.	8	32.568	1.481	16.589	0.0025645	0.030399	0.000155	0.001653	17.57
Mahindra and Mahindra Ltd.	9	35.885	1.909	14.607	0.0012804	0.0316797	0.000088	0.001741	17.42
HDFC Bank Ltd.	10	24.051	1.128	14.230	0.0035844	0.035264	0.000252	0.001993	17.03
Reliance Industries Ltd.	11	18.902	0.835	13.056	0.0005844	0.035849	0.000045	0.002038	16.95
Tata Steel Ltd.	12	26.797	1.695	11.090	0.0031151	0.038962	0.000281	0.0023185	16.26
Sun Pharmaceutical Industries Ltd.	13	12.843	0.454	10.667	0.0002795	0.039243	0.000026	0.002345	16.20
Housing Development Finance Corp Ltd.	14	18.08	1.015	9.931	0.0008503	0.040093	0.000086	0.002431	15.99
Gail India Ltd.	15	18.869	1.118	9.722	0.0015248	0.041618	0.000157	0.002587	15.62
Tata Power Co Ltd.	16	21.222	1.394	9.485	0.0010398	0.042658	0.000113	0.002697	15.37
NTPC Ltd.	17	12.315	0.617	6.994	0.0004739	0.043132	0.000068	0.002765	15.17
Sterlite Industries Ltd.	18	20.855	1.894	6.787	0.0007190	0.043851	0.000106	0.002871	14.87
Infosys Ltd.	19	11.221	0.85	3.789	0.0002044	0.044055	0.000054	0.002925	14.67
Hindalco Industries Ltd.	20	12.881	1.521	3.209	0.0002174	0.044273	0.000068	0.002992	14.42
Cipla Ltd.	21	9.347	0.433	3.111	0.0001	0.044373	0.000023	0.003016	14.35
Bharat Heavy Electricals Ltd.	22	11.26	1.219	2.674	0.000575	0.044948	0.000215	0.003231	13.59
Wipro Ltd.	23	8.384	1.241	0.309	0.000021	0.044969	0.000068	0.003299	13.31
Tata Consultancy Services Ltd.	24	6.544	0.531	-2.742	-0.000107	0.044862	0.000039	0.003338	13.13
Oil and Natural Gas Corporation	25	2.957	1.003	-5.028	-0.000874	0.04399	0.000174	0.003512	12.26
ITC Ltd.	26	1.1875	0.229	-29.749	-0.000003	0.0001632	0.000001	0.000001	2.08
Hindustan Unilever Ltd.	27	18.251	-0.115	-89.139	-0.001106	0.042882	0.000012	0.003524	11.91
					0.043045		**0.003525**		

$$Z_i = \left[\frac{\beta_i}{\sigma_{ei}^2}\right]\left\{\left[\frac{R_i - R_f}{\beta_i}\right] - C^*\right\}$$

$$X_i = \left[\frac{Z_i}{\sum_{i=1}^{N} Z_i}\right]$$

The Table 3 and Figure 1 show the results of the application of the above - mentioned formula. The Table 3 and Figure 1 show the proportion of investment to be made in each of the five companies selected using Sharpe's single index model in this study. It may be inferred from the Table that 41.41% of the investment can be made in Hero Motocorp Ltd. ; 41.82% in State Bank of India ; 9.93% in Larsen and Toubro Ltd. ; 4.95% in ICICI Bank Ltd. ; and about 1.89% of the investments could be made in Bharti Airtel's scrips. It must be noted that the proportion of investment to be made depends on the respective company's average return, beta, and excess return to beta ratio.

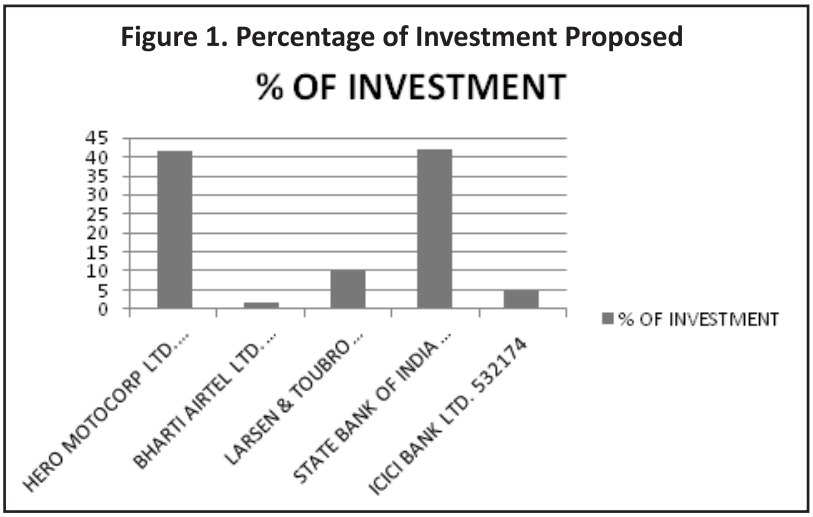
Summary of Findings

(1) It is possible to construct an optimal portfolio using all the 30 companies' scrips listed on the Bombay Stock Exchange.

Table 3. Proportion of Investment Proposed

Security	$\frac{\beta_i^2}{\sigma_{ei}^2}$	$\frac{R_i - R_f}{\beta_i}$	C^*	Z_i	X_i	% of Investment
Hero Motocorp Ltd.	0.000049	28.472	17.713	0.000527	0.4141	41.41
Bharti Airtel Ltd.	0.000019	22.682	17.713	0.000024	0.0189	1.89
Larsen & Toubro Ltd.	0.00007	19.519	17.713	0.000126	0.0993	9.93
State Bank Of India	0.000415	18.996	17.713	0.000532	0.4182	41.82
ICICI Bank Ltd.	0.000665	17.89	17.713	0.000063	0.0495	4.95
				0.001273	1	100

Figure 1. Percentage of Investment Proposed



(2) It was found that while constructing the optimal portfolio using all the 30 companies, three companies were excluded due to incomplete data. Those companies are as follows: DLF Ltd. ; Bajaj Auto Ltd. ; Coal India Ltd.

(3) It was also found that companies with high returns were not qualified for the portfolio construction as they involved high risk, which is not very helpful for investors and the aim of the study was selecting those companies which gave maximum return and minimum risk.

(4) Companies with negative mean return and negative beta move negatively with the market returns.

(5) The stocks with systematic risk greater than 1 are riskier since for a 1% change in market returns, the change in stock returns is greater than 1%.

(6) The return may be low or high, and the risk may be minimum or maximum. But these alone do not influence the performance of the shares and the selection of shares for portfolio construction. The security selection has to be decided based on the excess return to beta ratio.

(7) The excess return to beta ratio shows the performance of a stock and helps in eliminating those companies which are not efficient.

(8) The risk associated with the individual stock is not the same for all the years. It differs from time to time.

(9) The betas of the stocks included in the portfolio are relatively lower than 1 for two companies and more than 1 for the other two companies. From the returns perspective, these companies were performing better as evinced by their high excess return to beta ratios.

Suggestions

The following suggestions are provided on the basis of the above findings:

(1) The beta and variance of the stocks keep changing frequently. So, the market should be observed by investors continuously.

(2) Investments should be made in stocks that have relatively lower beta and higher returns. This is because investors are rational.

(3) The proportion of investment in each of the securities changes from time to time. The optimal portfolio is thus, subject to change.

(4) Market analysis should be made regularly so that one can keep on updating the present situation and can minimize the consequence of incurring losses.

(5) The stocks must be continuously evaluated and the portfolio has to be updated periodically.

(6) Investors must be aware of the utility of security screening in optimal portfolio construction and may make use of it.

Research Implications

The Indian capital market is strengthening and more domestic and foreign investors are attracted towards investing in the securities of Indian companies. The studies of this kind enable individual investors and fund managers to execute effective diversification as this study has considered all the 30 companies listed in the BSE-Sensex. The individuals and institutional investors may save their time and cost as the movement of securities is studied in total with the help of their benchmark index. It may also be observed that by applying this model,

securities belonging to various sectors with excess return to beta ratio find a place in the portfolio constructed (and not only those companies' scrips which have high returns). It is also seen that the model is very simple to apply (unlike the complexities involved in the Markowitz model) that continuous revision of the portfolio may be made easily with less efforts. This helps investors not to be carried away by the returns of the high performing companies. Thus, one of the major implications of this study is that it enables investors to make decisions wisely.

Conclusion

To conclude, the present study conducted for testing the utility of Sharpe's single index model in optimal portfolio construction included all the 30 companies' scrips listed on the Bombay Stock Exchange with Sensex as the benchmark index. The study has made an attempt to help those investors who intend to invest in the companies that are traded on the Bombay Stock Exchange considering all the 30 companies listed under the Sensex. The method used in this study for the construction of optimal portfolio is very effective and feasible as revision of the optimal portfolio can be done continuously as an ongoing exercise. The use of 'cut-off rate' is very effective as those securities which are not efficient are excluded. The excess return to the beta ratio also plays a major role in eliminating those companies which have maximum returns with maximum risk. Thus, this study would help the investors to minimize their overall risk and maximize the return over any period of time. The optimal portfolio thus developed using William Sharpe's model proves to be the best model for investment decisions. The investors are, thus, enabled to spread their risk by investing in a group of securities using this model.

Limitations of the Study and Scope for Further Research

The study has the following limitations :

- The study is confined to the scrips included in the BSE Sensex only.
- The results of the study may not hold good for a long period of time due to volatility in the Indian stock markets.
- The companies in the portfolio will change if the benchmark index is changed.
- Data relating to closing prices of shares were considered only for a period of 7 years for the construction of the portfolio.
- The portfolio construction was done purely by applying Sharpe's single index model, which does not consider the economy factors, industry factors, and the company factors.

Further research in portfolio construction may be attempted by considering all the companies trading on the BSE and not restricting the sample to 30 companies only, which may give wide opportunities to fund managers for decision making. Also, the decisions taken to invest in the selected stocks could be made by the fund managers by considering the macro-economic and industry factors that also affect a company's performance in the globalized world.

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