

Application of the Sharpe's Single Index Model for Optimal Portfolio Construction

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Abstract – The main purpose of this paper is to construct an optimal portfolio by applying Sharpe's single-index model. The present study is based on the secondary data. For the purpose of constructing an optimal portfolio, a sample of top fifteen stocks listed on Bombay Stock Exchange (BSE) was selected in this study. BSE Sensitive Index (Sensex) has been used as market index. Monthly closing prices of selected stocks as well as market index for the period of April 2011 to March 2017 were used in this study. A unique cut off point was computed. The results of the study have been constructed an optimal portfolio. The findings of the study will be useful for investors and practically related for the purpose of investing.

Keywords: Stock Market, Sharpe's Single Index Model, Optimal Portfolio, Beta

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INTRODUCTION

Harry Markowitz in which he made a simple premise that almost all investors invest in multiple securities rather than in a single security, to get the benefits from investing in a portfolio consisting of different securities. In this theory, he tried to show that the variance of the rates of return is a meaningful measure of portfolio risk under a reasonable set of assumptions and also derived a formula for computing the variance of a portfolio. His work emphasizes the importance of diversification of investments to reduce the risk of a portfolio and also shows how to diversify such risk effectively. Although Markowitz's model is viewed as a classic attempt to develop a comprehensive technique to incorporate the concept of diversification of investments in a portfolio as a risk – reduction mechanism, it has many limitations that need to be resolved. One of the most significant limitations of Markowitz's model is the increase d complexity of computation that the model faces as the number of securities in the portfolio grows (Mandal, 2013). Modern Portfolio Theory (MPT) or portfolio theory was introduced by Harry Markowitz with his paper "Portfolio Selection," which appeared in the 1952 Journal of Finance. Using diversification, Markowitz proposed that investors focus on selecting portfolios based on their overall risk-reward characteristics instead of merely compiling portfolios from securities that each individually has attractive risk-reward characteristics. In a nutshell investors should select portfolios and not individual securities (Chitnis 2010). The construction of an optimal portfolio by applying Sharpe's single index model is an important process because it is a process of choosing securities in that way for earning

maximum return at a minimum level of risk. Thus, the main purpose of this paper is to construct an optimal portfolio by applying Sharpe's single index model.

REVIEW OF THE LITERATURE

Review of some of the studies is presented in the following discussion: -

Paudel (2006) tested the Markowitz and Sharpe model of portfolio selection to Nepalese stocks by applying a sample of 30 stocks traded in Nepalese stock market. The study used the period of FY 1997/98 to Mid-May 2006 and the selection of the companies in this study was based on the criteria that were the study selected those companies whose stocks were listed before the FY 1996/97. The study revealed that the application of these models provided better opinion for the selection of optimal portfolio.

Another study conducted by **Terol et al. (2006)** in their study selecting the optimal portfolio with the help of fuzzy programming and the Sharpe's single index model. The study considered the quarterly data for the period of 1999-2003. The study provided some of the improvement of the portfolio selection models.

Kapusuzoglu (2008) in their study calculated alpha, beta and correlation coefficients and also explained their effects. The study also explained stock-index relationship on the basis of single factor.

On the other hand **Chitnis (2010)** constructed two optimal portfolios by applying Sharpe's single index

model of capital asset pricing. The study used monthly stock prices from 1 April 2004 to 31 March 2009. The study constructed two optimal portfolios from a different sample size of 26 stocks and the each were selected from the securities listed on National Security Exchange. The study defined a cutoff point by applying Sharpe's single index model. In the study Nifty 50 as considered the market index and performance of two optimal portfolios evaluated on the basis of Sharpe's ratio.

Taneja and Bansal (2011) evaluated the Sharpe's single index model in order to choose optimum portfolio. The study used the weekly adjusted share prices of securities from the period of April 2004 to March 2009. The results of the study concluded that the Single Index Model had been successfully to research at the optimum portfolio by diversifying all the unsystematic risk.

Telebnia et al. (2011) showed that small companies have greater beta and average return as compared to large companies and the study found that Fama & French model has sound for selecting an optimal portfolio and VaR model was not sound for selecting an optimal portfolio.

On the other hand, **Varadharajan and Vikkraman (2011)** study constructed an optimal portfolio by using the Sharpe's single index model. The study used 25 stocks for different five sectors namely oil & gas, IT, banking, steel and communication sector. The study used those stocks that are listed in National Stock Exchange (NSE). The results of the study showed risk and return are directly proportional to each other and suggested that investors should be made in stocks that have relatively lower beta and higher returns.

Mandal (2013) in their study used the Sharpe's Index model for the purpose of constructing the optimal portfolio. The study used the BSE SENSEX as market performance index and the study used the data for the period April 2001 to March 2011, the proposed method formulates a unique cut-off rate and selects those securities to construct an optimal portfolio whose excess return to beta ratio is greater than the cut-off rate. Then, proportion of investment in each of the selected securities is computed on the basis of beta value, unsystematic risk, and excess return to beta ratio and cut-off rate of each of the securities concerned. The results of the study showed that the non-performing assets has increased drastically for the US bank for the period of 2008-2010.

Sen and Fattawat (2014) studied the Sharpe's Single Index Model and its application for portfolio construction. The study used the data from the period of January 2010 to December 2013 on monthly basis in BSE Sensex as market performer. In the study, the method was formulated a unique cut off rate and select those securities whose excess return to beta ratio was greater than a cut off rate then proportion of investment in each selected securities decided on the

basis of the beta value, unsystematic risk, excess return to beta ratio and cut off rate of each security was concerned. The study revealed that there was a significant difference between the total risk of the portfolio calculated under two different mechanism found in Sharpe's Index Model and Markowitz Model. It was observed that the total risk was found to be 2.21 percent in Markowitz Model whereas the total risk of the optimal portfolio was 1.3874 percent.

Marry and Rathika (2015) used the Sharpe's single index model for the purpose of optimal portfolio's construction. The study used the period from September 2010 to September 2014. The study used the Sharpe's Single Index Model with the help of monthly closing prices of 10 companies listed in NSE and CNX PHARMA price index. The study revealed that out of ten companies only one company was selected for investment purpose on the basis of cut off point which was -0.011182.

Shah (2015) in their study constructed the optimal portfolio with the help of Sharpe's single index model and Capital Asset Pricing Model (CAPM). The study used the top 15 BSE securities on the basis of their market capitalization. The study used the period from January 2000 to March 2015. The results of the study concluded that as per Sharpe model, the portfolio will consist of 5 securities and its weight age of investment was include namely HDFC Bank Ltd. 43.39% , HDFC Ltd. 30.03%, ICICI Bank Ltd. 18.23%, TCS Ltd. 3.89%, and TATA Motors Ltd. 4.47%. The study also concluded that as per the Capital Asset Pricing Model 11 securities were undervalued and would be profitable for investor if he invest in them.

OBJECTIVE OF THE STUDY

The present study is concerned with the following objective:

- To construct an optimal portfolio by applying Sharpe's single index model.

DATA BASE AND RESEARCH METHODOLOGY

The present study is based on the secondary data. For the purpose of constructing an optimal portfolio, a sample of top fifteen stocks listed on Bombay Stock Exchange (BSE) was selected in this study. The stocks were selected on the basis of their market capitalization. BSE Sensitive Index (Sensex) has been used as market index. Monthly closing prices of selected stocks as well as market index for the period of April 2011 to March 2017 were used in this study. The data relevant for this study has been collected from the Centre for Monitoring of Indian Economy (CMIE) prowess database software. In this study, 364-days Treasury bill rate is considered as risk free rate of return. In the study, the Sharpe's single index model has been applied for constructing an optimal portfolio

and according to this model a unique cutoff rate was computed.

Sharpe's Model for optimal portfolio

The single index model is as follows:

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

Where, R_i is the expected return on security i, α_i is the intercept, R_m is the return on market index. β_i is the slope, e_i is the error term.

The following steps used in this study to construct an optimal portfolio:

1. Firstly find the excess return to beta ratio for each stock.
2. Ranked them each stock from the highest to lowest.
3. Calculated the cutoff point. The value of cutoff point is given by:

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

Where, C_i is the cutoff point, σ_m^2 is the variance in the market index, σ_{ei}^2 is the stock's unsystematic risk. After that the stocks whose excess return to beta ratio is lower than the cutoff rate are excluded from the portfolio and those stocks whose excess return to beta ratio is higher than the cutoff rate are selected for optimal portfolio.

RESULTS AND ANALYSIS

Expected Return, Variance, Correlation, Unsystematic risk, Alpha and Beta of thirty selected stocks

Table 1 represents the expected return, variance, correlation, unsystematic risk, alpha and beta of thirty selected stocks during the study period. All the selected stocks have represented positive return. It is clear from the table 1 that among the fifteen listed companies HDFC bank Ltd. has the highest expected return and Cipla Ltd. has the lowest expected return during the study period. In the context of beta, the stock of Dr. Reddy's Laboratories Ltd. has the highest

beta and the stock of Sun Bajaj Auto Ltd. has the lowest beta.

Table 1. Expected Return, Variance, Correlation, Unsystematic risk, Alpha and Beta of fifteen selected stocks (April 2011 to March 2017)

Sr. No.	Stock Name	Expected return	Variance	Corr. with market	Beta
1	Adani Ports and Special Economic Zones Ltd.	7.21	11.6	0.78	1.21
2	Asian Paints Ltd.	7.05	8.00	0.62	1.11
3	Axis Bank Ltd.	8.05	5.72	0.51	0.89
4	Bajaj Auto Ltd.	8.32	8.59	0.45	0.45
5	Bharti Airtel Ltd.	7.25	9.45	0.65	0.78
6	Cipla Ltd.	4.85	7.21	0.70	0.99
7	Coal India Ltd.	6.01	6.80	0.49	0.56
8	Dr. Reddy's Laboratories Ltd.	8.74	11.4	0.81	1.33
9	GAIL (India) Ltd.	5.11	7.18	0.55	0.67
10	HDFC Bank Ltd.	17.1	19.44	0.41	0.93
11	Hero Motor Corp. Ltd.	10.91	12.2	0.50	1.20
12	Hindustan Unilever Ltd.	7.76	11.8	0.87	1.31
13	Housing Development Finance Corporation Ltd.	6.75	6.98	0.54	0.79
14	ICICI Bank Ltd.	9.61	11.51	0.62	0.89
15	Infosys Ltd.	7.08	6.98	0.38	0.67

Ranking of stocks on the basis of excess return to beta ratio and the calculation of the cutoff rate

Table 2 shows the ranking of stocks on the basis of excess return to beta ratio and to find out a cutoff point. The cutoff point is computed which help in selecting the optimal portfolio and the stocks whose excess return to beta ratio is lower than the cutoff rate are excluded from the portfolio. It can be observed from table 2 that the unique cutoff rate will be 4.42. It has been found that the first five stocks has excess return to beta ratio is more than the cutoff rate. So the top five stocks make the optimal portfolio.

Table 2. Ranking of stocks on the basis of excess return to beta ratio and the calculation of the cutoff rate

Sr. No.	Stock Name	$\frac{R_i - R_f}{\beta_i}$	$\frac{(R_i - R_f) \beta_i}{\sigma_{ei}^2}$	$\sum_{i=1}^N \frac{(R_i - R_f) \beta_i}{\sigma_{ei}^2}$	$\frac{\beta_i^2}{\sigma_{ei}^2}$	C_i
1	HDFC Bank Ltd	9.65	0.57	0.63	0.08	1.76
2	Hero Motor Corp. Ltd.	8.78	0.88	1.39	0.11	3.30
3	ICICI Bank Ltd.	7.79	0.87	2.20	0.12	4.37
4	Dr.Reddy's Laboratories Ltd.	6.89	0.18	2.39	0.09	4.42
5	Bajaj Auto Ltd..	5.31	0.29	2.59	0.07	4.10
6	Axis Bank Ltd.	2.24	0.38	2.88	0.19	3.79
7	Hindustan Unilever Ltd.	1.38	0.19	2.90	0.17	3.67

FINDINGS

- It is clear from the table 1 that among the fifteen listed companies HDFC bank Ltd. has the highest expected return and Cipla Ltd. has the lowest expected return during the study period. In the context of beta, the stock of Dr. Reddy's Laboratories Ltd. has the highest beta and the stock of Sun Bajaj Auto Ltd. has the lowest beta.
- It can be observed from table 2 that the unique cutoff rate will be 4.42. From table 2 it has been found that the first five stocks have excess return to beta ratio is more than the cutoff rate. So the top five stocks make the optimal portfolio.

CONCLUSIONS

In this paper, Sharpe's single index model has been applied to construct an optimal portfolio. This model has been applied to fifteen listed stocks of Bombay Stock Exchange (BSE) over the study period of April 2011 to March 2017. The results of the study constructed an optimal portfolio. The findings of the study will be useful for investors and practically related for the purpose of investing.

The present study has its limitation in terms of number of stocks and period of the study under studied. In the study only six years data has been considered and the number of stocks was not more and the period of the study was not large.

Further research, should be made to construct an optimal portfolio by applying other asset pricing models.

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