Construction of Optimal Portfolio using Sharpe's Single Index Model

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Abstract - *Portfolio Construction is an important process of investment in the equity market. A good combination of portfolio will give a maximum return for a particular level of risk. To make wise decisions in investment there is a need for knowledge on security analysis and portfolio management. The aim of the study is construction of an optimal Portfolio using Sharpe's single index model. The study is based on monthly closing prices of select companies listed in BSE Limited for period of four years starting from 14.03.2018 to 14.03.2022. The Study reveals that only six company stocks constitute optimal portfolio out of 15 Stocks with different Proportion of Investment and these are Avenue Supermarts Ltd (32.82%), Nestle India Ltd (22.64%), Adani Power Ltd (14.94%), Dr. Reddy's Laboratories Ltd (9.54%), Asian Paints Ltd (14.28%), and Titan Company Ltd (5.77%) respectively*

Key Words: Constitution, Optimal Portfolio, Single Index Model, BSE

1. INTRODUCTION

Security analysis and portfolio management emerged as important aspects for rational investors and decision making. The portfolio is a combination of securities such as Stocks, Bonds and Money Market Instruments. The process of blending the broad assets Classes to obtain optimal returns with minimum risks are called Portfolio construction. Any Portfolio constructed, either by an individual investor or a fund manager is expected to meet the Investor's goals. A Portfolio tries to trade off the risk-return preferences of an investor by not putting all eggs in single basket and thus allows for sufficient diversification.

Markowitz was the first who laid the foundation of "Modern Portfolio Theory" to quantify risk. In the Modern approach, Markowitz Model is used in the Selection of Securities based on the Risk and Return analysis. He has provided an analytical tool for the analysis and selection of optimal portfolio. He won Nobel Price for this Contributed 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 prefer portfolio analysis. He made the numerous and Complex Computations easy which were essential to attain the Optimal Portfolio of SIM. The Model has been using by The Fund manager to construct an optimal portfolio till today.

Every investor undergoes confusion while selecting securities for his or her 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 that Sharpe's Single Index Model has be used to construct an optimal portfolio. This helps the investors 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.

2. REVIEW OF LITERATURE

Review of the literature involve referring of existing research work in the respective demine. It provides theoretical framework for the research and enlarge knowledge of the researcher. In this researchers have reviewed various scholarly articles and publications some of them are as follows.

Varadharajan, Vikkraman, P. and Selvakuman, J. (2011) in their study entitled Construction of Optimal Portfolio using Sharpe's single index model with reference to FMCG Industry in India. The researchers considered five-year stock prices from 2005 to 2009 of 10 companies listed in BSE. This resulted in weights for better investment in HUL, P & G, Britannia and Dabur with 11.8%, 3.82%, 42.02% and 42.36% respectively.

Nalini, R. (2014) Carried out the portfolio construction and proportion of investment in each stock by using Sharpe's single index model of 15 companies from BSE during 2009 to 2014. Out of 15 stocks four stocks are selected to construct a portfolio which is ITC limited (70.88%), Tata Consultancy Services Ltd (10.08%), Dr Reddy's Laboratories Ltd (17.41%) and Bajaj Auto Limited (1.63%) respectively.

Poornima, S. and Ramesh, A.P. (2015) they have analysed that optimal portfolio using Sharpe's single index model. For this purpose of analysis, the monthly closing prices of 10 companies from the banking sector and 10 companies from the IT sector listed in the BSE are selected and Stock

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prices for the period of January 2010 to December 2015 have considered. This study reveals that only three companies are selected for the portfolio construction. From banking sector Bank of Baroda (12%) and Axis Bank (38%) and IT sector Ramco Systems Company (50%) is selected to Portfolio construction.

Murthy, J. (2016) Attempted to construct an optimal portfolio by using sharp's single index model. For this purpose, 14 Metal stocks are selected from iron and steel industry and these stocks is Constituent of the Nifty Metal index. The monthly data for the stock price period of January 2012 to December 2016 have considered. This study reveals that only 2 companies stocks constitute the optimal portfolio which is Vedanta and Tata steel with the proportion of investment of 86.37% and 13.62% respectively.

Madan, K.M. and Kumar, M.N.V. (2018) this study estimated portfolio by considering both Sharpe's Single Index model and CAPM approach. For this study 20 different companies are taken from 5 different sectors, which are listed in NSE 50 index. Among them four companies are selected for portfolio construction, which are Infosys limited (34%), Tech Mahindra (32%), BPCL (29%) and Dalmia Bharat Cement Limited (5%) respectively and CAPM has resulted that among 20 companies, 9 companies' stocks are overpriced and 11 company stocks are under-priced.

Chakraborty, S. and Patel, A.K. (2018) this study made on Construction of optimal portfolio using Sharpe's Single Index Model and Markowitz Model. In this research, all 50 stocks of NSE Nifty 50 index are taken into consideration and weekly data of all the stocks for the period of September 14, 2016 to September 15, 2017 have considered. Out of total 50 stocks, 37 stocks have positive return and from those only 6 stocks are eligible for inclusion in optimal portfolio.

Archana, H.N. and Srilakshmi, D. (2020) constructed an optimal portfolio by using Sharpe's single index model by considering during the period 1st January 2019 to 31st December 2019. For this study closing prices of BSE 30 stocks are collected from different sector out of 30 stocks, 10 stocks are selected to construct an optimal portfolio and those are Nestle India Limited, Bharti Airtel, TCS, Bajaj Finance, Reliance, Infosys, Kotak Bank, Titan, ICICI Bank and Asian Paints respectively.

3. RESEARCH GAP

After review of literature, it was found that there are many studies have undertaken and constructed the optimal portfolio by taking sample from the particular industries such as Banking, IT sector, FMCG and Iron and steel industry. The Present study has been selected sample securities from the different industries to construct an optimal portfolio. This study has been conducted taking frame work prior to 14.03.2022.

Hence, the present study is undertaken by considering the research gap, which has been found after review of literature.

4. OBJECTIVE OF THE STUDY

The aim of the study is to construct an optimal Portfolio Using the Sharpe's Single Index Model

5. METHODOLOGY

The study uses analytical research method. It is purely based on the secondary data-The monthly closing price of the 15 companies in BSE is obtained for four years from 14t March 2018 to 14th March 2022. The data was analyzed with use of different steps.

6. SAMPLE DESIGN

The total population of the study is 7462 companies which are listed in BSE under different sector. For the purpose of the study required 15 companies are taken from the top 100 stocks on the basis of their capitalization. The 15 companies are - Reliance Industries Ltd (Reliance), HDFC Bank Ltd (HDFC), SBI Life Insurance Company Ltd (SBI Insurance), Asian Paints Ltd (Asian Paints), Avenue Supermarts Ltd (avenue), Larsen and Toubro Ltd (L and T), Titan Company Ltd (Titan), Maruthi Suzuki India Ltd (Maruthi Suzuki), Ultra Tech Cement Ltd (Ultra Tech), Tata Steel Ltd (Tata Steel), Vedanta Ltd (Vedanta), Dr Reddy's Laboratories Ltd (Reddy's Lab) , Tata Motors Ltd (Tata Motors), Nestle India Ltd (Nestle), Adani Power Ltd (Adani Power). Here onwards these companies are referred as the short names given in bracket.

7. DATA ANALYSIS AND DISCUSSION

The data is calculated for the study analyzed by using Mean return, risk, excess return to beta ratio and cut-off.

Mean Return

Average monthly return of select securities is calculated by using historical prices and showed in table 1. This return is calculated by using the following formula.

$R_i = (P_t - P_o/P_o) \times 100$

Where,

P_t = Current Closing Price

P_o = Previous Closing Price

Return = [(Current Month Stock Price – Previous Month Stock Price) /Previous Month Stock Price] 100

Table 1: Mean Return of Sample Companies Stock

SL. No	Securities Name	Mean Return (Ri) in %
1	Reliance	2.2432
2	HDFC	0.5815
3	SBI Insurance	1.3293
4	Asian Paints	2.169
5	Avenue	2.9106

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6	L & T	0.7695
7	Titan	2.5366
8	Maruthi Suzuki	0.472
9	Ultra Tech	0.9849
10	Tata Steel	2.007
11	Vedanta	1.298
12	Reddy's Lab	1.483
13	Tata Motors	1.7515
14	Nestle	1.8586
15	Adani Power	4.7405
Average of total return		**1.81%**

From the Table 1, the researcher has found that Benchmark of Return is 1.81% which is the Average of 15 Companies Mean Return. As per the Benchmark Adani Power has the highest return followed by Reliance, Asian Paints, Avenue, Maruthi Suzuki, Titan, Vedanta and Nestle Stock.

Though these companies are earning highest return but they may have the risk also higher. Therefore, to know the Risk Return trade-off individual securities risk has been calculated.

Risk

In order to know the market risk faced by each security, the beta values of sample Companies stock returns are calculated.

A beta below 1 indicates that a volatile investment whose price movements are not highly correlated with the market.

Table 2: Beta Values of Sample Companies' Stocks

SL. No	Securities Name	Beta(β)
1	Reliance	1.1066
2	HDFC	1.1648
3	SBI Insurance	0.8828
4	Asian Paints	0.5672
5	Avenue	0.4464
6	L & T	1.111
7	Titan	0.9332
8	Maruthi Suzuki	1.1755
9	Ultra Tech	0.875
10	Tata Steel	1.3074
11	Vedanta	1.5607
12	Reddy's Lab	0.2634
13	Tata Motors	1.819
14	Nestle	0.3138
15	Adani Power	1.1963
	Total Average Beta	**0.9815**

The 15 sample companies Average Beta is 0.9815. Therefore this average of total 15 companies is less risky than the market. Tata Motets, L &T, Maruthi Suzuki, Tata steel, Vedanta, and Adani power has the Beta value greater than 1 which means they are highly Volatile.

Reddy's lab, Nestle, Avenue, Asian Paints, Ultra Tech and SBI Insurance has the less beta even than the average Beta which represents lower volatility.

Tata Motors has the highest Beta but its return is less than the average return. Reddy's lab stock is less risky and return is also less. Nestle and Avenue stocks are less risky but stock

return is more than the benchmark. There for the study has to calculate excess return to Beta ratio to ranking the stocks as per their Risk and Return.

Excess Return to Beta Ratio

The Excess Return to beta ratio measures the additional return on a stock per unit of systematic risk. It means for every one rupee of systematic risk how much will be the return.

Excess Return to Beta ratio is calculated by using the following formula.

Excess Return to Beta Ratio = (Mean Return of Stock – Risk free rate)/Beta

The Risk-free rate is taken as the interest rate on the 10 years government Bond is 6.83%. The monthly average of Risk-free rate is 0.569167% for the period under study.

Table 3: Calculation of Excess Return to Beta Ratio and Ranking of stocks

Security	Ri	Rf	Beta(β)	Ri-Rf	Ri-Rf/β	Rank
Reliance	2.243	0.569	1.107	1.674	1.513	7.000
HDFC	0.582	0.569	1.165	0.012	0.011	14.000
SBI Insurance	1.329	0.569	0.883	0.760	0.861	9.000
Asian Paints	2.169	0.569	0.567	1.600	2.821	5.000
Avenue	2.911	0.569	0.446	2.341	5.245	1.000
L &T	0.770	0.569	1.111	0.200	0.180	13.000
Titan	2.537	0.569	0.933	1.967	2.108	6.000
Maruthi Suzuki	0.472	0.569	1.176	-0.097	-0.083	15.000
Ultra Tech	0.985	0.569	0.875	0.416	0.475	11.000
Tata Steel	2.007	0.569	1.307	1.438	1.100	8.000
Vedanta	1.298	0.569	1.561	0.729	0.467	12.000
Reddy's Lab	1.483	0.569	0.263	0.914	3.469	4.000
Tata Motors	1.752	0.569	1.819	1.182	0.650	10.000
Nestle	1.859	0.569	0.314	1.289	4.109	2.000
Adani Power	4.741	0.569	1.196	4.171	3.487	3.000

Table 3 shows that Avenue stock has the highest return to the beta ratio of 5.24514 and followed by Nestle, Adani, Reddy's Lab, and Asian Paints. Maruthi Suzuki stock has the lowest of -0.0827.

The ranking of stocks done based on an excess return to the beta ratio reveals that Avenue Supermarts Ltd stock ranks first; the Maruthi Suzuki India Ltd stock ranks the last.

The selection of the stock depends on a unique cut-off rate such that all stocks with highest beta ratio are included and

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stocks with lowest ratio are left out the construct an optimal portfolio.

Cut-Off Point

The cut off is calculated by using the following equation

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

Where,

$\sigma^2 m$ = Variance of the Market Index

$\sigma^2 ei$ = 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 a Cut-off point after which cumulative value of Ci start declining. Those securities which have value of Ci or equal to cut off point will be selected in optimal portfolio.

Table 4 it is seen that Titan stock has the highest C value 1.800019.that is cut-off rate for the portfolio. All the securities which are before the cut-off point will be considered for the construction of optimal portfolio. They are Avenue, Nestle, Adani Power, Reddy's lab, Asian Paints and Titan. But, the inventor cannot invest equally on these stocks. So, the researcher needs to calculate the proportion of investment to be made optimal investment on each stock.

Table 4 Calculation of 'C' Values

Security	Ri-Rf*βi	62ei	(Ri-Rf)βi/6ei	∑(Ri-Rf)βi/62ei	βi2/62ei	∑Bi2/62ei	C*
Avenue	1.045	8.285	0.126	0.126	0.024	0.024	0.634
Nestle	0.405	5.659	0.071	0.198	0.017	0.041	0.914
Adani Power	4.990	23.874	0.209	0.407	0.060	0.101	1.472
Reddy's Lab	0.241	8.149	0.030	0.436	0.009	0.110	1.532
Asian Paints	0.907	7.165	0.127	0.563	0.045	0.155	1.708
Titan	1.836	8.811	0.208	0.771	0.099	0.254	1.800
Reliance	1.852	9.164	0.202	0.973	0.134	0.387	1.732

Tata Steel	1.880	12.534	0.150	1.123	0.136	0.524	1.608
SBI Insurance	0.671	8.398	0.080	1.203	0.093	0.616	1.521
Tata Motors	2.151	18.667	0.115	1.318	0.177	0.794	1.361
UltraTech	0.364	8.239	0.044	1.363	0.093	0.887	1.284
Vedanta	1.137	14.421	0.079	1.442	0.169	1.056	1.172
L and T	0.223	8.362	0.027	1.468	0.148	1.203	1.065
HDFC	0.014	7.889	0.002	1.470	0.172	1.375	0.948
Maruthi Suzuki	-0.114	9.590	###	1.458	0.144	1.519	0.861

Proportion of Investment

The Proportion for each selected stocks will be found by using the following formula.

$$X_i = \frac{Z_i}{\Sigma Z_i}$$

$$Z_i = \frac{\beta_i}{\sigma ei^2} \left[R_i - \frac{Rf}{\beta_i} - C* \right]$$

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

Table 5: Proportion of Investment on Select Stock

Security	Beta(βi)	6ei2	Ri-Rf/βi	C*	Zi	∑Zi	Wi
Avenue	0.446	8.285	5.245	1.800	0.186	0.186	0.328
Nestle	0.314	5.659	4.109	1.800	0.128	0.314	0.226
Adani Power	1.196	####	3.487	1.800	0.085	0.398	0.149
Reddy's Lab	0.263	8.149	3.469	1.800	0.054	0.452	0.095
Asian Paints	0.567	7.165	2.821	1.800	0.081	0.533	0.143
Titan	0.933	8.811	2.108	1.800	0.033	0.566	0.058

From the table 4 the study has identified six stocks which are going to be part of the optimal portfolio, and then calculated the proportion of investment to be made in each security is given in table 5. The highest proportion (32.82%) will be made on Avenue stock which also has very high return among the sample stocks and further investment shall be on Nestle (22.64%), Adani Power (14.94%), Reddy's Lab (9.54%), Asian Paints (14.28%), and Titan (5.77%) respectively.

A look at the individual Security returns from these stocks as well as their respective returns on Portfolio is also presented in Table 6.

Table 6: Return on Portfolio

Sl. No.	Securities Name	Monthly Stock Returns (in %)	Proportion (Wi-%)	Monthly Return on Portfolio %
1	Avenue	2.9106	32.82	0.9553
2	Nestle	1.8586	22.64	0.4208
3	Adani Power	4.7405	14.94	0.7082
4	Reddy's Lab	1.483	9.54	0.1415
5	Asian Paints	2.169	14.28	0.3097
6	Titan	2.5366	5.77	0.1464
Total Monthly Return On Portfolio			$\sum Xi = 100.00$	2.6818

Table 6 presents the Proportion of Investment, Individual security return and the returns on the Portfolio. The returns on the portfolio are calculated based on the proportion of investment in each security. The higher return on Portfolio is from the Avenue Supermart Ltd i.e. 0.9553% and the lowest is Dr Reddy's Laboratory Ltd i.e.0.1415%. If an investor invests in the above-Constructed Portfolio, his/her total monthly expected Portfolio return is 2.6818%. Thus, 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 drive the best benefits of diversification.

8. FINDINGS

From the above analysis and interpretation, the following findings have been drawn.

- Among 15 different stocks Avenue stock has the highest monthly return of 4.7405% and Maruthi Suzuki stocks has the lowest return of 0.472%.
- It is found that out of 15 stocks considered for the study, only 6(Six) stocks are occupied in the optimal portfolio.
- Tata Motors Limited has the highest beta value of 1.819 indicating the stock is highly volatile.
- The higher return on Portfolio is from the Avenue Supermart's stock i.e. 0.9553% and the lowest is Dr Reddy's Laboratory Ltd i.e.0.1415%.
- If an investor invests in the six stocks Portfolio, his/her total monthly expected portfolio return is 2.6818%. Thus, Sharpe's Single Index Model is useful to investors and helps the fund managers in deciding about the securities to be included in their Portfolio to drive the best benefits of diversification

9. SUGGESTIONS

If the Investor would like to invest in constructed portfolio it will helps in minimizing the risk and maximizes the return. Once the investment made on constructed optimal portfolio is not enough, the investor has to keep an eye on the performance of the selected stocks and need to be monitor, revise and rebalance either by deleting one stock, adding one stock or changing the proportion on stock.

10.CONCLUSION

Constructing an optimal portfolio is a challenging task for the individual as well as the institutional investors. This paper attempted to construct an optimal portfolio using Sharpe's single index model. Among the 15 sample companies, only 6 were selected for the optimal portfolio. The final decision of investing should be made only after considering all the factors affecting the securities. These can be general economic or macroeconomic factors that govern the movement and action of these securities in the market.

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