

An Optimal Portfolio Construction by Using Sharpe's Index Model

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ABSTRACT

An attempt is made here to get an insight into the idea embedded in SHARPE's Single Index Model and to construct an optimal portfolio empirically using this model. While making investment decisions particularly in EQUITY MARKET, **risk and return** plays an important role, perhaps the most relevant question is which stock should be placed in the portfolio matters a lot. A good combination of equity stocks in the portfolio will give better return for a given level of risk. SHARPE's SINGLE INDEX Model method involves selecting a cut-off rate for inclusion of securities in a portfolio. Taking **BSE Sensex** as a market performance index with sixteen stocks of eight different sectors and considering monthly indices along with the monthly prices of sample securities for the period of **April 2018 to Mar 2023**. Proportion of investment in each of the selected securities is computed based on beta value, Variance, Correlation unsystematic risk, excess return to beta ratio and cut-off rate of each of securities.

Keywords: Techniques to calculate risk, variance, standard deviation, correlation co-efficient, return on portfolio, risk of portfolio, financial Planning, Portfolio

INTRODUCTION

The investor always prefers to trade -off between risk and return and to mitigate the risk and investors will do diversification. Diversification means combine of two or more assets, which gives the least risk and highest return.to diversify such risk effectively. Although mark of its 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 my phoneestablishment of market its model is the increased complexity of computation that the model faces as the number of securities in the portfolio grows full good to determine the variance of the portfolio, the variance between each possible pair of securities must be computed, which is represented in a covariance matrix.Thus, increase in the number Off security results In a large covariance matrix, which in turn, results in a more complex computation. If there are any securities in a portfolio, the Markowitz's model requires n average (or expected) Returns, and variance this environments terms and $n(n-1)/2$ convenience terms that is in total $n(n+3)/2$ data-inputs).

Due to these practical difficulties, security analysts did not like to perform their tasks using the huge burden of data inputs required of this model. They searched for a more simplified model to perform their task comfortably. To this direction, in 1963 William F. Sharpe had developed a simplified Single Index Model (SIM) for portfolio analysis taking cue from Markowitz's concept of index for generating covariance terms. This model gave us an estimate of a security's return as well as of the value of index. Markowitz's model was further extended by Sharpe's a when he introduced the capital assets pricing model to solve the problem behind the determination of correct, arbitrage - free, fair or equilibrium price of an asset. Sharp single index model is very useful to construct an optimal portfolio by analysing how and why securities are included in an optimal portfolio with their respective weights calculated based on some important vegetables under consideration.

Review of Literature

- **Dr. N Krishnamoorthy and MahabubBasha S (2021)**
Constructed a portfolio using Sharpe Index Model, which consisted 30 securities of BSE Sensex. In order to construct the portfolio of BSE Sensex 30 stocks with 5 years data i.e., from June 2016 to July 2021 have been considered.
- **Dr.G.Sudarsana Reddy and Ashwini R**
The aim of the study is to construct optimal portfolio using Sharpe's Single Index model taking 15 stocks listed at Bombay Stock Exchange (BSE). With use of simple random sampling the researcher selected 15 stocks from the top 100 stocks listed at BSE.
- **Pritpal Bhullar, Pradeep Kumar Gupta, DyalBhatnagar (2022)**
This study investigated the impact of COVID-19 on the volatility of BSE Sensex stock index. The findings suggest the significant negative effect of COVID-19 fatality cases on BSE Sensex stock index during the specified study period. This negative coefficient of COVID-19 fatality cases in India reflects the increasing volatility of the BSE Sensex stock index.

Research Methodology

The study is empirical in nature. The study is based on secondary source and the data required for this study was obtained from the website finance.yahoo.com. Sixteen companies from the BSE market were selected for the study.

Objectives Of the Study

1. To evaluate the performance of securities by constructing a portfolio of the 16 securities of 8 different sectors.
2. To allocate investment in different stocks considering risk-return criteria.
3. To provide direction to investors regarding performance of securities.
4. To know the impact of Covid Pandemic on the different sectors.

Limitations of the Study

1. The study includes only sixteen securities.
2. The results of the company may not be universally applicable.
3. The historical closing prices are of only 5 years.

Formulas Used In construction of Portfolio

1. Return on stock

$$\text{Returns} = \frac{\text{Closing Price} - \text{Opening Price}}{\text{Opening Price}} * 100$$

Were,

Closing Price = P_t

Opening Price = P_0

2. Excess returns on beta ratio for each security.

Were,

$$\text{Excess Returns to Beta} = \left(\frac{R_i - R_f}{\beta_i} \right)$$

R_i = the expected return on stock i

R_f = the return on a risk-free asset

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

3. Arrange all the securities in ascending order and calculating the cut-off rate by using following formula

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

4. $X_i = \frac{z_i}{\sum_{i=1}^N z_i}$

$$z_i = \frac{\beta_i}{\sigma_e^2} \left[\frac{R_i - R_f}{\beta_i} - C^* \right]$$

The first expression indicates the weights on each security and they add up to one.

The second shows the relative investment in each security.

Treasury bill rate is considered at the risk-free rate return i.e 7%.

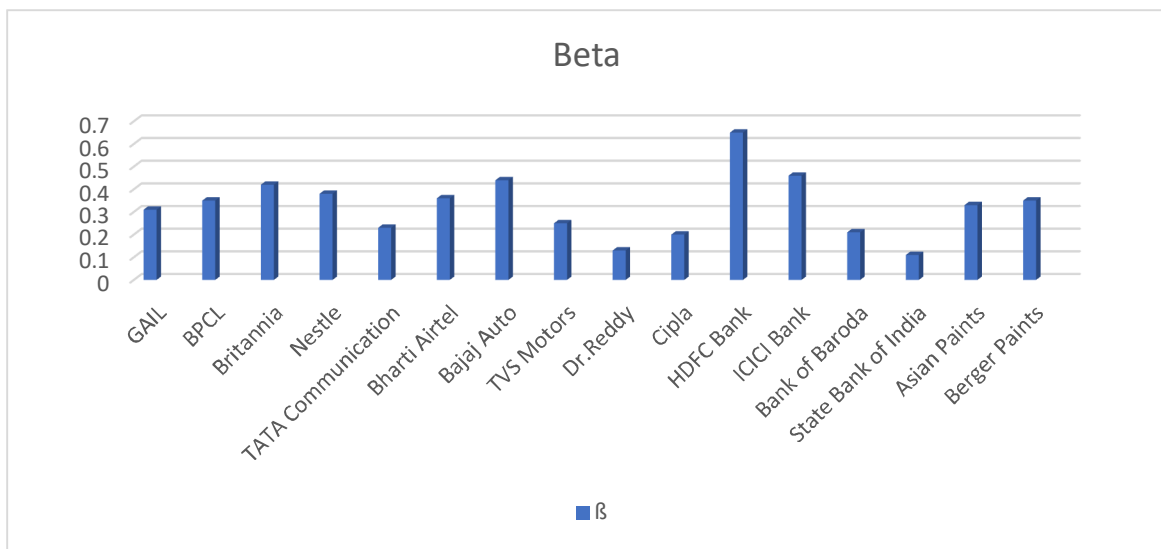
Data Analysis and Interpretation

Table No. 1 Showing the Beta values of all 16 companies.

Companies	β
GAIL	0.31
BPCL	0.35
Britannia	0.42
Nestle	0.38
TATA Communication	0.23
Bharti Airtel	0.36
Bajaj Auto	0.44

TVS Motors	0.25
Dr.Reddy	0.13
Cipla	0.2
HDFC Bank	0.65
ICICI Bank	0.46
Bank of Baroda	0.21
State Bank of India	0.11
Asian Paints	0.33
Berger Paints	0.35

Graph No. 1. Showing the Beta values of all 16 companies.



Interpretation: -

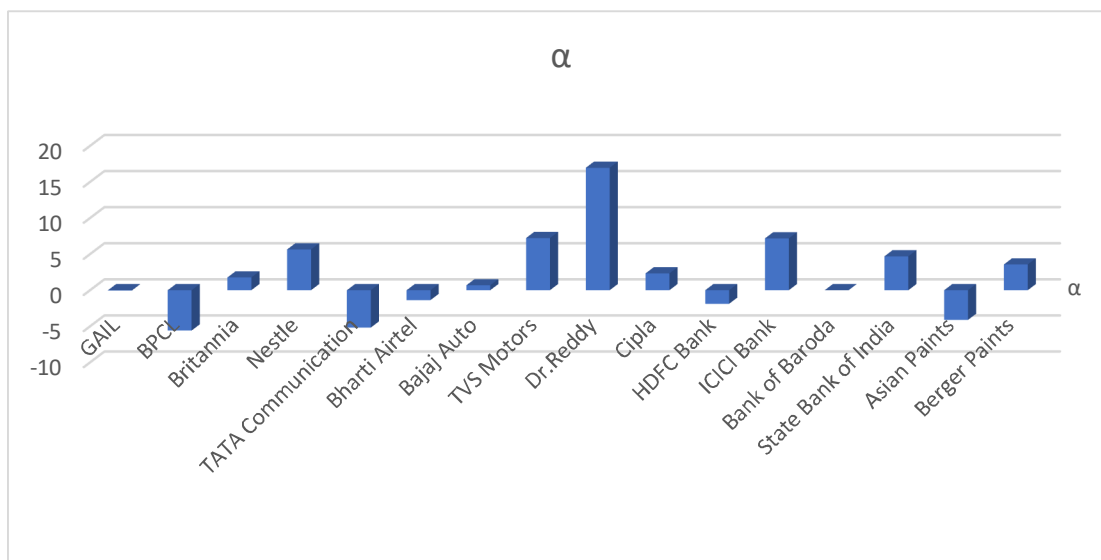
Companies with low beta values (less than 0.5): GAIL, TATA Communication, Dr. Reddy's, Cipla, Bank of Baroda, State Bank of India. These companies are considered less volatile than the overall market, Companies with moderate beta values (between 0.5 and 1): BPCL, Britannia, Nestle, Bharti Airtel, TVS Motors, Asian Paints, Berger Paints. These companies have moderate volatility compared to the market, Companies with high beta values (greater than 1): Bajaj Auto, HDFC Bank, ICICI Bank. These companies are relatively more volatile than the market.

Table No. 2 Showing the Alpha of all 16 companies

Companies	α
GAIL	-0.04
BPCL	-5.59
Britannia	1.77
Nestle	5.65
TATA Communication	-5.18
Bharti Airtel	-1.37

Bajaj Auto	0.68
TVS Motors	7.23
Dr.Reddy	16.96
Cipla	2.33
HDFC Bank	-1.88
ICICI Bank	7.18
Bank of Baroda	-0.0024
State Bank of India	4.694917
Asian Paints	-4.11
Berger Paints	3.57

Graph No. 1. Showing the Alpha values of all 16 companies.



Interpretation: -

Companies with positive alpha values: Britannia, Nestle, Bajaj Auto, TVS Motors, Dr. Reddy's, Cipla, ICICI Bank, State Bank of India, Berger Paints. These companies have performed better than the benchmark or the overall market. Companies with negative alpha values: GAIL, BPCL, TATA Communication, Bharti Airtel, HDFC Bank, Bank of Baroda, Asian Paints. These companies have underperformed compared to the benchmark or the overall market.

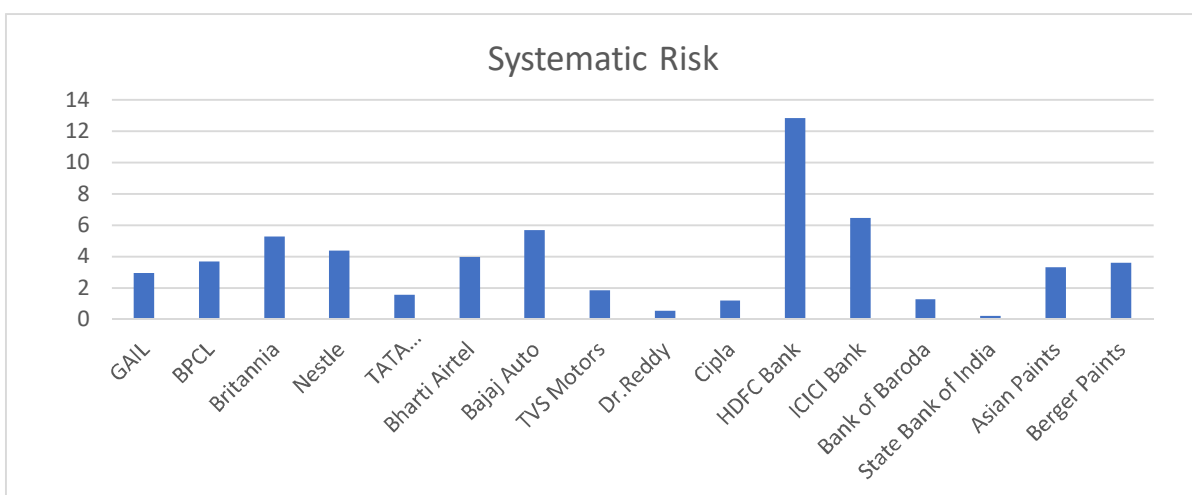
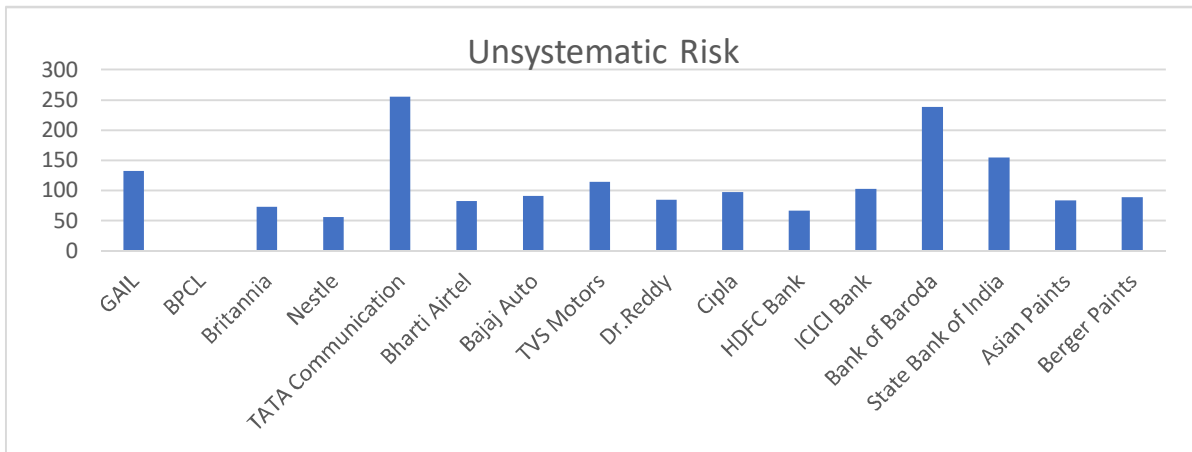
Table No. 3 Showing the calculation of Systematic risk and Unsystematic risk

Securities	σ^2	r	r^2	Systematic Risk	Unsystematic Risk
GAIL	105.57	0.59	0.35	2.95	132.57
BPCL	100.56	0.64	0.41	3.67	126..85

Britannia	47.65	0.53	0.28	5.25	72.35
Nestle	30.39	0.38	0.15	4.37	55.97
Tata Communication	226.38	0.62	0.39	1.53	254.80
Bharti Airtel	56.31	0.50	0.25	3.96	82.30
Bajaj Auto	66.12	0.65	0.42	5.67	90.40
TVS Motors	85.48	0.42	0.18	1.84	113.56
Dr.Reddy	55.25	0.18	0.03	0.54	84.66
Cipla	67.95	0.30	0.09	1.17	96.74
HDFC Bank	49.19	0.84	0.70	12.81	66.33
ICICI Bank	78.70	0.75	0.57	6.44	102.21
Bank of Baroda	208.87	0.55	0.30	1.28	237.55
SBI	127.31	0.56	0.21	0.21	154.283
Asian Paints	56.74	0.46	0.21	3.31	83.38
Berger Paints	61.88	0.50	0.25	3.57	88.26

Table No.4 Showing the Systematic & Unsystematic risk of all 16 companies.

Companies	Systematic Risk	Unsystematic Risk
GAIL	2.95	132.57
BPCL	3.67	126.85
Britannia	5.25	72.35
Nestle	4.37	55.97
TATA Communication	1.53	254.80
Bharti Airtel	3.96	82.30
Bajaj Auto	5.67	90.40
TVS Motors	1.84	113.56
Dr.Reddy	0.54	84.66
Cipla	1.17	96.74
HDFC Bank	12.81	66.33
ICICI Bank	6.44	102.21
Bank of Baroda	1.28	237.55
State Bank of India	0.21	154.283
Asian Paints	3.31	83.38
Berger Paints	3.57	88.26



Interpretations

Systematic Risk: HDFC Bank has the highest systematic risk with a value of 12.81, indicating it is most influenced by market-wide factors. State Bank of India has the lowest systematic risk at 0.21, suggesting it is less affected by overall market movements.

Unsystematic Risk: TATA Communication has the highest unsystematic risk at 254.80, indicating that it has unique company-specific risk factors that are not correlated with the overall market. Bank of Baroda also has a high unsystematic risk of 237.55.

Comparing Companies: While systematic risk varies across the companies, it is generally in the range of 0.21 to 12.81. On the other hand, unsystematic risk shows more variation, ranging from 55.97 to 254.80.

Table No. 5 Showing the calculations of excess return to beta ratio

Stocks	R_i	$R_i - R_f$	β	e_i^2	$\frac{R_i - R_f}{\beta}$	Ranks
GAIL	-0.57	-0.64	0.31	0.35	-2.024	16
BPCL	-0.12	-0.19	0.35	0.41	-0.55	14

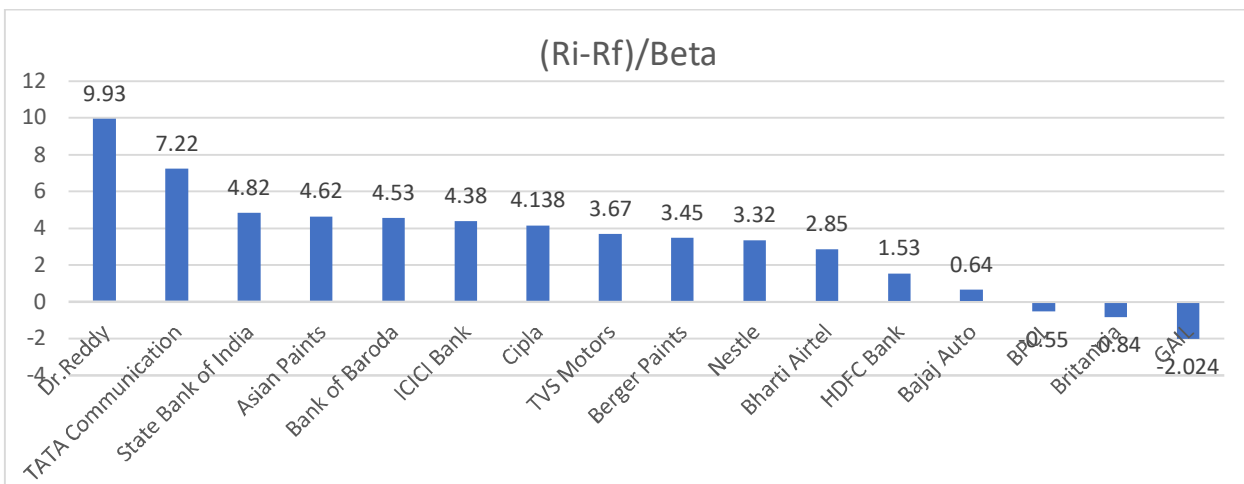
Britannia	0.91	0.84	0.42	0.27	-0.84	15
Nestle	1.34	1.27	0.38	0.15	3.32	10
TATA Communication	1.70	1.63	0.23	0.39	7.22	2
Bharti Airtel	1.10	1.04	0.36	0.25	2.85	11
Bajaj Auto	0.69	0.62	0.96	0.42	0.64	13
TVS Motors	0.98	0.91	0.25	0.18	3.67	8
Dr.Reddy	1.41	1.34	0.13	0.03	9.93	1
Cipla	0.89	0.82	0.2	0.09	4.138	7
HDFC Bank	1.07	1	0.65	0.70	1.53	12
ICICI Bank	2.10	2.03	0.46	0.57	4.38	6
Bank of Baroda	1.01	0.94	0.21	0.30	4.53	5
State Bank of India	1.59	1.52	0.31	0.42	4.82	3
Asian Paints	1.61	1.54	0.33	0.21	4.62	4
Berger Paints	1.26	1.19	0.35	0.25	3.45	9

Interpretation

1. The excess return to beta ratio measures the excess returns generated by a stock relative to its systematic risk (measured by beta). A higher ratio indicates better performance compared to the market, considering the risk taken.
2. Looking at the given data, we observe that TATA Communication has the highest excess return to beta ratio of 7.22, indicating that it has generated significant excess returns relative to its beta.
3. GAIL has the lowest excess return to beta ratio of -2.024, implying that its performance has been poor compared to its systematic risk.
4. Nestle also shows a high excess return to beta ratio of 3.32, indicating good performance relative to its beta.
5. The ranks provided suggest the relative performance of each stock based on their excess return to beta ratio. Stocks with higher ranks have better performance in generating excess returns relative to their beta.

Table No 6 Showing the Excess return to beta ratios of all 10 companies in highest to lowest rank-wise order.

Securities	(Ri-Rf)/Beta	Rank
Dr.Reddy	9.93	1
TATA Communication	7.22	2
State Bank of India	4.82	3
Asian Paints	4.62	4
Bank of Baroda	4.53	5
ICICI Bank	4.38	6
Cipla	4.138	7
TVS Motors	3.67	8
Berger Paints	3.45	9
Nestle	3.32	10
Bharti Airtel	2.85	11
HDFC Bank	1.53	12
Bajaj Auto	0.64	13
BPCL	-0.55	14
Britannia	-0.84	15
GAIL	-2.024	16



Interpretation

1. Dr. Reddy has the highest (Ri-Rf)/Beta value of 9.93, indicating that it has achieved significant excess returns relative to its beta. It holds the top rank in terms of this performance measure.
2. TATA Communication follows closely with an (Ri-Rf)/Beta value of 7.22, ranking second in terms of excess returns relative to beta. State Bank of India, Asian Paints, and Bank of Baroda also show relatively high (Ri-Rf)/Beta values, indicating good performance in generating excess returns compared to their systematic risk.

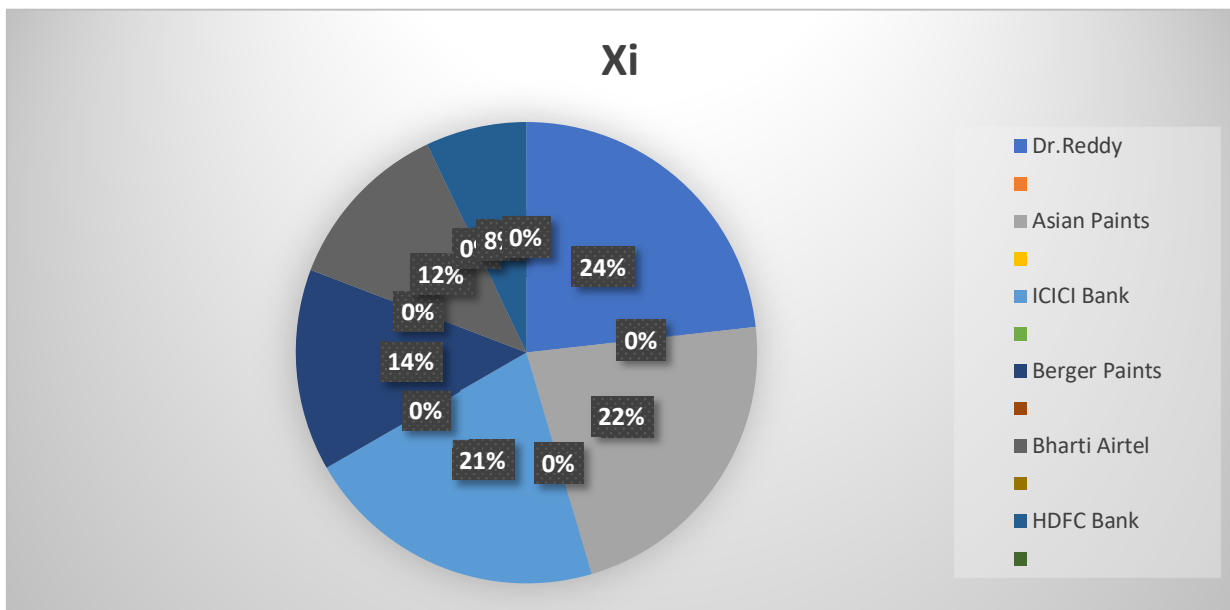
3. On the other hand, GAIL has the lowest (Ri-Rf)/Beta value of -2.024, suggesting poor performance relative to its beta. It ranks last among the securities analysed
4. It is important to note that while a high (Ri-Rf)/Beta value generally implies better performance, it also indicates higher risk. Therefore, it's crucial to consider risk-adjusted measures and other factors when making investment decisions.

Table No. 7 Ci values for each company is calculated using the following formula

Securities	$\frac{(R_i - R_f) * \beta}{\sigma_{e_i}^2}$	$\frac{\Sigma(R_i - R_f) * \beta}{\sigma_{e_i}^2}$	$\sigma_m^2 \frac{\Sigma(R_i - R_f) * \beta}{\sigma_{e_i}^2}$	$\frac{\beta_i^2}{\sigma_{e_i}^2}$	$\Sigma \frac{\beta_i^2}{\sigma_{e_i}^2}$	$\sigma_m^2 \Sigma \frac{\beta_i^2}{\sigma_{e_i}^2}$	Cut Off
Dr,Reddy	0.0033	0.0033	0.0979	0.0003	0.0003	0.0098	0.0969
Asian Paints	0.0090	0.0123	0.3681	0.0019	0.0023	0.0584	0.1444
ICICI Bank	0,0120	0.0243	0.7269	0.0027	0.0050	0.0819	0.2500
Berger Paints	0.0066	0.0309	0.9260	0.0019	0.0069	0.0577	0.4827
Bharti Airtel	0.0067	0.0376	1.1265	0.0024	0.0093	0.0704	0.5053
State Bank of India	0.0038	0.0414	1.2397	0.0008	0.0101	0.0235	0.7728
Cipla	0.0024	0.0438	1.3112	0.0006	0.0106	0.0173	0.8211
Britannia	0.0074	0.0511	1.6113	0.0037	0.0143	0.1103	0.8712
TVS Motors	0.0026	0.0538	1.6113	0.0007	0.0151	0.0216	0.9873
Nestle	-0.0009	0.0529	1.5855	0.0048	0.0199	0.1440	0.8695
HDFC Bank	0.0133	0.0663	1.9848	0.0087	0.0286	0.2605	0.9625
TATA Communication	0.0016	0.0679	2.0338	0.0002	0.0288	0.0068	1.0471
Bajaj Auto	0.0090	0.0769	2.3029	0.0140	0.0427	0.4183	0.9695
BPCL	-0.0022	0.0746	2.2359	0.0041	0.0468	0.1226	0.8886
Bank of Baroda	0.0009	0.0756	2.2638	0.0002	0.0470	0.0062	0.9396
GAIL	-0.0002	0.0754	2.2577	0.0009	0.0480	0.0280	0.9263

Table No. 8 Showing percentage of portfolio investment in each company

Securities	Ci	Zi	Xi
Dr.Reddy	0.0969	0.0217	23%
Asian Paints	0.4827	0.0210	22%
ICICI Bank	0.7728	0.0197	21%
Berger Paints	0.9873	0.0134	14%
Bharti Airtel	0.9625	0.0116	12%
HDFC Bank	1.0471	0.0065	8%



Findings

Risk and return play an important role in making any investment decisions. This study aims at analysing the opportunities that are available for investors as per as returns are concerned and the investment of risk thereof.

1. HDFC Bank has the highest Ci value of 1.0471, indicating a relatively higher numerical value among the given securities.
2. Dr. Reddy has the lowest Ci value of 0.0969, suggesting a comparatively lower numerical value.
3. HDFC Bank has the lowest Zi value of 0.0065, indicating a relatively lower numerical value among the given securities.
4. Berger Paints has the highest Zi value of 0.0217, suggesting a relatively higher numerical value.
5. Dr. Reddy has the highest Xi percentage of 23%, indicating a relatively higher value compared to other securities.
6. HDFC Bank has the lowest Xi percentage of 7%, suggesting a relatively lower value.

Suggestions

- The proportion of investment in each of the stock may change time to time hence the constructed optimal portfolio is subject to change.
- The beta and variance of the stocks may change frequently. So, investors are suggested to observe the market continuously.
- In the present situation study Dr.Reddy, Asian Paints, ICICI Bank, Berger Paints, Bharati Airtel, HDFC Bank are advisable for the investor
- In the present situation study BPCL, Nestle, Bajaj Auto, GAIL are not advisable for

the investors to go for investment.

Conclusions

Investment in individual security is always riskier and therefore investors tend to invest in a group of securities termed as portfolio. Portfolio helps in diversifying the risk and maximizes the returns. It is not as easy task to construct a portfolio which is optimal. It requires analysis of return and risk. Apart from it, the investors must compute the excess return earned for per unit risk, market return, cut off rate and proportion of funds to be invested in individual securities. Thus, this paper attempts to discuss the methodology and computations involved in selecting the stocks for building the portfolio and the proportion of funds to be invested. The study employed Sharpe's Single Index Model for selecting the stocks from BSE Sensex

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