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Markowitz Model Is Right Choice to Investment

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Abstract

Purpose: The main objective of this paper is to study the portfolio selection using Markowitz Model as this model offers better investment alternatives of rational investors.

Design / methodology / approach: The study is empirical in nature and secondary sources have been considered for the study. Data about the opening and closing prices of 10 companies stocks were chosen from the Bombay Stock Exchange (BSE) website. The paper explicates about select 10 stocks based on market capitalization traded at the Bombay Stock Exchange (BSE) in India. Efficient frontier of optimal portfolios was constructed by using Risk and return analysis obtained from Markowitz Model.

Findings: The study found that out of 26 sets of portfolio, only four sets of portfolio were feasible and it was obtained from efficient frontier curve (DEF). Further, the investment on these feasible sets of portfolio is influenced by investors' risk appetite.

Practical Implications: Don't put all your eggs in one basket, the primary objective of diversification is to minimize risk. This study is the new concept of risk and return measurement and their application to selection of optimal portfolios. The Markowitz Model helps to the investors to make better combination or choice of securities in order to reap a higher return at the given level of risk and also lowest risk at the given level of return.

Originality / Value: The value of this study is the selection of efficient portfolio with the help of efficient frontier curve. The Markowitz Model offers optimal construction of portfolios with respect to various level of risk. Investors can reduce their risk by diversification of their investments over the volatility in the capital market. An efficient portfolio is anticipated to give the highest return for a given level of risk (speculators) or lowest risk at the given level of return (risk averse investors).

Keywords: investments, portfolio, risk, return, efficient frontier and Markowitz Model

JEL Classification: G11

I. Introduction

Nowadays several investment avenues are available to individual and institutional investors. A rational investor always attempts to minimize risk and maximize return on his investment. Of the many investment avenues available, investment in the capital market is increasing in the past two decades. The number of investors in

equity shares is also increasing year after year. Investors diversify their investment in more than one security. Risk and return are the two major factors considered by individuals while deciding about the group of securities in which they can invest. The objective of this paper is to enable investors to analyze and select a portfolio using the Markowitz Model developed by Harry Markowitz who is considered the Father of Modern Portfolio Theory.

Harry Markowitz (1952) developed a model that could be used to help investors in the selection of a portfolio. Markowitz's portfolio model is concerned with selecting an optimal portfolio by risk-averse investors. According to this model, the investors should select efficient portfolios, i.e. the portfolio that maximizes return at a given level of risk or minimize risk at a given level of return, which can be formed by combining securities having less than perfect positive correlations in their returns. Markowitz analyzed the implications of the fact that the investors, although seeking high expected returns, generally wish to avoid risk. It is the basis of all scientific portfolio management. Although the expected return on a portfolio is directly related to the expected returns on component securities, it is not possible to deduce portfolio riskiness simply by knowing the riskiness of individual securities. The riskiness of a portfolio depends upon the attributes of individual securities as well as the interrelationships among securities. A portfolio manager by his knowledge, background, and experience is expected to study the various avenues available for profitable investment and advise his client to enable the latter to maximize the return on his investment and at the same time safeguard the funds.

II. Review of Literature

This part of the paper brings out the results of few studies conducted in the area chosen for the study. It was a development of Markowitz's portfolio theory in the 1950s that the modern theory of investment commenced. The capital market theory is an extension of the portfolio theory of Markowitz (1952-1959). The portfolio theory is a description of how rational investors should build efficient portfolios and the capital market. It has been useful to understand the complex relationship between securities returns and risks.

Iyiola Omisore, Munirat Yusuf, and Nwufo Christopher (2012) studied the modern portfolio theory as an investment decision tool. This research paper is an academic exposition into the modern portfolio theory (MPT) written with the primary objective of showing how it aids an investor to classify, estimate, and control both the kind and the amount of expected risk and return in an attempt to maximize portfolio expected return for a given amount of portfolio risk, or equivalently minimize risk for a given level of expected return.

Pawel Wnuk Lipinski (2013) conducted a study titled that “Portfolio selection models based on characteristics of return distributions”. This study is relating to the problem of optimal portfolio selection. The objective of this study is to indicate the best method and criteria for optimal portfolio selection. To achieve the objective six models including such optimization criteria as mean, variance, skewness, kurtosis, and transaction costs are analyzed. The method of fuzzy multi-objective programming is used to transform multiple conflicting criteria into a single objective problem and to find optimal portfolios. All the six models, which allowed investment in

WIG20 stocks and risk-free rate and do not include transaction costs constraint in the model, obtained much better results when it comes to returning, return to risk ratio, and skewness in comparison to WIG, Allianz Akcji FIO and equally weighted portfolio of WIG20 stocks.

Noor Azlinna Azizanand Shahryar Sorooshian (2013) conducted a study on "Stock Market performance and modern portfolio theory: Case on Malaysian stock market and Asian Indices". Stocks market performance measurement has long been regarded as the most interesting part of the investment. Many new methods emerge every year but most of these are rooted in Modern Portfolio theory by Harry Markowitz. In this research paper, the authors have used the efficient frontier from modern portfolio theory to determine the best stocks performance in the KLCI index from 2006-2010.

Purvisha Fadadu, Hiral Mathukiya, and Chetna Parmar (2015) conducted a study on "Portfolio Selection: Using Markowitz Model on selected Sectors Companies in India". The objectives of this study were to calculate the return and risk of scrip regarding portfolio diversification and to evaluate the portfolio return of different portfolios designed for the combination of various sectors companies. FMCG, Banking, IT, Infrastructure, and Automobile sectors were considered for analysis of the proportion of investment with the number of different combinations. It examined the portfolio based on the proportion of Infosys, TATA Motors & DLF script. So with comparison to all other investment proportions, it would more profitable. Portfolio selected based on a high return, low variance, and low risk.

Hui-Shan Lee, Fan-Fah Cheng, and Shyue-Chuan Chong (2016) conducted a study titled that “Markowitz Portfolio Theory and Capital Asset Pricing Model for Kuala Lumpur Stock Exchange: A Case Revisited". This study examined whether CAPM is applicable to forecast the behavior of each stock and its return as well as its validity in the portfolio with stocks listed in Malaysia's main market. It estimated the suitability of the Markowitz model to assess the performance of the Malaysia investment portfolio. This is done within the framework of 2010 to 2014 using weekly data of 60 companies. It concluded that CAPM was a reasonable indicator of stock prices in Malaysia as well as in the portfolio basket. It suggested applying Markowitz's portfolio diversification to reduce the unsystematic risk.

Vinay Kumar (2018) conducted a study titled that "A Simplified Perspective of the Markowitz Portfolio Theory". The purpose of this study was to shed the light on the contributions made by Harry Markowitz in the area of security analysis and portfolio management. The study founded that the lower the correlation between assets, the greater the reduction in risk that can be derived. The study considered the situation in which an investor has exposure to just one asset class, such as to Indian Equities. But if this investor diversified to hold Gilt funds, some of the risks embedded in this portfolio can be removed without necessarily impacting on returns.

III. Research Objectives

The major objectives of this study are:

- To understand the theoretical issues relating to Markowitz Model in portfolio analysis; and
- To test empirically the utility of the Markowitz model in optimal portfolio analysis and construction.

IV. Research Design and Methods

There are various ways and models to analyze the portfolios and build an optimal portfolio when the investors are to make decisions relating to portfolio analysis and construction in the process of their planning for investment. The scope of the present study is limited to understanding and empirically testing the Markowitz Model in portfolio analysis and construction. Out of the 28 stock exchanges in India, the study is limited to the BSE, and out of the thousands of stocks traded, the scope of the present paper is limited to a sample of ten stocks.

Research Methodology: This study is empirical and the data provided in this study was collected from the secondary source. Data about the opening and closing price of 10 companies stocks were chosen from the Bombay Stock Exchange (BSE) website. The top 10 companies were selected according to their market capitalization from those listed in the BSE. And the sample companies chosen are Reliance Industries Ltd, Tata Consultancy services Ltd, HDFC Bank Ltd, Hindustan Unilever Ltd, Infosys Ltd, ICICI Bank Ltd, State Bank of India, Housing development Finance Corp Ltd, ITC Ltd and Bajaj Finance Ltd. The study is covered financial year from1st April 2017 to 31st March 2022. The yearly opening and closing prices of the stock as considered for this period to analyze the individual stock risk and return for the construction of an optimal portfolio, the Markowitz model is applied. Thus, the study has made at the attempt by including the top 10 companies for their market capitalization listed in the Bombay Stock Exchange for the construction of the optimal portfolio. The share prices of selected companies for a period of five years from 2017-2022 have been considered for the portfolio analysis and construction using the Markowitz model.

V. Results and Discussion

This analysis is covered in two parts. The steps involved in computation and tabulation are presented for the convenience of effective learning and also to facilitate data analysis and interpretation.

Steps involved in computations

This part deals with the details about the steps involved in the computation. To compute the individual and portfolio securities risk and return of the sample companies the following steps were followed right from the pertaining the share prices from the website.

The first part is arranged in 3 groups are as follows.

- Group A brings out in the detail the steps that are followed in obtaining opening, closing prices, and the formulae obtained in the computation of risk and return of individual securities as well as the covariance and correlation coefficient of the sample companies.
- Group B describes the details about methods and formulae that are used for computation of portfolio efficient frontier of two stocks and selection of optimal portfolio construction.

- Group C covers details about the steps and formulae that are used for comparison of individual stocks risk and return with the portfolio risk and return using the Markowitz model risk and return of the portfolio

Basic computation of Mean, Standard Deviation, a Correlation coefficient

1. Opening and closing balance of sample stocks are collected from BSE.
2. Step involved in the computation of mean return.

The opening and closing price of the sample securities were collected from the Bombay Stock Exchange. Return is computed by using the following formula for computing the security return.

$$\textbf{Security Return} = \left[\frac{closing\ price - opening\ price}{opening\ price} \times 100\right]$$

After computing the security return, mean return or average return(R_i) is computed as under;

$$\bar{R}_i = \left[\frac{\sum R_i}{N}\right]$$

Computation of Risk

The risk is measured by the standard deviation so, the standard deviation of sample companies are calculated as under;

For computing the standard deviation first we need to find out the variance of security using the following formula.

$$\sigma_i^2 = \frac{\sum R_i - \overline{R_i}}{N}$$

Using the value of the variance of security, we can compute the standard deviation of security. The following formula can be used to compute the standard deviation.

$$\sigma_i = \sqrt{variance}$$

Computation of Covariance

Covariance between two securities can be computed for determining the correlation coefficient relationship between possible Stocks. Covariance value can be computed using the following formula.

$$\rho_q = \frac{\sum (R_i - \bar{R}_i)(R_j - \bar{R}_j)}{N}$$

Computation of Correlation Coefficient

After computing sample companies stocks, using the value of covariance of security, the correlation coefficient can be found using the following formula.

$$r_q = \frac{\sigma_q}{\sigma_i \times \sigma_j}$$

Computation of Weights

After computing of correlation coefficient with the help of the weights can be computed using the following formula.

$$W_1 = \frac{\sigma_2^2 - r_{12}\sigma_1\sigma_2}{\sigma_1^2 + \sigma_2^2 - 2r_{12}\sigma_1\sigma_2}$$

$$W_2 = 1 - W_1$$

Computation of Portfolio Return and Portfolio Risk

Expected Return:

$$R_P = W_1.E(R_1) + W_2.E(R_2)$$

Expected Risk:

$$\sigma_P = \sqrt{W_1^2\sigma_1^2 + W_2^2\sigma_2^2 + 2r_{12}W_1W_2\sigma_1\sigma_2}$$

Table 1: market capitalization followed by top 10 companies in BSE

SL.NO	Company	Market capitalization (Rs. in Crores)
1	Reliance Industries Ltd	16,24,681.08
2	Tata Consultancy Services Ltd	10,95,355.32
3	HDFC Bank Ltd	7,57,659.72
4	Hindustan Unilever Ltd	6,03,551.26
5	Infosys Ltd	6,01,900.14
6	ICICI Bank Ltd	5,22,498.11
7	State Bank of India	4,27,488.90
8	Housing development finance Corp Ltd	4,02,121.99
9	ITC Ltd	3,62,327.81
10	Bajaj Finance Ltd	3,58,138.64

The study has been considered the top 10 companies, namely, Reliance Industries Ltd, Tata Consultancy services Ltd, HDFC Bank Ltd, Hindustan Unilever Ltd, Infosys Ltd, ICICI Bank Ltd, State Bank of India, Housing development Finance Corp Ltd, ITC Ltd and Bajaj Finance Ltd. with respect to their market capitalization from those listed in the BSE (Table.1).

Table 2: Average returns and standard deviations followed by top 10 companies in BSE

SL.NO	Company	Average Return (%)	Standard Deviation (%)
1	Reliance Industries Ltd (RIL)	15.6436	18.9236
2	Tata Consultancy Services Ltd (TCS)	6.9490	26.0442
3	HDFC Bank Ltd (HDFC)	6.1536	31.2533
4	Hindustan Unilever Ltd (HUL)	22.6904	24.5103
5	Infosys Ltd (INFY)	12.5014	41.9267
6	ICICI Bank Ltd (ICICI)	21.0740	20.1121
7	State Bank of India (SBI)	14.3785	29.7120
8	Housing development finance Corp Ltd (HD)	10.9934	17.3991
9	ITC Ltd (ITC)	4.5803	17.9674
10	Bajaj Finance Ltd (BAJAJ)	43.5991	41.4493

The researchers have been evaluated the average returns and standard deviations of the top 10 companies on yearly basis listed on BSE (Table.2). From the Table.2, The Bajaj Finance Ltd has got the highest return of 43.5991% and standard deviation of 41.4493%. In order to construct the optimal portfolio, researchers have been selected stocks with positive returns.

Table 3: Correlation coefficient between each of the Two Asset Portfolios

SL.NO	Two Assets Portfolios	Correlation (r_q)
1	RIL AND TCS	0.2266
2	RIL AND HDFC	-0.6976
3	RIL AND HUL	-0.6180
4	RIL AND INFY	0.3885
5	RIL AND ICICI	0.2438
6	RIL AND SBI	-0.2081
7	RIL AND HD	-0.1503
8	RIL AND ITC	-0.7074
9	RIL AND BAJAJ	-0.2863
10	TCS AND HDFC	0.0609
11	TCS AND HUL	-0.1015
12	TCS AND INFY	0.9379
13	TCS AND ICICI	0.3138

14	TCS AND SBI	0.3722
15	TCS AND HD	0.1900
16	TCS AND ITC	-0.6174
17	TCS AND BAJAJ	0.2187
18	HDFC AND HUL	0.8410
19	HDFC AND INFY	0.0068
20	HDFC AND ICICI	-0.3822
21	HDFC AND SBI	0.0356
22	HDFC AND HD	0.3897
23	HDFC AND ITC	0.2304
24	HDFC AND BAJAJ	0.5028
25	HUL AND INFY	-0.2314
26	HUL AND ICICI	-0.2643
27	HUL AND SBI	-0.2618
28	HUL AND HD	0.6931
29	HUL AND ITC	0.0573
30	HUL AND BAJAJ	0.7226
31	INFY AND ICICI	0.0810
32	INFY AND SBI	0.2152
33	INFY AND HD	-0.0544
34	INFY AND ITC	-0.5927
35	INFY AND BAJAJ	-0.0432
36	ICICI AND SBI	0.6429
37	ICICI AND HD	0.4474
38	ICICI AND ITC	-0.4512
39	ICICI AND BAJAJ	0.4591
40	SBI AND HD	0.0127
41	SBI AND ITC	0.0883
42	SBI AND BAJAJ	0.1700
43	HD AND ITC	-0.5017
44	HD AND BAJAJ	0.9789
45	ITC AND BAJAJ	-0.3956

From the table.3, the researchers have obtained 45 sets of Correlation Coefficients which is from -0.0432 to 0.9379.

The following table shows the Correlation coefficient ranges less than or equal to zero from the two assets portfolios.

Table 4: Correlation coefficient between each of the Two Asset Portfolios

SL.NO	Two Assets Portfolios	Correlation (r_q)
1	RIL AND HDFC	-0.6976
2	RIL AND HUL	-0.6180
3	RIL AND SBI	-0.2081
4	RIL AND HD	-0.1503
5	RIL AND ITC	-0.7074
6	RIL AND BAJAJ	-0.2863
7	TCS AND HDFC	0.0609
8	TCS AND HUL	-0.1015
9	TCS AND HD	0.1900
10	TCS AND ITC	-0.6174
11	HDFC AND INFY	0.0068
12	HDFC AND ICICI	-0.3822
13	HDFC AND SBI	0.0356
14	HUL AND INFY	-0.2314
15	HUL AND ICICI	-0.2643
16	HUL AND SBI	-0.2618
17	HUL AND ITC	0.0573
18	INFY AND ICICI	0.0810
19	INFY AND HD	-0.0544
20	INFY AND ITC	-0.5927
21	INFY AND BAJAJ	-0.0432
22	ICICI AND ITC	-0.4512
23	SBI AND HD	0.0127
24	SBI AND ITC	0.0883
25	SBI AND BAJAJ	0.1700
26	HD AND ITC	-0.5017
27	ITC AND BAJAJ	-0.3956

A main benefit of accumulating a portfolio with low correlation among the constituent securities is a decrease in the volatility of the overall portfolio returns. Therefore out of 45 sets, 26 sets have been considered for the

construction of optimum portfolio based on correlation coefficient values range less than or equal to 0.00 (Tabe.4).

The following table shows the weights, return, and standard deviation of each set in two stocks portfolios

Table 5: Weights, Return, and Standard Deviation of each set in two stock Portfolios

Portfolio Sets	**Two assets Portfolios**	σ_1	σ_2	r_{12}	W_1	W_2	$E(R_1)$	$E(R_2)$	R_P	σ_P
1	RIL AND HDFC	18.9236	31.2533	-0.6976	0.62	0.38	15.64	6.15	12.05	9.17
2	RIL AND HUL	18.9236	24.5103	-0.6180	0.46	0.54	15.64	22.69	19.48	10.51
3	RIL AND SBI	18.9236	29.712	-0.2081	0.66	0.34	15.64	14.38	15.21	14.34
4	RIL AND HD	18.9236	17.3991	-0.1503	0.70	0.30	15.64	10.99	14.27	13.55
5	RIL AND ITC	18.9236	17.9674	-0.7074	0.36	0.64	15.64	4.58	8.58	8.21
6	RIL AND BAJAJ	18.9236	41.4493	-0.2863	0.66	0.34	15.64	43.60	25.11	15.91
7	TCS AND HDFC	26.0442	31.2533	0.0609	0.68	0.32	6.95	6.15	6.69	20.87
8	TCS AND HUL	26.0442	24.5103	-0.1015	0.34	0.66	6.95	22.69	17.33	17.63
9	TCS AND HD	26.0442	17.3991	0.1900	0.72	0.28	6.95	10.99	8.081	20.25

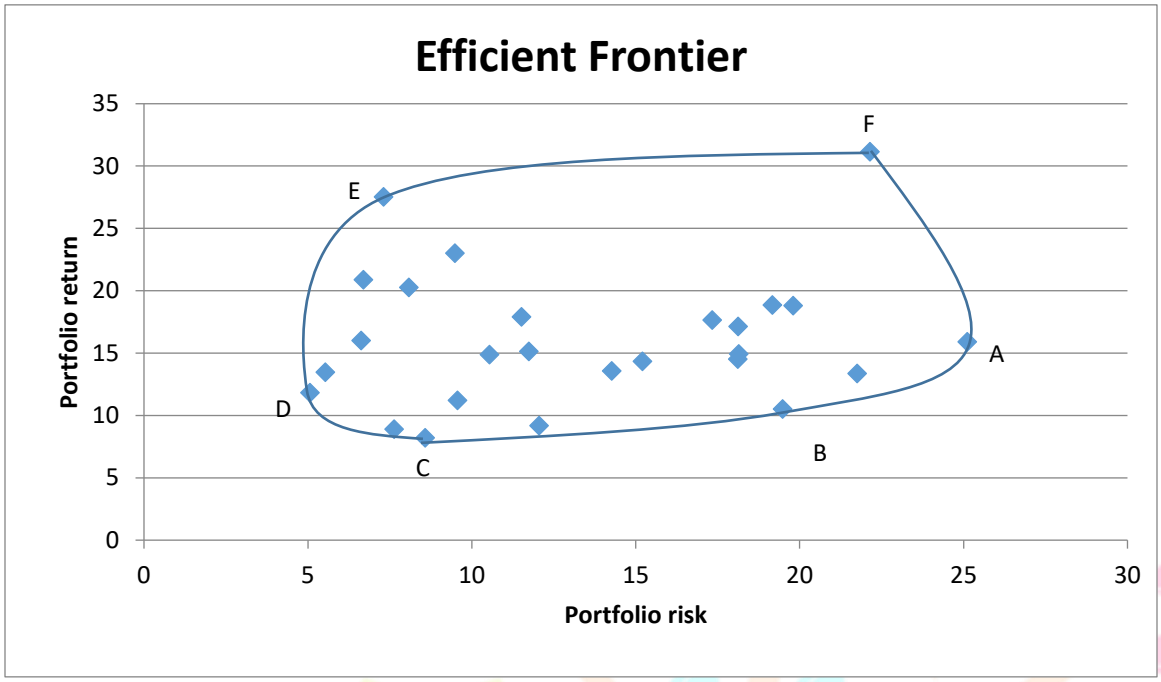
10	TCS AND ITC	26.0442	17.9674	-0.6174	0.20	0.80	6.95	4.58	5.060	11.83
11	HDFC AND INFY	31.2533	41.9267	0.0068	0.82	0.18	6.15	12.50	7.31	27.52
12	HDFC AND ICICI	31.2533	20.1121	-0.3822	0.20	0.80	6.15	21.07	18.14	14.93
13	HDFC AND SBI	31.2533	29.712	0.0356	0.60	0.40	6.15	14.38	9.48	23.02
14	HUL AND INFY	24.5103	41.9267	-0.2314	0.72	0.28	22.69	12.50	19.79	18.79
15	HUL AND ICICI	24.5103	20.1121	-0.2643	0.42	0.58	22.69	21.07	21.76	13.36
16	HUL AND SBI	24.5103	29.712	-0.2618	0.45	0.55	22.69	14.38	21.76	17.14
17	HUL AND ITC	24.5103	17.9674	0.0573	0.33	0.67	22.69	4.58	18.13	14.88
18	INFY AND ICICI	41.9267	20.1121	0.0810	0.22	0.78	12.50	21.074	10.54	18.84
19	INFY AND HD	41.9267	17.3991	-0.0544	0.34	0.66	12.50	10.99	19.17	17.89
20	INFY AND ITC	41.9267	17.9674	-0.5927	0.12	0.88	12.50	4.58	11.51	13.47
21	INFY AND BAJAJ	41.9267	41.4493	-0.0432	0.69	0.31	12.50	43.60	22.14	31.14

22	ICICI AND ITC	20.1121	17.9674	-0.4512	0.30	0.70	21.07	4.58	18.11	11.20
23	SBI AND HD	29.712	17.3991	0.0127	0.22	0.78	14.38	10.99	9.56	15.14
24	SBI AND ITC	29.712	17.9674	0.0883	0.21	0.79	14.38	4.58	11.74	16.00
25	SBI & BAJAJ	29.712	41.4493	0.17	1.07	-0.07	14.38	43.60	12.32	31.44
26	HD AND ITC	17.3991	17.9674	-0.5017	0.48	0.52	10.99	4.58	6.63	8.89
27	ITC AND BAJAJ	17.9674	41.4493	-0.3956	0.65	0.35	4.58	43.60	7.63	14.52

Applying Markowitz minimum variance portfolio formula, the weight of each stock included in 27 portfolios have been calculated which is presented in table.5. The expected return and standard deviation of all 27 sets of two stocks portfolios have been computed. The expected return of the portfolios range between 5.0598 percentages to 25.108 percentage, whereas portfolio risks (standard deviation) ranges between 8.92065 percentages to 31.1445 percentage. Out of 27 sets of portfolio, one portfolio (SBI and Bajaj finance) has got negative weights (1.0705 & -0.0705) hence 26 sets of portfolios have been considered for the construction of optimal portfolio.

The following chart shows the return and standard deviation of 26 sets of portfolios

Chart 1: Efficient Frontier



The chart-1 shows the risk and returns pattern of 26 sets. X-axis represents portfolio risk and Y- axis represents portfolio return. Point C shows the minimum risk level (8.89005 percentage standard deviation) corresponding to the minimum return (5..0598percentage return) whereas point R shows the maximum return(25.108 percentage return) earned at a risk level of 31.1445 percentage standard deviation. The area ABCDEF is the area of all feasible (attainable) portfolios from the sample companies chosen for the study.

The boundary region identified as the curve ABCDEF dominates all other portfolios in the region. The area is known as the Markowitz efficient frontier. DEF includes set D (RIL & ITC), E (HUL & ICICI) and F (INFOSYS &BAJAJ). Hence, as per Markowitz Model, these three sets (portfolios) are efficient portfolios.

As per the risk and return preference of the investors, they will choose the optimal portfolio out of these 3 two portfolios. Those investors with a high appetite for risk will choose set-F and those with a low appetite will choose set-D.

VI. Conclusion

To conclude, risk and return play an imperative role in making any investment decisions. The present paper attempted to help investors in the analysis and selection of portfolios considering their return and risk using the Markowitz model. With the help of Markowitz efficient frontier, an investor can easily find out where to invest h is savings. As per the risk and return preference of the investor, he will choose the optimal portfolio out of certain portfolios. Those investors with high appetite risk will choose high-risk stocks and those with a low appetite will choose low-risk stocks. The Markowitz Model, no doubt, involves several calculations and is time-consuming. This model is suitable for those investors with fewer stocks in their portfolios. When the number of stocks increases Markowitz Model involves procedure and complex calculations which are the major limitation of this model and Sharpe's Single Index Model may be applied under such circumstances.

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