

Constructing Optimal Equity Portfolio of Large Cap Companies using Sharpe's Single Index Model

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Abstract

Portfolio construction is an important process of the investors for investment in the equity market. A good combination of a portfolio will give maximum return for a particular level of risk. This research tries to construct an optimal portfolio in Indian stock market with the help of the Sharpe's single index model. In this research, top 10 stocks of Nifty have been selected on the basis of their market capitalization. The monthly data for all the stocks for the period of April 2010 to December 2016 have been considered. 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, the 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 study finds that four company stocks constitute the optimum portfolio and these are TCS, HUL, ITC, and HDFC bank with ideal proportion of investment of 31%, 30%, 27% and 12% respectively.

Keywords: Beta, Portfolio Construction, Optimal Portfolio, Systematic Risk and Unsystematic Risk.

1. Introduction

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 to this group of securities. But, another problem that exists is that the investor has a problem of deciding which securities to hold and how much to invest in each of them. The key factor that governs portfolio selection is the risk and return characteristics. So, the general trend is that the investor tries to choose the optimal portfolio taking into consideration the risk and return element of all possible portfolios. Portfolio construction is investing in a variety of funds or investment options that work together to meet the requirements of the investor. As the risk element of individual securities, as well as portfolios, change the investor must periodically review and revise the investment portfolios. Here this study is mainly focused on Equity portfolio construction of large cap companies of Nifty. Portfolio constructions are of two types, they are Traditional Approach and Modern Approach. The traditional approach is based on Current Income, Tax Considerations, Capital Appreciation, Liquidity and Safety. The traditional approach usually begins with the analysis of constraints, and then we will determine the objectives of investment. After determining the objectives the type of portfolio is selected. The portfolio can comprise of Bonds and Common Stock or only Bonds or only Common Stocks. After selecting the type of portfolio the risk and return of the selected type are assessed. The last step of Traditional approach is diversification. Similarly, the Modern approach of portfolio construction comprises of three methods. They are Markowitz Model of portfolio construction which was developed by Harry M. Markowitz in 1969, the Sharpe Index Model of portfolio construction developed by William Sharpe and later John Linter and Jan Mossin formulated the development of the Capital Asset Pricing Model of portfolio construction.

An investor invests his funds in a portfolio expecting to get good returns consistent with the risk that he has to bear. The return realized from the portfolio has to be measured and the performance of the portfolio has to be evaluated. It is evident that rational investment activity involves the creation of an investment portfolio. Portfolio management comprises all the processes involved in the creation and maintenance of an investment portfolio. It deals specifically with the security analysis, portfolio analysis, portfolio selection, portfolio revision & portfolio evaluation. Portfolio management makes use of analytical techniques of analysis and conceptual theories regarding the rational allocation of funds. Portfolio management is a complex process which tries to make investment activity more rewarding and less risky. The selection of portfolio depends upon the objectives of the investor. Investment is no longer a simple process. It requires a scientific knowledge, a systematic approach and also professional expertise. Portfolio management is the only way through which an investor can get good returns while minimizing risk at the same time. So the purpose portfolio management objectives can be divided into:

- a) Risk minimization,
- b) Safeguarding capital,
- c) Capital Appreciation,
- d) Choosing optimal mix of securities and
- e) Keeping track on performance.

2. Literature Review

Debasish, (2012) Studied “Optimal Portfolio Construction in Stock Market-An Empirical Study on Selected Stocks in Manufacturing Sectors of India”. The study states that risk and return play an important role in making any investment decisions. This study analyzed the opportunities that are available for investors. Sharpe Single Index model was used to construct the portfolio. The data was collected from NSE Nifty and top 14 stocks were used to construct the portfolio. Based on the calculations, three stocks namely Hero Motor Corp., Tata Motors and Asian Paints were included in the Optimal Portfolio constructed.

Varadharajan and Ganesh, (2012) applied the Single Index Model on equity portfolio of large caps companies of selected sectors in India. They tried 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 1st April 2006 to 31st March 2011. From the analysis it was found that only five companies were included in the portfolio constructed out of the eighteen companies.

Sarker and Rani, (2013) Studied “Optimal Portfolio Construction: Evidence from Dhaka Stock Exchange in Bangladesh”. Sharpe’s single-index model was applied by using the monthly closing prices of 164 companies listed in Dhaka Stock Exchange (DSE) for the period from July 2007 to June 2012. Out of 164 companies taken for the study, 7 companies were showing negative returns and the other 157 companies are showing positive returns. The results are almost similar to the earlier results (e.g. Paudel and Koirala, 2006; Singh, 2007; Kumar, 2011; Elton et al., 1976; and Meenakshi and Sarita, 2012).

Sen and Fattawat, (2014) studied Sharpe’s Single Index Model and its Application Portfolio Construction. Their study reveals that the construction of optimal portfolio investment by using Sharpe’s Single Index Model is easier and more comfortable than by using Markowitz’s Mean-Variance Model.

Naveen, (2014) Studied “Application of Sharpe Single Index Model to BSE”. The study shows that Sharpe gave a road map to construct the optimal portfolio. The study shows that cut off rate plays a vital role in constructing the optimal portfolio. The study also states that investor should continuously monitor his portfolio because market situation keeps on changing so investor should revise his portfolio accordingly.

3. Research Methodology

This is a descriptive study on the construction of a portfolio of stocks. The data taken for this study is of secondary in nature. The data has been collected from the official website of National Stock Exchange (NSE), namely www.nseindia.com. The study is conducted with the monthly financial data for the past six years starting from April 2010 to December 2016. The sample size of the study is limited to monthly stock price series of 10 selected stocks, these stocks are also part of the 50 stocks that constitute NSE Nifty. These stocks have been selected on the basis of their market capitalization.

3.1 Return

The monthly return on each of the selected stocks is calculated with the following formula:

$$R_i = \frac{R_{in}}{R_{in-1}} - 1$$

Where R_{in} , R_{in-1} are the share price at time n and $n - 1$ for security i .

3.2 Sharpe’s Optimal Portfolio

The second phase in the context of testing of Sharpe’s model for selection of appropriate securities in portfolio is used, the average returns of individual returns or portfolio are adjusted to that of risk free return (here 6.34 percent is considered as risk free rate based on the portfolio on 364-day Government of India T-Bills). Therefore to estimate the coefficients with risk free adjusted average return on individual stock and on market risk, the following model is used. The selection of any stock is directly related to its excess return – beta ratio:

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

Where,

R_i = expected return of the stock i

R_f = the return on a riskless asset

β_i = the expected change in the rate of return on stock i associated with one unit change in the market return

The excess return is the difference between the expected return on the stock and the riskless rate of interest such as the rate offered on the government security or Treasury bill. The excess return to beta ratio measures the additional return on a security (excess of the riskless assets return) per unit of systematic risk or non-diversifiable risk. This ratio provides a relationship between potential risk and reward.

Ranking of the stocks is done on the basis of their excess return to beta. Portfolio managers would like to include stocks with higher excess return to beta ratios. The selection of the stocks depends on a unique cut – off rate such that all stocks with higher ratios of $(R_i - R_f) / \beta_i$ are included and the stocks with lower ratios are left out. The cutoff point is denoted by C^* .

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

The highest C_i value is taken as the cut – off point C^* . The stocks ranked above C^* have high excess return to beta than the cut – off C_i and all the stock below C^* has low excess returns to beta. If the number of stock is large, there is no need to calculate the C_i values for all the stocks after the ranking has been done.

It can be calculated until the C^* value is found and after calculating for one or two stocks below it the calculations can be terminated.

Securities are added to the portfolio as long as:

$$\frac{R_i - R_f}{\beta_i} > C_i$$

3.3 Construction of the Optimal Portfolio

After determining the securities to be selected, the investors should find out how much should be invested in each security. The percentage of funds to be invested in each security can be estimated as follows:

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

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

The first expression indicates the weights on each security and they sum up to one. The second shows the relative investment in each security. The residual variance or the unsystematic risk has a role in determining the amount to be invested in each security.

4. Findings & Analysis

The results of the Sharpe Single index model for each of the 10 selected stocks are presented in table-1. It can be seen from the table that TCS yielded the maximum annual returns of 19.21% among the companies selected and Coal India yielded the lowest annual return of -2.25%.

Further, beta is a measure of the systematic risk associated with stock returns and higher beta value signify that the volatility in stock return is high and thus not always desirable. It can be seen from table-1 that with the exception of SBI and HDFC bank (with the beta of 1.51 and 1.09 respectively), the other beta values is less than 1.0. The lowest beta is observed for TCS with the value of 0.28.

According to the Sharpe model, the excess return of any stock is directly related to its excess return to beta ratio. It measures the additional return on a security (excess of the risk less asset return) per unit of systematic risk. The ratio provides a relationship between potential risk and reward. For the calculation of this ratio, the risk free-return (R_f) is taken as the rate of return on the 364 - days Treasury bill which is found to be 6.34% for the period under study. Ranking of the stocks is done on the basis of their excess return to beta. Based on the excess return to beta ratio, the scrip's are ranked from 1 to 10, with TCS being in the first rank and Coal India being in the last.

Table – 1
 Ranking of Securities based on Excess Return to Beta Ratio:

Company	R _i	R _f	R _i – R _f	Beta (β _i)	$\frac{R_i - R_f}{\beta_i}$	Rank
TCS	19.21%	6.34%	12.87%	0.28	46.18%	1
Reliance	3.60%	6.34%	-2.74%	0.95	-2.88%	9
HDFC Bank	18.87%	6.34%	12.53%	1.09	11.54%	4
ITC	16.63%	6.34%	10.29%	0.56	18.44%	3
ONGC	4.75%	6.34%	-1.59%	0.95	-1.68%	8
Infosys	9.60%	6.34%	3.26%	0.61	5.34%	6
HDFC	14.46%	6.34%	8.12%	0.94	8.61%	5
SBI	6.76%	6.34%	0.42%	1.51	0.28%	7
HUL	21.15%	6.34%	14.81%	0.47	31.30%	2
Coal India	2.25%	6.34%	-4.09%	0.71	-5.77%	10

Table – 2
 Calculation of Systematic Risk & Unsystematic Risk:

Company	σ_i^2	Beta	Systematic Risk	Unsystematic Risk (σ_{ei}^2)
TCS	0.544	0.28	0.026	0.518
Reliance	0.712	0.95	0.300	0.412
HDFC Bank	0.549	1.09	0.392	0.158
ITC	0.366	0.56	0.103	0.262
ONGC	0.864	0.95	0.297	0.567
Infosys	0.896	0.61	0.124	0.773
HDFC	0.557	0.94	0.295	0.263
SBI	1.377	1.51	0.755	0.622
HUL	0.614	0.47	0.074	0.540
Coal India	0.790	0.71	0.167	0.623

4.1 Cut-off point

The selection of the stocks depends on a unique cut-off rate such that all stocks with higher ratios of excess return to beta are included and stocks with lower ratio are left out. The cumulated values of C_i start declining after a particular C_i and that point is taken as the cut-off point and that stock ratio is the Cut-off ratio C. The highest value of C_i is taken as the cut-off point that is C*. From table – 3 it is seen that HDFC Bank has the highest the cut-off rate of C* = 10.46.

Table – 3
 Calculation of Ci:

Company	$\frac{R_i - R_f}{\beta_i}$	$\frac{R_i - R_f}{\sigma_{ei}^2} * \beta_i$	$\sum_{i=1}^N \frac{R_i - R_f}{\sigma_{ei}^2} * \beta_i$	$\frac{\beta_i^2}{\sigma_{ei}^2}$	$\sum_{i=1}^N \frac{\beta_i^2}{\sigma_{ei}^2}$	$\frac{\beta_i}{\sigma_{ei}^2}$
TCS	46.186	6.92	6.92	0.15	0.15	0.538
HUL	31.302	12.99	19.91	0.41	0.56	0.877
ITC	18.430	21.90	41.80	1.19	1.75	2.128
HDFC Bank	11.535	86.23	128.04	7.48	9.23	6.882
HDFC	8.615	29.14	157.18	3.38	12.61	3.589
Infosys	5.342	2.57	159.75	0.48	13.09	0.790
SBI	0.278	1.02	160.77	3.66	16.75	2.426
ONGC	-1.681	-2.65	158.11	1.58	18.33	1.670
Reliance	-2.882	-6.32	151.80	2.19	20.53	2.306
Coal India	-5.767	-4.66	147.14	0.81	21.33	1.138

Company	$\frac{R_i - R_f}{\beta_i}$	$\sigma_m^2 \sum_{i=1}^N \frac{R_i - R_f}{\sigma_{ei}^2} * \beta_i$	$1 + \sigma_m^2 \sum_{i=1}^N \frac{\beta_i^2}{\sigma_{ei}^2}$	Ci
TCS	46.186	2.30	1.05	2.19
HUL	31.302	6.61	1.19	5.56
ITC	18.430	13.87	1.58	8.77
HDFC Bank	11.535	42.49	4.06	10.46
HDFC	8.615	52.15	5.18	10.06
Infosys	5.342	53.01	5.34	9.92
SBI	0.278	53.35	6.56	8.13
ONGC	-1.681	52.47	7.08	7.41
Reliance	-2.882	50.37	7.81	6.45
Coal India	-5.767	48.82	8.08	6.04

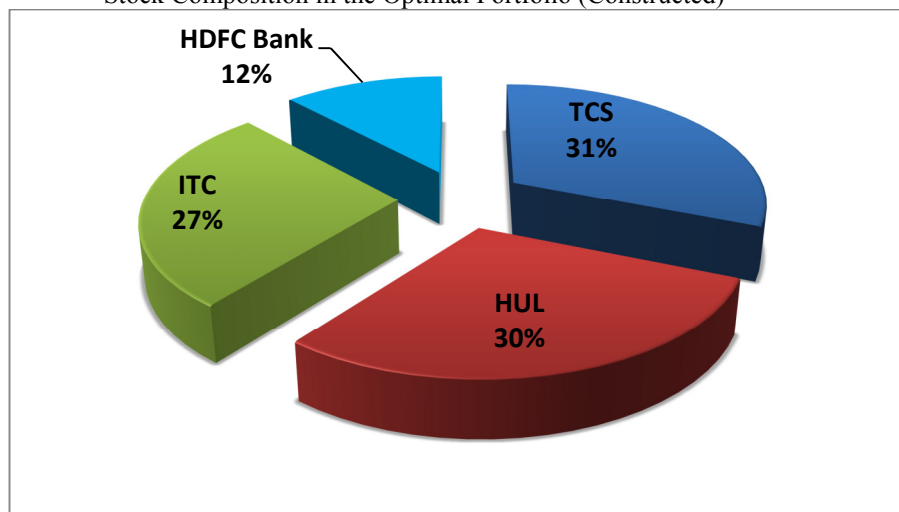
All the stocks having greater excess return to beta ratio than C* can be included in the portfolio. With this criterion, only four stocks namely TCS, HUL, ITC and HDFC Bank qualifies to be included in the optimal portfolio.

Table – 4
 Calculation of Zi and Wi for the Selected Securities in the Optimal Portfolio

Company	$Z_i = \frac{\beta_i}{\sigma_{ei}^2} \left(\frac{R_i - R_f}{\beta_i} - C^* \right)$	$X_i = \frac{Z_i}{\sum_{i=1}^N Z_i}$	Xi (%)
TCS	19.22	0.3106	31.06%
HUL	18.28	0.2954	29.54%
ITC	16.96	0.2742	27.42%
HDFC Bank	7.41	0.1197	11.97%
	61.86		

The four securities ranking from 1 to 4 are selected for the optimal portfolio. By using Sharpe index model, we are able to find out the proportion of investments to be made for each of the three stocks included in the optimal portfolio. The maximum investment should be made in TCS with a proportion of 31.06%, followed by HUL, ITC, and HDFC Bank with investment proportion of 26.54 %, 27.42% and 11.97%, respectively. Table – 4 represents the proportion of investment to be made in each security. Among four securities selected for the investment one belongs to IT sector, two companies are from FMCG sector and one from the banking sector. Evidently, the companies chosen for the investments are growing at a steady rate in the recent years. The percentage of funds to be invested in each security is presented in figure – 1:

Fig – 1
Stock Composition in the Optimal Portfolio (Constructed)



5. Conclusion

Risk and return play a vital role in making any investment decisions. This research aims at analyzing the opportunity that are available for investors as per as returns are concerned and the investment of risk thereof. Out of 10 companies of Nifty on the basis of their market capitalization taken for the study, 3 companies are showing negative return and the remaining 7 companies are showing positive returns. With regard to beta values, out of 10 companies selected, only two companies stock showed beta above 1, indicating that the investments in these stocks are outperforming than the broader market. Finally out of the 10 selected, four stocks namely TCS, HUL, ITC, and HDFC bank are included in the Optimal Portfolio constructed in this study with a maximum suggested investment in TCS.

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