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## OPTIMAL PORTFOLIO CONSTRUCTION USING SHARPE'S SINGLE INDEX MODEL - A STUDY OF SELECTED STOCKS FROM BSE

Dr. R. Nalini\*

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**Abstract:** *To make wise decisions in investment, there is a need for knowledge on security analysis and portfolio management. A rational investor aims at attaining maximum return with minimum risk. As the scope of investment avenues with varying degrees of risk is vast, the scope of the present study is relating to equity portfolio construction with selected stocks from the BSE. Constructing an optimal portfolio is a challenging task for the individual as well as the institutional investors. This study is aimed at creating awareness in the minds of investors regarding the utility of Sharpe's Single Index Model in portfolio construction. The Indian investors also may reap the benefits of Sharpe's Single Index Model (SIM) as the number of companies traded in the stock exchanges is increasing year after year. Fifteen companies from the S&P BSE Sensex index were selected for the study. Among the fifteen sample companies, only four were selected for optimal portfolio using SIM. The results of the present study and such micro level studies have more utility value to the fund managers.*

**Key words:** *Systematic Risk, Unsystematic Risk, Cut-off rate, Beta, Excess Return to Beta Ratio.*

**JEL Classification Code:** *G02, G11, G150.*

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\*Associate Professor of Commerce, Maharanis Commerce & Management College for Women, J. L. B. Road, Mysore



## **INTRODUCTION**

Investment is the employment of funds on assets with the aim of earning income or capital appreciation. Every investment involves a return and risk. The possibility of variation in the actual return is known as investment risk. To make wise decisions in investment, there is a need for knowledge on security analysis and portfolio management. A portfolio is a combination of securities. Any portfolio constructed, either by an individual investor or a fund manager is expected to meet the investor's goals. A rational investor aims at attaining maximum return with minimum risk. It is, therefore, important to construct a portfolio using either of the two popular approaches, namely, traditional and modern.

In the traditional approach, investor's needs in terms of income and capital appreciation are evaluated and appropriate securities are selected to meet the needs of the investor. In the modern approach, Markowitz model is used in selection of securities based on to the risk and return analysis. Markowitz laid foundation for quantifying risk and his contribution is popularly known as 'Modern Portfolio Theory'. He has provided analytical tools for analysis and selection of optimal portfolio. He won Nobel Prize for this contribution to portfolio management in 1990. But, William Sharpe extended the work done by Markowitz. He considered market index while analyzing the portfolio. He simplified the amount and type of input data required to perform portfolio analysis. He made the numerous and complex computations easy which were essential to attain the optimal portfolio. He developed the Single Index Model to make these computations easy and construct an optimal portfolio. Till today, fund managers use this model in portfolio analysis and construction.

Indian investors also may reap the benefits of Sharpe's Single Index Model as the number of companies traded in the stock exchanges is increasing year after year. The Bombay Stock Exchange Ltd (BSE) that was established in 1875 is the Asia's First Stock Exchange and one of the leading exchanges in India. Over the past 137 years, the BSE has facilitated the growth of the Indian corporate sector by providing it an efficient capital-raising platform. It provides an efficient and transparent market for trading in equity, debt instruments, derivatives, mutual funds

More than 5000 companies are listed on BSE making it world's No. 1 exchange in terms of listed members. BSE's popular equity index - the S&P BSE SENSEX - is India's most widely tracked stock market benchmark index. **As on 9<sup>th</sup> May 2014 the total turnover of the index**



being Rs.32,38,54,77,753 the traded quantity being 23,72,40,286 and the index value 22,994. (update) . Bearing these in mind, the present study was undertaken to facilitate effective decision making by the investors.

### **NEED FOR THE STUDY**

Every investor undergoes confusion while selecting securities for his portfolio. He also faces dilemma while deciding about the proportion of investment to be made in each security. To help investors get out of such chaotic situations the Sharpe's Single Index model may be used to construct an optimal portfolio. This helps the investor to find a portfolio that best suits his needs. The present study is undertaken to prove that by applying this model an individual can construct a portfolio with maximum return for a given level of risk.

### **PROBLEM STATEMENT**

An investor considering investment in securities is faced with the problem of choosing from among a large number of securities and how to allocate those funds over a group of securities. The hurdle that exists is that the investor has a problem of deciding which securities to hold and how much to invest in each of them. Though Markowitz Model enables an investor to arrive at an optimal portfolio, the Single index model is helpful in avoiding the difficulty of data input and time cost consideration. Therefore, the present study is entitled, "Optimal Portfolio Construction using Sharpe's Single Index Model- A Study of Selected Stocks from BSE".

### **SCOPE OF THE STUDY**

The rational investors never ignore the risk factor while taking investment decisions. The investors prefer to invest in a group of securities which is known as a portfolio in order to diversify the risk. There are different investment avenues for investors to invest. While some investment avenues involve huge risk others may be either less risky or risk less avenues. Therefore, it is essential to educate the investor about the investment alternatives and the risk and return from those investments. As the scope of investment avenues with varying degrees of risk is vast, the scope of the present study is relating to equity portfolio construction with selected stocks from the BSE.

### **RESEARCH METHODOLOGY**

The study is empirical in nature. The study is based on secondary source and the data required for this study was obtained from the website [www.moneycontrol.com](http://www.moneycontrol.com). Fifteen



companies from the S&P BSE Sensex index were selected for the study. The steps followed are

i). Estimate the return on stock. The equation to be used

$$R_i = \frac{(P_t - P_o)}{P_o} \times 100$$

Where,

$P_t$  = current year price

$P_o$  = previous year price.

ii). Next, find excess return to beta ratio for each security

$$\text{Excess return to beta ratio} = \frac{(R_i - R_f)}{\beta_i}$$

where,

$R_i$  = the expected return of stock i

$R_f$  = risk free rate of return

$\beta_i$  = systematic risk of stock i

iii). As a next step, arrange all the securities in ascending order and then calculate the 'Cut-off rate' ' $C_i$ ' by using following equation:

$$C_i = \frac{\sigma_m^2 \sum_{i=1}^N \frac{(R_i - R_f)}{\sigma_{ei}^2} \times \beta_i}{1 + \sigma_m^2 \sum_{i=1}^N \frac{\beta_i^2}{\sigma_{ei}^2}}$$

Where,

$\sigma_m^2$  = variance of the market index

$\sigma_{ei}^2$  = variance of stock movement that is not associated with the movement of market index i.e. stocks' unsystematic risk

The point will be selected as cut off point after which cumulative value of  $C_i$  start declining. Those securities which have value of  $C_i$  more or equal to cut off point will be selected in optimum portfolio.

The proportion for each selected securities will be found by using the following formula

$$X_i = \frac{Z_i}{\sum_{i=1}^N Z_i}$$



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

While the first expression ( $X_i$ ) indicates the weights on each security, the second shows the relative investment in each security.

## OBJECTIVES OF THE STUDY

The following are the objectives of the study:

- to get a practical knowledge as to the idea embedded in Sharpe's index model;
- to construct an optimal portfolio empirically using the Sharpe's Single Index Model; and
- to calculate the proportion of investment to be made into each of the stock that is included in the optimal portfolio.

## LIMITATIONS OF THE STUDY

The limitations of the present study are:

1. The study uses yearly prices instead of monthly data
2. Only fifteen companies have been selected for conducting this study.
3. The results of the study may not be universally applicable

## LITERATURE REVIEW

**Varadharajan and Ganesh (2012)** applied the SIM on equity portfolio of large caps companies of selected sectors in India. The main aim of this study is to find out the optimum portfolio from the selected companies in three major sectors like power sector, shipping sector and textile sector. From each sector six companies have been selected and so a total of eighteen companies are selected as samples. The companies with the largest market capitalization in each sector have been selected. Data for five financial years were used for constructing the portfolio; i.e. from 1<sup>st</sup> April 2006 to 31<sup>st</sup> march 2011. All calculations have been done using MS Excel. From the analysis it was found that only five companies were included in the portfolio constructed out of the eighteen companies.

**Tripathy, Sasikanta (2011)** applied the model on selected Indian banks' scrips. The author assumed that there is a positive relationship between the banked and individual stocks. Fifteen securities selected of the banks comprised in BANKEX as a sample. The data is based on secondary source for the period from 1<sup>st</sup> April 2011 to 31<sup>st</sup> march 2012. It was found that



there is a linear relationship between security returns and the common factor that there is no difference among the return of all the banks from the ANOVA.

**Dileep and Rao, Kesava (2013)** studied the applicability and utility of the Single Index Model in the Indian context and also evaluated the performance of the portfolio thus constructed in terms of its rate of return. A sample of thirty companies belonging to various sectors was chosen for study and the data required for this study was collected from secondary sources. It was found that only four companies were included in portfolio construction. The study concluded that William Sharpe's Single Index Model will be sustainable and applicable to the Indian market where investors can construct a portfolio for improving the expected returns on their investment.

**Mandal, Niranjan (2013)** applied Sharpe's Single Index Model considering the daily prices of twenty one securities for the period of ten years i.e. April 2001 to March 2011. In order to determine the daily market return, the BSE Sensex was taken as the market performance index. After formulating the cut-off rate, those securities whose  $C_i$  values greater than the cut-off point were selected. Then to arrive at the optimal portfolio the proportion of investment in each of the selected securities in the optimal portfolio was computed on the basis of beta value, unsystematic risk, excess return to beta ratio and the cut off rate of the security concerned. Different statistical tools and techniques charts and diagrams have been used for the purpose of analysis and interpretation of data. From the samples of twenty one securities an optimum portfolio was constructed using ten securities. From the study it is observed that the Sharpe's Single Index Model gives an easy mechanism for constructing an optimal portfolio of stocks for a rational investor by analyzing the reason behind the inclusion of securities in the portfolio with their respective weights.

**Kumar, Arun and Manjunatha (2013)** presented an approach to the portfolio selection based on Sharpe's Single Index Model. The main objective of the study is to analyze the performance of securities based on aggregate weighted average of EPS, Sales and net profit. The secondary data has been collected from websites. Stocks covered in S&P CNX Nifty are taken out for analysis. The yearly data for five years has been taken. The securities which top on aggregate weighted average have been selected for the constructing portfolio. For analyzing the securities various statistical tools like weighted average, simple average, standard deviation, regression analysis, systematic and unsystematic risk are used. Out of



the fifty companies in S&P CNX Nifty only six securities were selected for the optimal portfolio construction. The percentage of investment to be made in the selected securities has been calculated using Sharpe's Single Index Model. The study reveals that stock prices and market index move in the same direction.

**Sarker, Mokta Rani (2013)** conducted a study to construct an optimal portfolio using Sharpe's Single Index Model considering no short sales. The study has been conducted on individual securities listed in Dhaka Stock Exchange, where short sales are not allowed. The monthly closing prices of one hundred and sixty four companies listed in Dhaka Stock Exchange and share price index for the period of July 2007 to June 2012 have been considered in this study. This method formulates a unique cut-off point, selects stocks having excess return to beta ratio surpassing this cut-off point and determines the percentage of investment to be made in in each of selected stocks. The optimum portfolio consists of thirty three stocks selected out of one hundred and sixty four stocks giving the return of 6.17%. From this empirical analysis to some extent, an investor can forecast individual securities return through the market movement and can make use of it.

**Gopalakrishna, Muthu (2014)** explains the investment alternatives available for rational investor. A comparison of traditional portfolio theory with that of modern portfolio theory is made in this study. This study aims to test whether single index model offers an appropriate explanation of stock returns on IT stocks. The samples included in this study consists of 13 actively traded scrips listed in the National Stock Exchange Limited, Bombay (NSE).The scrips in the sample are selected from NSE IT index. The secondary data for a period 2004-2008 has been used for the study. By applying regression on the market return and excess security return it is found that IT index has a phenomenal amount of sensitiveness over S&P CNX Nifty. The study investigated that there are four aggressive stocks having beta coefficient of more than one. It is recommended that among the sample companies all the stocks are undervalued except one stock and thus the investors can pick these stocks to revise their portfolio.

**Desai, Radhika and Surti, Manisha (2013)** constructed an optimal portfolio using fifty companies which were listed on the NSE and the time duration of the study is three years. Among the fifty companies only ten companies were selected for the optimum portfolio. The proportion of investment made in each security has been calculated using the Sharpe's



Single Index Model. The volatility of security has been analysed. The research provides direction to investors regarding performance of securities. Once the performance is analysed and optimum portfolio of securities is constructed, it enables the investor to take appropriate decisions.

**Andrade, Pratibha Jenifer (2012)** aimed at developing an optimal portfolio of equity of IT sector through Sharpe's Single Index Model. In this study, a sample of six top performing IT companies traded in BSE has been chosen. The data related to the daily returns of the securities and the market index has been collected through secondary sources. Data has been collected for a period of three years i.e. 2009 to 2011. It was found that the optimal portfolio has been constructed with five companies.

**Debasish, Satya Swaroop and Khan, Jakki Samir (2012)** selected a sample fourteen stocks from the various manufacturing sectors like automobiles, cement, paints, textiles oil & refineries and these are traded in the NSE. The daily data for all the stocks for the period Jan 2003 to November 2012 has been considered. Percentage of investment in each of selected stock is decided based on respective beta value, stock movement variance unsystematic risk, return on stock risk free return. Among the fourteen selected companies an optimal portfolio using Sharpe's Single Index Model constituted only three stocks. The proportion of investment to be made was also calculated using Single Index Model.

Thus, the literature survey made for the present study showed that there is enough scope for studying the utility of Sharpe's Single Index Model under the Indian conditions especially considering the securities of companies traded through the BSE which is one of the oldest stock exchange in the world and which is considered as one of the major attractions to any investor, either individual or institutional.

### **SHARPE'S SINGLE INDEX MODEL**

Sharpe's Model proposes that the relationship between each pair of securities can indirectly be measured by comparing each security to a common factor 'market performance index' that is shared amongst all the securities. This helps in reducing the burden of large input requirements and difficult calculations required in Markowitz's mean-variance approach. While Markowitz Model requires  $n(n-1)/2$  data inputs, the Sharpe's Model requires only  $(3n+2)$  data inputs, namely, the estimates of returns for each security, estimates for expected return on market index and estimates of variance of return. This forms the



essence of Sharpe's Model which has made financial analysts and researchers to consider it superior to the Markowitz Model.

### ASSUMPTIONS OF SIM

The Sharpe's Single Index Model is based on the following assumptions:

1. The expectations of all investors are homogeneous in nature.
2. A uniform holding period is used in estimating risk and return for each security.
3. The price movements of a security is not only dependent upon the nature of the other securities. They are also dependent on the general business and economic conditions.
4. The indices, to which the returns of each security are correlated, are likely to be some securities' market proxy.
5. The random disturbance terms ' $e_i$ ' has an expected value zero (0) and a finite variance. It is not correlated with the return on market portfolio ( $R_m$ ) as well as with the error term ( $e_i$ ) for any other securities.

### CONSTRUCTION OF AN OPTIMAL PORTFOLIO USING SIM

Generally, most of the stock prices over a period of time move with the market index. Fund managers do selection of securities based on the management efficiency and security analysis which is done considering various parameters like the turnover of company, its profit margin, DPS, EPS, return on investment and the like.

The rate of return of the stocks included in portfolio, using daily closing prices of each company is computed using the formula:

$$R_i = \frac{(P_t - P_o)}{P_o} \times 100$$

Where,

$P_t$  = current year price

$P_o$  = previous year price.

- The rate of return of the Sensex index may be computed using daily closing points as under:

$$R_m = \frac{(P_t - P_o)}{P_o} \times 100$$



Where,

P<sub>t</sub> = current year price.

P<sub>o</sub> = previous year price.

- Beta, to evaluate the risk.

$$\beta = \frac{\sum (R_m - \bar{R}_m) (R_i - \bar{R}_i)}{(R_m - \bar{R}_m)^2}$$

Where,

$\beta$  = beta

R<sub>m</sub> = return of market index

$\bar{R}_m$  = mean of market index

R<sub>i</sub> = return of individual stock

$\bar{R}_i$  = mean of individual stock

- The excess return to Beta is computed using following formula:

$$\frac{R_i - R_f}{\beta}$$

The securities are ranked according to this ratio.

- The variance of the index movement is computed as under:

$$\sigma^2 = \frac{\sum (R_m - \bar{R}_m)^2}{N-1}$$

- The variance of the Stock price movement is computed as under:

$$\sigma^2 = \frac{\sum (R_i - \bar{R}_i)^2}{N-1}$$

- The systematic and unsystematic risks are computed as under:

$$\text{Systematic risk} = \beta^2 \sigma_m^2$$

$$\text{Unsystematic risk} = \sigma_{ei}^2 - \text{Systematic risk}$$

- C<sub>i</sub> values for all the stocks according to the ranked order is computed using the following formula:



$$C_i = \frac{\sigma_m^2 \sum_{i=1}^N \frac{(R_i - R_f)\beta_i}{\sigma_{ei}^2}}{1 + \sigma_m^2 \sum_{i=1}^N \frac{\beta_i^2}{\sigma_{ei}^2}}$$

$\sigma_{ei}^2$  = unsystematic risk

$\beta$  = beta value of individual security

$\sigma_m$  = market index risk

$R_i - R_f$  = excess return

- $X_i$  and  $Z_i$  are to be determined to know how much funds needs to be invested in each security using the following formula:

$$X_i = \frac{Z_i}{\sum_{i=1}^N Z_i}$$

Where,

$X_i$  = proportion of investment

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

$\sigma_{ei}^2$  = unsystematic risk

$\beta$  = beta value of individual security

$R_i - R_f$  = excess return

$C^*$  = cut off point

## MERITS OF SHARPE'S SINGLE INDEX MODEL

The following are the merits of SIM:

- The model is simple to understand and easy to apply.
- If one has 'n' securities at his disposal, it requires only (3n+2) estimates but Markowitz's model requires  $n(n-1)/2$  estimates.
- It provides an estimate of security's return as well as of the index value.
- It greatly helps in obtaining the following inputs required for applying the Markowitz's model:
  - The expected return on each security
  - The variance of return on each security
  - The covariance of return between each pair of securities



- e) This provides reason for either the 'inclusion' or the 'exclusion' of a security in while constructing an optimal portfolio.

### LIMITATIONS OF SIM

- a. The Single Index Model proposed by William Sharpe does not consider uncertainty in the market as time progresses; instead the model optimizes for a single point in time.
- b. This model assumes that security prices move together only because of common co-movement with the market. But there are influences beyond the general business and market conditions, like industry-oriented factors that also influence movement of securities together.

### DATA ANALYSIS AND INTERPRETATION

This part of the paper brings out data analysis and interpretation relating to the present study. The data required for this study has been collected from secondary source. Fifteen companies listed under S&P BSE Sensex have been selected for the study. The chosen companies belong to various respective sectors. They have been presented below:

**Table 4.1: Sample Companies**

Sl . no	Company name
1	Axis Bank Limited
2	Bajaj Auto Limited
3	Cipla Limited
4	Housing Development Finance Corporation Limited
5	Hero Motocorp Ltd.
6	Dr. Reddy's Laboratories Ltd.
7	Hindustan Unilever Limited
8	Industrial Credit and Investment Corporation of India Bank
9	Infosys Limited
10	ITC Limited
11	Larsen & Toubro Limited
12	Maruti Suzuki India Limited
13	Oil and Natural Gas Corporation Limited
14	Tata Consultancy Services Limited
15	Wipro Limited

Table 4.1 represents the list of sample companies selected for the purpose of this study. The historical stock prices pertaining to the above companies for six years (2009-2014) were



collected from [www.moneycontrol.com](http://www.moneycontrol.com). The returns of the individual securities and market index are calculated using the following formulae :

$$\text{Security Return} = \frac{\text{Current Year Security Price} - \text{Previous Year Security Price}}{\text{Previous Year Security Price}} \times 100$$

$$\text{Index Return} = \frac{\text{Current Year Index} - \text{Previous Year Index}}{\text{Previous Year Index}} \times 100$$

- Mean Returns of the securities and index are calculated using the following formulae

- $\bar{R}_i = \sum R_i / N$

- $\bar{R}_m = \sum R_m / N$

Where,

$\bar{R}_i$  = mean of individual security returns

$R_i$  = individual security returns

$\bar{R}_m$  = mean of market index returns

$R_m$  = market index returns

$N$  = number of returns

S&P BSE SENSEX is the index selected as benchmark index for the present study. A sample of fifteen companies listed under this index was selected for constructing an optimal portfolio using Sharpe's Single Index Model. As a first step, the mean returns of these companies' stocks were computed and tabulated as under:

**Table 4.2: Mean Returns of Sample Companies' Stocks**

Sl . no	Scrip Name	Mean Return (in %)
1	Axis Bank Limited	12.93
2	Bajaj Auto Limited	21.01
3	Cipla Limited	3.9
4	Dr. Reddy's Laboratories Ltd.	20.89
5	Housing Development Finance Corporation Limited	19.15
6	Hero Motocorp Ltd.	4.43
7	Hindustan Unilever Limited	17.27
8	Industrial Credit and Investment Corporation of India Bank	12.51
9	Infosys Limited	8.29
10	ITC Limited	23.95
11	Larsen & Toubro Limited	8.60



12	Maruti Suzuki India Limited	8.29
13	Oil and Natural Gas Corporation Limited	2.12
14	Tata Consultancy Services Limited	26.61
15	Wipro Limited	8.16

Source: Computed and compiled by the author

Table 4.2 shows the mean returns of the fifteen companies selected for the construction of an optimal portfolio using Sharpe's Single Index Model. This table reveals that Tata Consultancy Services has the highest return of 26.61% and ONGC company has the lowest mean return of 2.12%.

In order to know the market risk face by each security, the beta values of sample companies' stock returns were computed and tabulated below.

**Table 4.3: Beta values of the Sample companies' Stocks**

Sl . no	Scrip Name	Beta values
1	Axis Bank Limited	2.01
2	Bajaj Auto Limited	0.93
3	Cipla Limited	0.76
4	Dr. Reddy's Laboratories Ltd.	0.72
5	Housing Development Finance Corporation Limited	1.24
6	Hero Motocorp Ltd.	0.22
7	Hindustan Unilever Limited	-0.09
8	Industrial Credit and Investment Corporation of India Bank	1.92
9	Infosys Limited	0.56
10	ITC Limited	0.55
11	Larsen & Toubro Limited	1.95
12	Maruti Suzuki India Limited	1.51
13	Oil and Natural Gas Corporation Limited	0.55
14	Tata Consultancy Services Limited	0.70
15	Wipro Limited	0.62

Source: Computed and compiled by the author

Table 4.3 shows the beta values of the fifteen companies' stock returns. A beta below 1 indicates either an investment in stocks with lower volatility than the market, or a volatile investment whose price movements are not highly correlated with the market. The Axis bank has the highest beta value of 2.01 which means it is highly volatile. HDFC (1.24), ICICI Bank (1.92), Larsen and Toubro (1.95) and Maruti Suzuki (1.51) have the beta values greater than 1 which means they are volatile. HUL has negative beta i.e.-0.09 which represents lower volatility. The beta values were calculated using the following formula:



$$\beta = \frac{\sum (R_m - \bar{R}_m) (R_i - \bar{R}_i)}{(R_m - \bar{R}_m)^2}$$

Where,

$\beta$  = beta

$R_m$  = return of market index

$\bar{R}_m$  = mean of market index

$R_i$  = return of individual stock

$\bar{R}_i$  = mean of individual stock

**Table 4.4: Ranking of the Stocks based on Excess Return to Beta Ratio**

Sl no.	Company name	$R_i$	$R_i - R_f$	$\beta$	$\frac{R_i - R_f}{\beta}$	Rank
1	Axis Bank Limited	12.93	4.93	2.01	2.45	6
2	Bajaj Auto Limited	21.01	13.01	0.93	13.98	4
3	Cipla Limited	3.9	-4.10	0.76	-5.39	12
4	Dr. Reddy's Laboratories Ltd.	20.89	12.89	0.72	17.9	3
5	Housing Development Finance Corporation Limited	19.15	11.15	1.24	8.99	5
6	Hero Motocorp Ltd.	4.43	-3.57	0.22	-16.23	14
7	Hindustan Unilever Limited	17.27	9.27	-0.098	-94.59	15
8	Industrial Credit and Investment Corporation of India Bank	12.51	4.51	1.92	2.34	7
9	Infosys Limited	8.29	0.29	0.56	0.52	8
10	ITC Limited	23.95	15.95	0.55	29.00	1
11	Larsen & Toubro Limited	8.60	0.60	1.95	0.31	9
12	Maruti Suzuki India Limited	8.29	0.29	1.51	0.19	11
13	Oil and Natural Gas Corporation Limited	2.12	-5.88	0.55	-10.69	13
14	Tata Consultancy Services Limited	26.61	18.61	0.70	26.97	2
15	Wipro Limited	8.16	0.16	0.62	0.26	10

Source: Computed and compiled by the author



Table 4.4 depicts the excess return and excess return to beta ratio. Excess return is the difference between expected return on the stock and the risk free rate of interest. The risk free rate of interest is assumed to be 8% in this study. The excess return to beta ratio measures the additional return on a security per unit of systematic risk. Table 4.4 shows that the ITC stock has the highest excess return to beta ratio of 29 while that of HUL stock has the lowest of -94.59. This ratio provides the relationship between potential risk and reward from a company's stock. The ranking of stocks done on the basis of excess return to beta ratio reveals that while the ITC stock ranks first, the HUL stock ranks the last.

In addition to the systematic risk of individual securities, their unsystematic risk as measured by  $\sigma_{ei}^2$ 's also computed and tabulated in the Table 4.5. It is the unique risk affecting the firm due to certain factors affecting only the company issuing such security. It is an avoidable or controllable risk. The companies are listed in this table based on their ranks. The excess return is divided by the unsystematic risk  $\sigma_{ei}^2$  and multiplied by the beta in order to calculate the 'C<sub>i</sub>' values. The Unsystematic risk is calculated using the following formula:

$$\sigma_{ei}^2 = \sigma^2 - \beta^2 \sigma_m^2$$

where,

$\sigma_{ei}^2$  = unsystematic risk

$\sigma^2$  = individual security risk

$\beta$  = beta value of individual security

$\sigma_m^2$  = expected variance of market index

**Table 4.5: Sample Companies based on their Ranks and Unsystematic Risk**

Rank	Company name	$\sigma_{ei}^2$	$(R_i - R_f / \sigma_{ei}^2) \beta$	Cumulative of $(R_i - R_f / \sigma_{ei}^2) \beta$
1	ITC Limited	129.07	0.0679	0.0679
2	Tata Consultancy Services Limited	1039.87	0.0123	0.0802
3	Dr. Reddy's Laboratories Ltd.	241.93	0.0384	0.1186
4	Bajaj Auto Limited	852.58	0.0142	0.1328
5	Housing Development Finance Corporation Limited	248.01	0.0557	0.1885
6	Axis Bank Limited	206.13	0.0481	0.2366
7	Industrial Credit and Investment Corporation of India Bank	200.09	0.043	0.2796



8	Infosys Limited	860.85	0.0002	0.2798
9	Larsen & Toubro Limited	191.70	0.0061	0.2859
10	Wipro Limited	392.07	0.0001	0.2860
11	Maruti Suzuki India Limited	449.81	0.0010	0.2870
12	Cipla Limited	64.48	-0.048	0.2390
13	Oil and Natural Gas Corporation Limited	53.78	-0.060	0.1790
14	Hero Motocorp Ltd.	45.66	-0.017	0.1620
15	Hindustan Unilever Limited	162.91	-0.0056	0.1564

Source: Computed and compiled by the author

Table 4.5 reveals that out of fifteen companies, Wipro Ltd has the highest value of 1073.75 and Hero Motocorp has the less risk of 45.66. As a next step the 'C<sub>i</sub>' was computed and tabulated below:

**Table 4.6: C<sub>i</sub> of Sample Companies' Stocks**

Rank	Company name	$\beta^2 / \sigma_{ei}^2$	Cumulative of $\beta^2 / \sigma_{ei}^2$	C <sub>i</sub>
1	ITC Limited	0.0043	0.0043	9.69
2	Tata Consultancy Services Limited	0.00045	0.0047	10.81
3	Dr. Reddy's Laboratories Ltd.	0.0021	0.0068	12.48
4	Bajaj Auto Limited	0.0010	0.0078	<b>12.64 C*</b>
5	Housing Development Finance Corporation Limited	0.0062	0.014	6.23
6	Axis Bank Limited	0.0196	0.0336	6.51
7	Industrial Credit and Investment Corporation of India Bank	0.0184	0.052	5.11
8	Infosys Limited	0.00036	0.0524	5.08
9	Larsen & Toubro Limited	0.198	0.072	3.83
10	Wipro Limited	0.00036	0.0725	3.80
11	Maruti Suzuki India Limited	0.0051	0.0776	3.57
12	Cipla Limited	0.0089	0.0865	2.68
13	Oil and Natural Gas Corporation Limited	0.0056	0.092	1.89
14	Hero Motocorp Ltd.	0.0011	0.0932	1.69
15	Hindustan Unilever Limited	0.0001	0.0933	1.63

Source: Computed and compiled by the author



Table 4.6 represents the  $C_i$  of sample companies. The  $\beta^2 / \sigma^2_{ei}$  and its cumulative are necessary for the calculation of  $C_i$ . The  $C_i$  value goes on increasing from 9.69 to 12.64 and thereafter, starts declining. Therefore, the value of 12.64 is considered as the 'cut-off point'. The securities which come after the cut-off point will not be considered for the optimal portfolio construction. The  $C_i$  is calculated and tabulated as under:

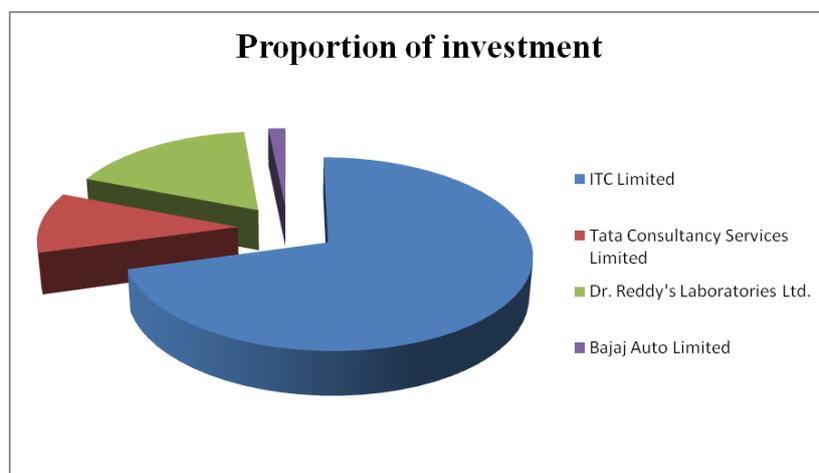
**Table 4.7: Proportion of Investment Proposed**

Rank	Script Name	$C_i$	$Z_i$	$X_i$
1	ITC Limited	9.69	0.06380	70.88
2	Tata Consultancy Services Limited	10.81	0.00945	10.08
3	Dr. Reddy's Laboratories Ltd.	12.48	0.01567	17.41
4	Bajaj Auto Limited	12.64 $C^*$	0.00147	1.63
			$\sum Z_i = 0.09039$	$\sum X_i = 100.00$

Source: Computed and compiled by the author

Table 4.7 represents the proportion of investment to be made in each security. The four securities ranking from 1 to 4 are selected for the optimal portfolio. The percentage of funds to be invested in each security is presented in figure 4.1:

**Figure 4.1: Proportion of Investment Proposed**



In a sample of fifteen companies four companies have been selected for the optimal portfolio construction applying SIM. Once the companies on which investment is to be made are known it is essential to know the proportion of investment to be made in each company's security. Figure 4.1 represents the proportion of investment to be made by the investor to earn maximum returns. The figure shows that 70.88% of investment may be



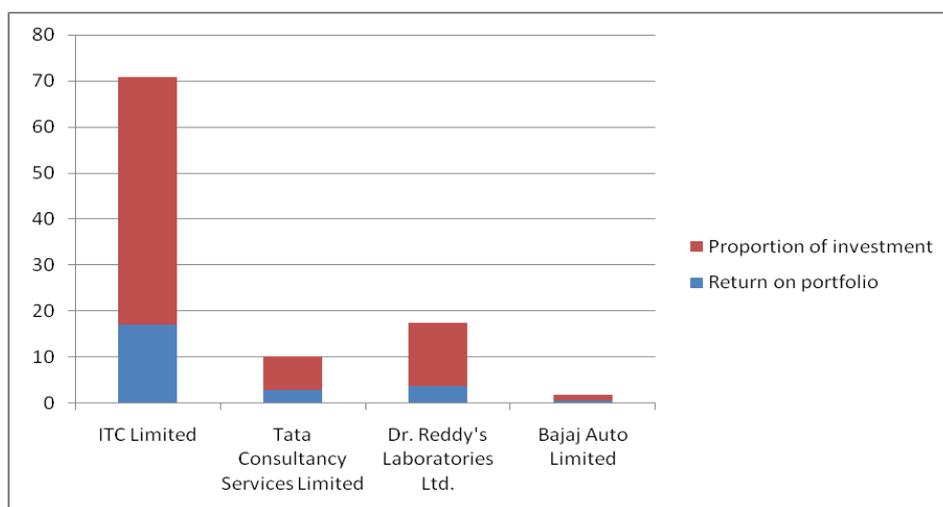
made in the ITC stock % (which means majority of the funds is to be invested on this company's stock), followed by 17.41 % in Dr. Reddy's Laboratories Ltd , 10.08 % in Tata Consultancy Services Ltd, and 1.63% in Bajaj Auto Limited stock. A look at the individual security returns from these stocks as well as their respective returns on portfolio is also presented below:

**Table 4.8: Return on Portfolio**

Company name	$X_i$	Returns (in %)	Return on portfolio %
ITC Limited	70.88	23.95	16.98
Tata Consultancy Services Limited	10.08	26.61	2.68
Dr. Reddy's Laboratories Ltd.	17.41	20.89	3.64
Bajaj Auto Limited	1.63	21.01	0.34
<b>Total Return on portfolio</b>	<b><math>\sum X_i = 100.00</math></b>		<b>23.64</b>

Source: Computed and compiled by the author

Table 4.8 represents the proportion of investment, individual security return and the returns on portfolio. The returns on portfolio are calculated based on the proportion of investment in each security. The highest return on portfolio is from the ITC company i.e.16.98% and the lowest is Bajaj Auto i.e. 0.34%. Total return from the optimal portfolio is 23.64%. When one looks at the individual returns from the stocks in the above portfolio, it may be observed that the ITC and Tata Consultancy Services companies' security returns are higher than the portfolio return. On the other hand, Dr. Reddy's scrips and Bajaj Auto's scrips' returns are less than the portfolio return. Thus, the inclusion of stocks in a portfolio is beneficial to companies despite the fact that expected returns from individual stocks is less.



**Figure 4.2: Proportion of Investment and Return on portfolio**



Figure 4.2 depicts the proportion of investment to be made in individual security and the portfolio returns. ITC has the highest portfolio return and Bajaj Auto has the lowest portfolio return. If the investor invests on the above constructed portfolio, his total expected portfolio return is 23.64%.

Thus, the Sharpe's Single Index Model is useful to investors and helps the fund managers in deciding about the securities to be included in his portfolio to derive the best benefits of diversification.

## FINDINGS

The findings of the present study are presented below:

1. The Tata Consultancy Services Limited has the highest return of 26.6% and the Oil and Natural Gas Corporation Limited has the lowest return of 2.12%. If the investor wants to earn a maximum return without considering the risk aspect then investment can be made on those securities which yield high returns. Even though the return is high, the risk involved in the stock return should be considered while taking investment decisions.
2. The risk can be reduced if the portfolio is diversified. The point of diversity is to achieve a given level of expected return while bearing the least possible risk.
3. The return from Axis bank security has the highest beta value of 2.01 which means that it is highly volatile. Housing Development Finance Corporation Limited (1.24), Industrial Credit and Investment Corporation of India Bank Bank (1.92), Larsen & Toubro Limited (1.95) and Maruti Suzuki India Limited companies' stock returns (1.51) have the beta values greater than 1 which means that they are also volatile. But, they are less volatile compared to the Axis Bank security's return.
4. The excess return to beta ratio measures the additional return on a security per unit of systematic risk. The ITC Limited 's stock return has the highest excess return to beta ratio of 29 and that of Hindustan Unilever Limited is the lowest at -94.59. This ratio provides the relationship between potential risk and reward involved in a security's return.
5. The Wipro Limited's stock return has the highest unsystematic risk  $\sigma_{ei}^2$  of 1073.75 and that of the Hero Motocorp Ltd. has the least risk of 45.66. It is the unique risk



affecting the firm due to certain factors affecting only the company issuing such security. It is the avoidable risk.

6. The four securities ranking from 1 to 4 based on the  $C_i$  values were identified along with the proportion of investment to be made. The proportion of the investment to be made is 70.88% in ITC Limited 's stock, 10.08% in Tata Consultancy Services Limited ' stock, 17.41% in Dr Reddys Laboratories Ltd. and 1.63% in Bajaj Auto Limited company's stock. This implies that the majority of funds may be invested on the ITC company's stock.

## CONCLUSION

Constructing an optimal portfolio is a challenging task for the individual as well as the institutional investors. This paper made an attempt to construct an optimum portfolio using the Sharpe's Single Index Model. Among the fifteen sample companies, only four were selected for optimal portfolio. The final decision of investing should be made only after considering all the factors affecting the securities. These can be general economic factors or any other macroeconomic factors which govern the movement and action of the movement of these securities in the market. Many micro studies of this kind need to be conducted considering different types of samples. The results of the present study and such micro level studies have more utility value to the fund managers of emerging economies like India where the capital markets are still in their developing stages and many foreign institutional investors are also interested to invest in the leading stocks traded through the stock exchanges of these countries.

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