

To Construct an Optimum Portfolio using Sharpe's Single Index Model- A Study of Selected Stocks from NSE

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Abstract: Portfolio construction is done by emphasising on high returns with diversifiable risk. Investors always prefer to maintain acceptable returns to risk ratio. The present study is a focus to construct an optimal portfolio of selected fifty50 companies with the application of Sharpe Single Index Model. In this study a sample of top twenty companies of fifty50 listed Stocks has been considered based on 18th December 2018 Market capitalization. The daily closing share prices of the stocks from December 2017 to November 2018 have been used in the study.

The characteristics such as returns in association with the systematic and unsystematic risk of selected stocks were analysed. The analyses concluded that the four stocks (i.e. 56% in Hindustan Unilever, 28% in Bajaj finance, 7% in HCL tech, and 9% in Reliance.) with suggested proportion of investment can be beneficiary for an individual investor, financial planner or financial advisor are preferable in the construction of an optimal portfolio and thereby to spread the availability of funds.

Key Words: NSE NIFTY, Portfolio, Sharpe's Single Index Model.

I. Introduction:

The security analysis and portfolio management is the most concerned aspect for rational investment and decision making. A portfolio is a set of securities such as stocks, bonds and money market instruments. The process of blending together these assets classes, so as to obtain maximum return with minimum risk is called portfolio construction. It is a very difficult task to find out good investments among various types of investments. In an optimal portfolio every investor need maximum return with a minimum return. This process is done through the construction of an optimal portfolio. In this project, is attempted to test the Sharpe's single index model in India securities market. In this research this topic has taken to study the construction of optimal portfolio using Sharpe single index model.

The key assumption of the model is that the return on security is linearly related to the market/market index. Portfolio is a combination of securities such as stock, bond and money market instruments. The process of blending together the broad assets classes as so to obtain optimum return with minimum risk is called portfolio construction. It is defined as "Collection of investment held by individual or institution" portfolio management is all about strengths, weaknesses, opportunities and threats in the choice of debt vs. equity, domestic vs. international, growth vs. safety, and many other trade-offs encountered in the attempt to maximize at a given appetite for risk. The portfolio acts as an instrument to diversify the risk of investor upon number of securities which are taken in portfolio. Portfolio process: 1) Specification of investment objectives and constraints, 2) Choice of asset mix, 3) Formulation of portfolio strategy, 4) Selection of securities, 5) Portfolio execution, 6) Portfolio revision, 7) Portfolio evaluation.

Sharpe Model:

The Sharpe ratio or Sharpe index or Sharpe measure or reward-to-variability ratio is a measure of the excess return (or Risk Premium) per unit of risk in an investment asset or a trading strategy, named after William Forsyth Sharpe. Since its revision by the original author in 1994. The Sharpe Index is a measure with which you may measure the performance of your portfolio over a given period of time. The important aspect of the Sharpe Index is that this performance indicator takes into consideration the risk of the portfolio. The Markowitz Model was theoretically elegant and conceptually sounds in analysing the risk and returns of portfolio. However, its serious limitation was that it related each security to every other security in the portfolio. Another problem is that a number of co-variances have to be estimated. $(N^2-N)/2$ correlation coefficients are needed to be calculated every time. So, the need for sophistication arises, which reduces the volume of work. Then, William F. Sharpe published a simplified model to analyses the portfolio. This model needs $(3N+2)$ bits of information in compilation to $(N [N+3])/2$ bits of information in Markowitz analysis. Assumptions: Sharpe has assumed that the return of security is linearly related to a single index like the market index. Theoretically, the market index should consist of all the securities trading on exchange. However, a popular average can be treated as a surrogate for the market index. In the study it is "Nifty50". Means any movement in security can be judged by the movement in index. **Formula of Sharpe model:**

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

Where, R_i = It indicate the expected return on each security. R_f = It indicate the risk free rate of return. It is the rate on government securities, as they are considers non-risky assets. It is assumed that every investor is expecting this rate of returns on their investment. In this project it is the current rate of return on T-Bills of 365 days. $R_i - R_f$ = It shows how much particular security gives excess returns than risk free rate. $R_i - R_f/\beta_i$ = It is called excess return to beta ratio. It provides a comparative analysis of how much particular script has excess returns in compilation to per unit of risk. The security ranking is done on the basis of this ratio. These ratios are ranked in descending order. In portfolio it includes the stocks with higher ratios, as it gives the net high expected return. $R_i - R_f * \beta_i / \sigma_{ei}^2$ = It shows how much expected return will fluctuate due to un-systematic risk of particular security. $\sum R_i - R_f * \beta_i / \sigma_{ei}^2$ = It shows how much total probable return of the portfolio will fluctuate due to un-systematic risk of the scripts that be selected in the portfolio. $\beta_i^2 / \sigma_{ei}^2$ = It indicate the risk of not vary of the particular security with the change in market index due to the individual benefit which might be enjoyed by the company. It means particular shares may not exactly move or it can say co-vary with the market index. $\sum \beta_i^2 / \sigma_{ei}^2$ = It indicate the risk of not vary of the securities which are going to be selected in the portfolio with the change in market due to the individual benefits which might that the particular shares may not co-vary with the market index. C^* = It indicate the highest value of “ C_i ”. It is called “Cut-off” point. The stocks above C^* have high return to beta than the cut-off C_i . And all the stocks below it have low excess return on beta. The stocks above cut-off price have high probability of getting comparatively more return. **Note:** If any security has negative return or has lower ratio than cut-off rate before reaching cut-off rate, than it should be discarded from the further calculation.

II. Literature review

Dr. S Poornima, Aruna P Remesh (May 2016) conducted a research to study the optimal portfolio construction using sharpes singles index model with special preference to selected sectors listed in NSE. The study focus to build an optimal portfolio using Sharpe’s single Index Model to calculate the proportion of investment to be made in each of the stock that was included in the optimal portfolio the selected sectors such as banking, automobile and financial sector they selected total fifteen companies with five companies from each sector listed in NSE. They calculated cut-off values using all the collected data. On the basis of the cut-off values to know which securities performing highly well and which were performing low in the market. They concluded that Sharpe Index model aids investor as a tool to make his portfolio choices and take informed decisions. Through portfolio evaluation the investor can find out how well the portfolio has performed.

P.Varadharajan, Dr. P Vikkraman conducted a research to study the Construction of Portfolio Using Sharpe Index Model with Special Reference to Banking Industry. The study was focused to find best stocks to form portfolio for investment using Sharpe index model. The study used the secondary data collected from various sources such as NSE website and the RBI website. They selected 15 companies listed in NSE for the study. They concluded that study out of 15 banks only 4 banks was selected for the portfolio.

Dr. S Poornima, Aruna P Remesh (2015) conducted a research to study the Construction of optimal portfolio using Sharpe’s single index model- A study with reference to banking & IT sector. The study focused to construct an optimal portfolio using Sharpe’s Single Index model for that purpose monthly closing prices of 10 companies from banking sector and 10 companies from IT sector listed in the Bombay stock exchange (BSE) were selected. That study was based on secondary data obtained from the website www.moneycontrol.com. Twenty companies from the BSE Sensex index were selected for the study. Share prices for the period of January 2010 to December 2015 have been considered. Using all the collected data a cut-off rate have been calculated and that rate has been considered for the construction of optimal portfolio. They concluded that Portfolio is constructed by taking the last five years data. After constructing the portfolio only three companies were selected for the portfolio construction. From banking sector 2 companies were selected and from IT sector only 1 company is selected for optimal portfolio construction.

Dr. Sandip A. Vadher (July 2015) conducted a research to study the constructing an optimal portfolio using Sharpe’s single index model. The study was based on secondary data collected from website of Bombay Stock Exchange. The data has been taken for the study 30 companies of BSE was considered for the period of one year i.e. from January 2013 to December 2014.They concluded that out of 30 companies 7 companies are selected for investment purpose.

Thangjam Ravichandra conducted a research to study the optimal portfolio construction with Nifty Stocks. The study was based on secondary data collected from NSE NIFTY. The data has been taken from April 2008 to December 2013 with 50 stocks. He concluded that out of 50 stocks only 4 stocks selected.

Dr. S Poornima, Aruna P Remesh (March 2016) conducted a research to study analysis the construction of optimal portfolio using Sharpe’s single index model: a study with reference to automobiles and pharmaceutical sector. The study was focused to construct an optimal portfolio by using risk-return analysis of automobile & pharmaceutical sectors by using Sharpe’s Single Index model. That study includes 10 stocks from automobile sector and 10 stocks from pharmaceutical sector. That study was based on secondary data obtained from web sources. Twenty companies listed in the BSE Sensex index were selected for the study. Data have been taken from a period of five years (2010-2015) for that study. They concluded that after calculating the cut-off Values of that sample companies only 5 of them were selected for the optimal portfolio construction 2 from pharmaceutical

sector and the remaining 3 from automobile sector. That study helps the investors to minimize their investment risk and maximize the return of their investment.

Need for the study:

Every investor undergoes confusion while selecting securities for his portfolio. Investor 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.

III. Research Methodology

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. Through an optimal portfolio using Single index model is helpful in avoiding the difficulty of data input and time cost consideration. The main objective of study is to construct optimum portfolio using Sharpe's Single Index Model for selected stock of NSE. It can also, be studied to determine the weightage of each stocks in optimum portfolio and to understand the risk and return behavior through portfolio.

The study is purely based on secondary data obtained from the www.nseindia.com. The 20 companies listed in NIFTY50 index has chosen on the basis of their market capitalization for applying Sharpe's single index model and hence construct optimal portfolio. The companies chosen are Tata Consultancy Services Ltd (TCS), Reliance, HDFC Bank, Hindustan Unilever Limited (HUL), (ITC), HDFC, Infosys, State Bank of India (SBI), Maruti Suzuki, Kotak Mahindra, ICICI Bank, Larsen, Oil and Natural Gas Corporation Ltd (ONGC), Axis Bank, Coal India, Wipro, Bajaj Finance, Indian Oil Corporation Ltd (IOC), Asian paints, HCL Technologies Ltd. Data collected Daily closing price of Nifty50 of top 20 securities on basis of market capitalisation on date 18th December 2018. The period of study has been chosen for one year's i.e. December 2017 to November 2018.

IV. Data Analysis and Interpretation

Nifty50 been taken as the market index and daily index value for the period December 2017 to November 2018 has been obtained from www.nseindia.com. Risk free return has been taken to be the T-bill rate at 7.398% p.a.. The expected return, variance, correlation with the market, unsystematic risk, the intercept and the beta for all the 20 stocks has been calculated below: Ranking of stocks based on Excess Return to Beta Ratio- $(R_i - R_f) / \beta_i$ Risk Free Return $R_f =$ T-bill Rate = 7.398% p.a.

Construction for an Optimal Portfolio

Step 1: Find out the "excess return to beta" ratio for each stock under consideration.

Table 1: Securities have to be ranked from the highest return to beta to the lowest

Sr.	Script Name	Mean Return	Risk free Rate	Beta	Beta sq	Unsys. Risk	σ^2	Excess Return	Excess Return to Beta
		R_i	R_f	β_i	β_i^2	$\sigma_{e_i}^2$	σ^2	$(R_i - R_f)$	$(R_i - R_f) / \beta_i$
1	HINDUNILVR	0.1468	0.0740	0.7297	0.5325	1.7457	0.6130	0.0728	0.0998
2	BAJFINANCE	0.1856	0.0740	1.4557	2.1191	5.0176	0.6130	0.1116	0.0767
3	HCL TECH	0.0976	0.0740	0.5131	0.2633	3.0930	0.6130	0.0236	0.0460
4	RELIANCE	0.1152	0.0740	1.3089	1.7132	2.7091	0.6130	0.0412	0.0315
5	HDFC	0.0852	0.0740	1.2480	1.5575	2.2405	0.6130	0.0112	0.0090
6	AXISBANK	0.0823	0.0740	1.2462	1.5530	3.5450	0.6130	0.0083	0.0067
7	ASIAN PAINT	0.0796	0.0740	0.8865	0.7859	1.9433	0.6130	0.0056	0.0063
8	ICICIBANK	0.0812	0.0740	1.3652	1.8638	3.9403	0.6130	0.0072	0.0053
9	LT	0.0779	0.0740	1.0804	1.1673	1.9450	0.6130	0.0039	0.0036
10	HDFCBANK	0.0628	0.0740	0.7150	0.5112	1.0513	0.6130	-0.0112	-0.0156
11	ITC	0.0546	0.0740	0.8750	0.7656	1.7013	0.6130	-0.0194	-0.0221
12	KOTAKBKETF	0.0323	0.0740	0.9335	0.8714	0.9041	0.6130	-0.0417	-0.0446
13	WIPRO	0.0566	0.0740	0.3189	0.1017	1.9604	0.6130	-0.0174	-0.0545
14	SBIN	-0.0183	0.0740	1.4609	2.1342	4.0445	0.6130	-0.0923	-0.0632
15	MARUTI	-0.0359	0.0740	1.1162	1.2459	2.3428	0.6130	-0.1099	-0.0984
16	ONGC	-0.0835	0.0740	0.9977	0.9954	3.3672	0.6130	-0.1575	-0.1578
17	INFY	-0.0636	0.0740	0.7221	0.5214	11.868	0.6130	-0.1376	-0.1905
18	COALINDIA	-0.0293	0.0740	0.5161	0.2664	2.7152	0.6130	-0.1033	-0.2001
19	IOC	-0.3188	0.0740	1.4501	2.1028	16.266	0.6130	-0.3928	-0.2709
20	TCS	0.1084	0.0740	-0.0435	0.0019	1.2210	0.6130	0.0344	-0.7913

Step 2 : Proceed to calculations for determining cut off rate

Variance of market (σ^2) = 0.6130

Table 2: Proceed to calculations for determining cut off rate

sr. no	Script Name	σ_{ei}^2	$(R_i - R_f)/\beta_i$	$(R_i - R_f) * \beta_i / \sigma_{ei}^2$	$\sum (R_i - R_f) * \beta_i / \sigma_{ei}^2$	$\beta_i^2 / \sigma_{ei}^2$	$\sum (\beta_i^2 / \sigma_{ei}^2)$	Ci
1	HINDUNILVR	1.7457	0.0998	0.0304	0.0304	0.3050	0.3050	0.0157
2	BAJFINANCE	5.0176	0.0767	0.0324	0.0628	0.4223	0.7273	0.0266
3	HCL TECH	3.0930	0.0460	0.0039	0.0667	0.0851	0.8125	0.0273
4	RELIANCE	2.7091	0.0315	0.0199	0.0867	0.6324	1.4449	0.0282
5	HDFC	2.2405	0.0090	0.0062	0.0929	0.6952	2.1400	0.0246
6	AXISBANK	3.5450	0.0067	0.0029	0.0958	0.4381	2.5781	0.0228
7	ASIAN PAINT	1.9433	0.0063	0.0026	0.0984	0.4044	2.9825	0.0213
8	ICICIBANK	3.9403	0.0053	0.0025	0.1009	0.4730	3.4555	0.0198
9	LT	1.9450	0.0036	0.0022	0.1031	0.6001	4.0556	0.0181
10	HDFCBANK	1.0513	-0.0156	-0.0076	0.0955	0.4863	4.5419	0.0155
11	ITC	1.7013	-0.0221	-0.0100	0.0855	0.4500	4.9919	0.0129
12	KOTAKBKETF	0.9041	-0.0446	-0.0430	0.0425	0.9639	5.9558	0.0056
13	WIPRO	1.9604	-0.0545	-0.0028	0.0396	0.0519	6.0077	0.0052
14	SBIN	4.0445	-0.0632	-0.0333	0.0063	0.5277	6.5354	0.0008
15	MARUTI	2.3428	-0.0984	-0.0524	-0.0460	0.5318	7.0672	-0.0053
16	ONGC	3.3672	-0.1578	-0.0467	-0.0927	0.2956	7.3628	-0.0103
17	INFY	11.8681	-0.1905	-0.0084	-0.1011	0.0439	7.4067	-0.0112
18	COALINDIA	2.7152	-0.2001	-0.0196	-0.1207	0.0981	7.5048	-0.0132
19	IOC	16.2662	-0.2709	-0.0350	-0.1557	0.1293	7.6341	-0.0168
20	TCS	1.2210	-0.7913	-0.0012	-0.1569	0.0015	7.6356	-0.0169

Formula to calculate Ci :

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

Interpretation: In this , 20 companies is selected as sample unit but only first 4 companies whose Access Return to Beta Ratio is more than the cutoff point (C*) is indicated in yellow color in the above table has been selected for construction of optimal portfolio.

Step 3 : Construction of optimal portfolio

C* = 0.0282

Table 3: Construction of optimal portfolio

sr.no	Script Name	β_i	σ_{ei}^2	$(R_i - R_f)/\beta_i$	$Z_i = \beta_i / \sigma_{ei}^2 * [(R_i - R_f)/\beta_i - C^*]$	Investment in %
1	HINDUNILVR	0.7297	1.7457	0.0998	0.0299	56%
2	BAJFINANCE	1.4557	5.0176	0.0767	0.0151	28%
3	HCL TECH	0.5131	3.0930	0.0460	0.0039	7%
4	RELIANCE	1.3089	2.7091	0.0315	0.0049	9%
					$\sum Z_i = 0.0538$	100%

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

Out of 20 companies 4 companies i.e. Hindustan Unilever, Bajaj Finance, HCL Tech and Reliance has been selected for investment purpose for rational investor according to Sharpe’s single index model. From the above table it can be interpreted that

out of 100% investment an investor can invest 56% in Hindustan Unilvr, 28% in Bajaj finance, 7% in HCL tech, and 9% in Reliance.

Portfolio Return

$$R_p = N \sum X_i (\alpha_i + \beta_i R_m) \quad R_p = 1.516799632$$

Portfolio Variance:

$$\sigma_p^2 = [(\sum X_i \beta_i)^2 \sigma_m^2 + (\sum X_i^2 \sigma_{e_i}^2)]$$

$$(\sum X_i \beta_i)^2 = 0.46613 \quad (\sum X_i \beta_i)^2 \sigma_m^2 = 0.285738$$

$$(\sum X_i^2 \sigma_{e_i}^2) = 12.96718$$

$$\sigma_p^2 = 13.25292$$

$$\text{Portfolio Risk } \sigma_p = 3.6404$$

$$\text{Portfolio Beta } B_p = B_i * X_i$$

$$\Sigma \beta_p = 0.970745$$

According to Sharpe Model, Portfolio Return 1.51% it means an investor is getting 1.51% of Portfolio Return by constructing an Portfolio of NSE Top 20 securities according to market capitalization, and against it is bearing 3.64% Portfolio Risk.

Findings and Conclusion:

Based on the overall analysis it can be said that out of 20 companies only 4 companies is selected for portfolio construction. As is calculated proportion, an investor or financial planner or advisor can suggest to their client for making investment.

An investor came to know about in which proportion has to invest his money in a particular script. Constructing optimum portfolio using Sharpe's method can give higher return compare to the market return with minimum risk.

This shows that, the performance of securities which are selected in the portfolio is better as compare to other securities in market. Then after the weightage have been given to each security. So the investor can come to know that, how much proportion of investment in individual security has been allocated, which minimize the risk.

When any individual invest money in any one company the risk is higher compare to when an investor invest his money in various companies. The result of the study indicates that the presence of estimation risk reduced the relative impact of estimated systematic risk on optimal portfolio choice. The results are encouraging with an average return significantly higher than the market return.

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