

**A STUDY OF OPTIMAL PORTFOLIO  
CONSTRUCTION WITH NIFTY STOCKS BY USING  
SHARPE'S SINGLE INDEX MODEL**

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**Abstract**

This study attempts to construct an optimal portfolio by using Sharpe's Single index model. For this purpose NSE-NIFTY and all the 50 stocks have been used as market index for preparing portfolio. The daily data for all the stocks and index for the period of April 2006 to December 2011 have been considered. The proposed method formulates a unique cut off point (Cut off rate of return) and selects stocks having excess of their expected return over risk free rate of return surpassing this cut-off point. Percentage of investment in each of selected stocks is then decided on the basis of respective weights assigned to each stock depending on respective beta value, stock movement variance unsystematic risk, return on stock and risk free return vis-a-vis the cut off rate of return. The optimal portfolio consists of four stocks selected out of 50 short listed scripts, giving the return of 0.116 %.

**Keywords: Portfolio construction, Single index model, optimal portfolio, Risk and return trade off, Diversification, Nifty, Share market investment.**

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## Introduction

Portfolio is a combination of securities such as stocks, bonds and money market instruments. The process of blending together the broad assets classes so as to obtain optimum return with minimum risk is called portfolio construction. Diversification of investment helps to spread risk over many assets. A diversification of securities gives the assurance of obtaining the anticipated return on the portfolio. In a diversified portfolio, some securities may not perform as expected but others may exceed the expectation and making the actual return of the portfolio reasonably close to the anticipated one. Keeping a portfolio of single security may lead to a greater likelihood of the actual return somewhat different from that of the expected return. Hence, it is a common practice to diversify securities in the portfolio. The selection of portfolio depends on the various objectives of the investor namely:

1. Objectives and asset mix
2. Growth of income and asset mix
3. Capital appreciation and asset mix
4. Safety of principal and asset mix
5. Risk and return analysis and
6. Diversification.

The foundation of modern portfolio theory was laid by Markowitz<sup>1</sup> in 1951. Markowitz theory<sup>1</sup> advise investors to invest in multiple securities rather than put all eggs in one basket because efficient diversification of the portfolio involves combining securities with less than positive correlation in order to reduce risk in the portfolio without sacrificing any of the portfolio return.<sup>3</sup>

## Single Index Model

Share also developed a composite measure of portfolio performance similar to that of Treynor with only difference that he took standard deviation of the portfolio return as the measures of risk instead of beta. This measure also compares the actual average portfolio return with the average rate of return on risk free security for a given level of risk. The single index model assumes that co-movement between stocks is due to movement in the index.<sup>2,4</sup>

The basic equation underlying the single index model is:

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

where  $R_i$  is expected return on security  $I$ ;  $\alpha$  is intercept of the straight line or alpha coefficient (Constant);  $\beta_i$  is slope of straight line or beta coefficient;  $R_m$  is the rate of return on market index and  $e_i$  is error term.

## Review of Literature

Blog et al<sup>2</sup> suggest a simple and computationally very efficient heuristic method that always gives a optimal portfolio. Gregory and Shapiro<sup>5</sup> examined a cross- section of 464 stock and found that average return is more closely related to the beta measured with respect to a stock market index than to the beta measured with respect of consumption growth. Sunil Poshakwale provides evidence of day of the week effect. Campbell et al<sup>9</sup> highlighted the influence of both non-normal characteristics of the expected return distributed and the length of investment time horizon on the optimal portfolio selection. Bhaduri et al<sup>13</sup> results suggest that no speculative bubbles were present in the Indian stock market for the sample period considered for this study. Nanda et al<sup>14</sup> selected stocks from the clusters to build a portfolio, minimizing portfolio risk and compare the returns with that of the benchmark index i.e. Sensex.

## Data and source of the study

The study aims at constructing the optimal portfolio. For this purpose, daily data were collected for the shares and index value for the period from 1st April 2006 to December 2011. This study takes all the 50 shares which are part of NSE NIFTY as market index. The study has used secondary data because it pertains to historical analysis of reported financial data. Daily closing price of the shares and daily closing index value of the benchmark market index (NSE NIFTY) have been used for the study. They were collected from CMIE (centre for monitoring Indian economy) prowess package. The collected data were consolidated as per study requirements.

## Methodology

The share price of Nifty stocks has been taken for the purpose of analyzing risk and return characteristics. For the purpose analyzing risk characteristics of Nifty stocks the Standard Deviation (total risk) is calculated and for analyzing return characteristics of stocks, the daily

mean return is calculated. For this purpose the researcher clustered the nifty index. It already consists of 20 sectors.

Return

$$R_{it} = \frac{P_{it}}{P_{it-1}} - 1$$

where  $R_{it}$ ,  $P_t$ ,  $P_{t-1}$  are the return share price at time  $t$  and  $t-1$  for security  $i$ .

### Standard Deviation

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 6.11 percent is considered as risk free rate based on the portfolio on 91-day Government of India treasury bills). Therefore to estimates the coefficients with risk free adjusted average return on individual / portfolio 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  $R_i$  = the expected return on stock  $i$ ;  $R_f$  = the return on a riskless asset and  $\beta_i$  = 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 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 cut-off point is denoted by  $C^*$ .

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

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.

The  $C_i$  can be stated with mathematically equivalent way:

$$C_i = \frac{\beta_{ip} (R_i - R_f)}{\beta_i}$$

where  $\beta_{ip}$  = The expected changes in the rate of return on stock  $i$  associated with 1 percent in the return on the optimal portfolio;  $R_p$  = The expected return on the optimal portfolio and  $\beta_{ip}$  and  $R_p$  cannot be determined until the optimal portfolio is found. To find the optimal portfolio, the formula in above should be used.

Securities are added to the portfolio as long as:

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

Now,

$$R_i - R_f > \beta_{ip} (R_p - R_f)$$

The right hand side is the expected excess return on a particular stock based on the expected performance of the optimum portfolio. The term on the left hand side is the expected excess returns on the individual stock. Thus, the portfolio manager believes that a particular stock will perform better than the expected return base on its relation-ship to optimal portfolio.

### 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:

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

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

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.

### Analysis

For constructing an optimal portfolio, a sample of size 50 selected form the securities listed on NSE and included Nifty. NSE Nifty is taken as the market index. Daily closing price and returns are considered for the selected securities in the each sample from 1st April 2006 to 31st December. They were collected from CMIE (centre for monitoring Indian economy) prowess package. The average risk free return is considered as 6.11% p.a (91-day Government of India treasury bills).



Table 1

Stock Behavior of Automobile and Refineries sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant ( $\hat{\alpha}$ )	Beta ( $\hat{\beta}$ )	R <sup>2</sup>
Bajaj Auto Ltd.	0.1908	3.3260	0.0574*	0.161	0.658** (11.59)	0.160
Hero Motocorp Ltd.	0.0722	2.2965	0.0314*	0.041	0.519** (17.34)	0.195
Mahindra and Mahindra Ltd.	0.0656	3.2926	0.0199	0.004	1.005** # (26.15)	0.356
Maruti Suzuki India Ltd.	0.0572	2.4826	0.0230	0.009	0.786** (27.72)	0.383
Tata Motors Ltd.	0.0716	3.2068	0.0223	0.452	1.103** # (31.94)	0.452
Bharat Petroleum Corp. Ltd.	0.0655	2.7871	0.0235	0.030	0.578** (15.61)	0.164
Reliance Industries Ltd.	0.0710	3.0323	0.0234	0.002	1.160** # (39.63)	0.559
Cairn India Ltd.	0.1347	2.9928	0.0450*	0.080	0.942** # (25.83)	0.390
Oil and Natural Gas Corp. Ltd.	-0.0316	3.3937	-0.0093	-0.087	0.912** # (21.71)	0.276
G A I L (India) Ltd.	0.0706	2.7703	0.0255	0.020	0.824** (25.13)	0.338
<b>Average</b>	<b>0.0768</b>	<b>2.9581</b>	<b>0.0259</b>	<b>0.071</b>	<b>0.849</b>	<b>0.327</b>

Table 2

Stock Behavior of Banks and Finance sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant ( $\hat{\alpha}$ )	Beta ( $\hat{\beta}$ )	R <sup>2</sup>
Axis Bank Ltd.	0.1624	3.2603	0.0498*	0.091	1.166** (34.38)	0.489
H D F C Bank Ltd.	0.1210	2.5194	0.0480*	0.064	0.929** (36.568)	0.519
I C I C I Bank Ltd.	0.1049	3.3318	0.0315	0.022	1.355** # (46.101)	0.632
Kotak Mahindra Bank Ltd.	0.1146	3.7896	0.0302	0.039	1.234** # (29.051)	0.405
Punjab National Bank	0.1130	2.6817	0.0421*	0.055	0.949** (33.711)	0.479
State Bank of India	0.1208	2.7426	0.0440*	0.056	1.059** (40.538)	0.570
Infra. Dev. Fin. Co. Ltd.	0.1339	3.6813	0.0364*	0.052	1.347** # (36.003)	0.511
Reliance Capital Ltd.	0.0905	4.0437	0.0224	-0.007	1.596** # (42.703)	0.596
Housing Dev. Fin. Corp. Ltd.	0.0538	3.7064	0.0145	-0.011	1.068** (23.984)	0.317
<b>Average</b>	<b>0.1128</b>	<b>3.3063</b>	<b>0.0341</b>	<b>0.040</b>	<b>1.189</b>	<b>0.502</b>

Table 3

Stock Behavior of Cement and Steel sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant (á)	Beta(â)	R <sup>2</sup>
A C C Ltd.	0.0565	2.5361	0.0223	0.009	0.785** (26.757)	0.366
Ambuja Cements Ltd.	0.0605	2.6154	0.0231	0.014	0.760** (24.302)	0.323
Grasim Industries Ltd.	0.0430	2.5258	0.0170	-0.006	0.808** (28.174)	0.391
Steel Authority of India Ltd.	0.1177	3.5151	0.0335*	0.035	1.353** # (40.198)	0.566
Tata Steel Ltd.	0.0732	3.5206	0.0208	-0.008	1.342** # (39.294)	0.555
Jindal Steel and Power Ltd.	0.1449	4.9932	0.0290*	0.060	1.396** # (22.976)	0.299
Sesa Goa Ltd.	0.1023	4.4610	0.0229	0.040	1.021** (17.611)	0.200
<b>Average</b>	<b>0.0854</b>	<b>3.4524</b>	<b>0.0247</b>	<b>0.021</b>	<b>1.066</b>	<b>0.386</b>

Table 4

Stock Behavior of IT and Telecommunication sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant (á)	Beta (â)	R <sup>2</sup>
H C L Technologies Ltd.	0.0385	3.4454	0.0112*	-0.021	0.984** # (23.67)	0.312
Infosys Ltd.	0.0429	2.6403	0.0162*	-0.001	0.724** (22.34)	0.287
Tata Consul. Services Ltd.	0.0237	3.2496	0.0073	-0.028	0.853** (21.05)	0.264
Wipro Ltd.	0.0306	2.8528	0.0107*	-0.024	0.898** (27.49)	0.379
Bharti Airtel Ltd.	0.0788	2.6861	0.0293*	0.024	0.899** (30.47)	0.429
Reliance Comm. Ltd.	-0.0222	3.6229	-0.0061	-0.104	1.345** # (37.14)	0.527
<b>Average</b>	<b>0.0321</b>	<b>3.0829</b>	<b>0.0104</b>	<b>-0.026</b>	<b>0.951</b>	<b>0.366</b>



Table 5

Stock Behavior of Pharmaceuticals sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant ( $\hat{\alpha}$ )	Beta ( $\hat{\beta}$ )	R <sup>2</sup>
Cipla Ltd.	-0.0116	2.7602	-0.0042	-0.046	0.565** # (15.35)	0.400
Dr. Reddy's Lab. Ltd.	0.0496	2.6089	0.0190*	0.022	0.458** (12.86)	0.343
Ranbaxy Laboratories	0.0431	2.8978	0.0149*	-0.001	0.731** # (19.97)	0.244
Sun Pharm. Ind. Ltd.	0.0365	3.2128	0.0114*	0.007	0.480** (10.74)	0.292
<b>Average</b>	<b>0.0294</b>	<b>2.8699</b>	<b>0.0102</b>	<b>-0.005</b>	<b>0.559</b>	<b>0.320</b>

From the tables 1 to 8 it can be seen that a few stocks gave negative returns. The result of descriptive statistics presents the volatility behavior each variable. From this statistics it is clear that mean returns of banks and finance sector has given higher daily average return followed by cement and steel sector and automobile and refineries sector in Nifty stock. The standard deviation (total risk) is higher for construction and engineering, metal and others followed by cement and steel and lesser for pharmaceuticals.

From the above analysis (single index model), the securities as in table 9 are indentifying for further analysis to the investors on the basis of return, standard deviation (volatile) and beta value. The securities are selected on the basis of their performance in the sector wise classification; these securities are taken into consideration for construction of portfolio

- 1) Tata Motors Ltd.
- 2) Axis Bank Ltd.
- 3) Infrastructure Development Finance Co. Ltd.
- 4) Steel Authority of India Ltd.
- 5) Bharti Airtel Ltd.
- 6) Ranbaxy Laboratories Ltd.
- 7) Tata Power Co. Ltd.
- 8) Hindalco Industries Ltd.

Table 6

Stock Behavior of Power and Electrical Equipments sector Companies under NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant ( $\hat{\alpha}$ )	Beta ( $\hat{\beta}$ )	R <sup>2</sup>
N T P C Ltd.	0.0551	2.3019	0.0239*	0.006	0.814** (33.63)	0.477
Power Grid Co. of India	0.0365	2.6437	0.0138*	0.006	0.858** (26.81)	0.455
Reliance Infrastructure	0.0866	3.9301	0.0220*	-0.006	1.518** # (40.52)	0.570
Reliance Power Ltd.	-0.0723	3.4299	-0.0211	-0.119	1.069** # (22.55)	0.397
Tata Power Co. Ltd.	0.1070	2.8524	0.0375*	0.050	0.933** (29.28)	0.409
Bharat Heavy Ele. Ltd.	0.0411	2.9949	0.0137*	-0.020	1.003** (30.48)	0.429
Siemens Ltd.	-0.0240	4.0774	-0.0059	-0.091	1.093** # (21.63)	0.274
<b>Average</b>	<b>0.0328</b>	<b>3.1758</b>	<b>0.0103</b>	<b>-0.025</b>	<b>1.041</b>	<b>0.430</b>

Table 7

Stock Behavior of construction, engineering, metal and others sector Companies under NIFTY 50 during 2006-11

Name of Industry	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant ( $\hat{\alpha}$ )	Beta ( $\hat{\beta}$ )	R <sup>2</sup>
D L F Ltd.	0.0043	4.1479	0.0010	-0.075	1.505** # (33.67)	0.551
Jaiprakash Associates Ltd	0.0345	4.9429	0.0070	-0.068	1.682** # (31.35)	0.443
Sterlite Indus. (India) Ltd.	-0.0079	4.8494	-0.0016	-0.090	1.354** # (22.93)	0.298
Hindalco Industries Ltd.	0.0682	3.4101	0.0200*	-0.007	1.243** # (35.72)	0.508
Larsen and Toubro Ltd.	0.0381	3.4734	0.0110*	-0.030	1.125** (28.79)	0.401
I T C Ltd.	0.0321	2.5958	0.0124*	-0.008	0.654** (19.91)	0.242
Hindustan Unilever Ltd	0.0242	2.0999	0.0115*	-0.010	0.555** (21.25)	0.267
<b>Average</b>	<b>0.0276</b>	<b>3.6456</b>	<b>0.0076</b>	<b>-0.041</b>	<b>1.160</b>	<b>0.387</b>

Table 8  
Stock Behavior of all the seven sector of NIFTY 50 during 2006-11

Name of Company	Mean (Return)	Standard Deviation (Risk)	Return to Risk Ratio	Constant (ā)	Beta (â)	R <sup>2</sup>
Automobile and refineries	0.0768	2.9581	0.0259*	.017	0.856** (70.62)	0.801
Banks and finance	0.1128	3.3063	0.0341*	.040	1.189** # (73.88)	0.815
Cement and steel	0.0854	3.4524	0.0247*	.020	1.066** # (53.98)	0.702
Information tech. and telecomm	0.0321	3.0829	0.0104	-.010	0.872** (43.08)	0.600
Pharmaceuticals	0.0294	2.8699	0.0102	-.005	0.559** (25.72)	0.348
Power and electrical equipment	0.0328	3.1758	0.0103	-.019	1.047** # (59.48)	0.741
Constr., enng., metal and others	0.0276	3.6456	0.0076	-.042	1.151** # (66.18)	0.780
<b>Average</b>	<b>0.0567</b>	<b>3.2130</b>	<b>0.0176</b>	<b>0.001</b>	<b>0.963</b>	<b>0.684</b>

Compiled and Calculated from CMIE (Prowess package)

\* More than the average return to risk ratio. Figures in brackets shows 't' values.

\*\* Significant at 1% level # More than the average beta of the industry.

Table 9 and 10 clearly explain the results of empirical analysis. To achieve the objectives of the study, Single Index Market model is used. Sharpe' model is convenient as compared to the model given by Harry Markowitz. It helps in the creation of portfolio with less number of calculations as compared to any other model. In this association of individual share with the overall market or market portfolio is given an importance. Only those securities are desirable in the portfolio, which have positive excess return over risk free return. All the securities which have excess return to beta ratio more than the cut of point are portfolio and the securities included in the portfolio are the included in the portfolio. Such portfolio is the efficient securities.

Table 9

Result of Optimal Portfolio from Selected Company under NIFTY 50 during 2006-11

Name of Securities	Excess Return over beta	Excess return to unsystematic risk	Cumulative	Beta to unsystematic risk	Cumulative	Cut off rate to index
Tata Motors Ltd.	0.050	0.019	0.034	0.379	0.130	0.088*
Axis Bank Ltd.	0.125	0.052	0.071	0.417	0.796	0.067
Infrastructure Development Finance Co. Ltd.	0.087	0.043	0.114	0.493	1.289	0.073
Steel Authority of India Ltd.	0.074	0.039	0.152	0.521	1.810	0.074
Bharti Airtel Ltd.	0.069	0.021	0.173	0.301	2.111	0.073
Ranbaxy Laboratories Ltd.	0.036	0.007	0.180	0.184	2.295	0.070
Tata Power Co. Ltd.	0.096	0.029	0.209	0.305	2.601	0.073
Hindaleo Industries Ltd.	0.041	0.019	0.228	0.453	3.054	0.069

Compiled and Calculated from CMIE (Prowess package); The riskless rate of interest is 6.11 percent and the market variance is 3.82

Table 10

Result of Weights amount Invested in Portfolio from Selected Company under NIFTY 50 during 2006-11

S. No.	Name of Company	Residual Variance	Weights of Securities (%)	Mean return	Portfolio return
1	Tata Motors Ltd.	0.013	38	0.0716	0.027
2.	Axis Bank Ltd.	0.013	38	0.1624	0.062
3.	Steel Authority of India Ltd.	0.005	15	0.1177	0.017
4.	Tata Power Co. Ltd.	0.003	9	0.1070	0.09
Portfolio Return					0.116

Compiled and Calculated from CMIE (Prowess package)

## Suggestions to the Investors

- Do not have more trade in a day
- Do not buy and sell the securities on rumors.
- Do not employ all the funds in single sector, the loss possibly enormous.

- Deal with the trends before trying to select the securities from top to bottom.
- Do not purchase securities because it is low priced.
- Profit cannot be acquired every day from the markets.
- Do not buy too many stocks at once.

## Conclusion

Risk and return play an important role in making any investment decisions. This study aims at analyzing the opportunity that are available for investors as per as returns are concerned and the investment of risk thereof while investing in equity of firms belonging to Nifty 50 stocks in the national stock exchange. From the empirical analysis, it is concluded that returns on either individual securities or on portfolio comprises of securities of different companies listed in Nifty 50 stocks under various sectors are asymmetrical and heterogeneous. Out of 50 companies taken for the study, 6 companies are showing negative return and the other 44 companies are showing positive returns. Out of 50 companies, 24 companies where market beta is above 1, show that the investments in these stocks are outperforming than the market.

However, significance of the beta is not consistent with all security return, leading to the conclusion that every security depends to some extent on the overall performance of the market. From this empirical analysis, to some extent one can able to forecast individual security's return through the market movement and can make use of it. In the second phase, it is found that Indian security market in information

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