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Construction Of Optimal Portfolio Using Sharpe's Single Index Model: An Empirical Study on Nifty 50 Stocks

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Abstract

The construction of an optimal portfolio has become increasingly challenging in recent years, as investors expect to maximize returns and minimize risks from their respective investments. An investor needs to have proper knowledge of security analysis and portfolio theory for making correct investment decisions. In this study 50 companies of nifty50 listed Stocks have been considered. The daily closing share prices of the stocks from 1 February 2013 to 1 February 2023 have been used in the study. The characteristics such as returns in association with the systematic and unsystematic risk of selected stocks were analyzed. The proportion of investment of each stock included in the optimal portfolio was also computed. The analyses concluded with suggesting proportion of investment that 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. In early 1950, Harry Markowitz developed a comprehensive model which stated that investors can reduce their risk through diversification in the present study Sharpe's Single Index Model (SIM) is used to construct an optimal portfolio. The reason for choosing SIM over the Markowitz Model is that it requires fewer inputs and is easier to calculate. It is named as Single Index Model as it uses only a single index for portfolio construction.

Keywords: Portfolio Management, Sharpe's Single Index, Portfolio Construction.

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Introduction

In financial management, risk management is an important concept. Financial Risk Management can be defined as an act of creating economic value of the firm by effectively managing the exposure to the risk, with judicious use of several financial instruments and sophisticated techniques. The different type of exposure to risk, a firm is subjected to mainly involve credit risk and market risk. Financial risk management can be qualitative and quantitative in approach. In order to determine the optimal asset allocation strategies mathematical models are vastly used by the corporate investors and portfolio managers respectively. The key organizations in finance are households, business firms, financial intermediaries and capital markets. The tradition

in neoclassical economics is to consider the existence of households, their tastes and their endowments as exogenous to the theory. But other economic organizations are regarded as primary because of the functions they serve and are therefore endogenous to the theory. Giving concentration more on household, there are two players – consumer and investor. The consumer chooses how much of his/her income and wealth to allocate to current consumption and thereby, how to save for future consumption. As investor, the household solves the problem to determine the fractional allocation of his/her savings among the available investment opportunities. Risk management plays a critical role in determining the financial dynamics of the corporate investors. However, risk management holds equal significance when individual investors and their investment objectives are considered. Therefore, for this purpose asset management is important for the individual investors. If a person owns more than one asset for investment, he/she has an investment portfolio. A portfolio consists of more than one asset. The main aim of the portfolio owner is to enhance the value of portfolio by selecting investments that yield good returns.

Modern Portfolio Theory

The employment of funds on assets with an aim to earn return and capital appreciation is called investment. There are risk and return involved with every investment. An investor needs to have proper knowledge about security analysis and portfolio theory for making correct investment decisions. This can be done either through traditional or modern approach of portfolio construction. A rational investor wants to maximize his return by minimizing his risk. There are several models having the opinion that, by holding assets from different industries in a portfolio, risk can be considerably reduced. Analysts are of the opinion that when at least 15or more stocks are added to a portfolio, unsystematic risk can considerably be reduced. Studies have shown that systematic risk accounts for about one fourth of the total risk (Mandal, 2013). In the year 1950, Harry Markowitz proposed a new model stating that in order to obtain benefits of diversification, majority of investors invest in a number of securities. He emphasized on the fact that diversification helps to reduce portfolio risk effectively. Markowitz Model is very information intensive and lacks simplicity. As new securities are added in a portfolio, there is greater requirement of computation of co-variance. In order to overcome complexities of Markowitz Model, William Sharpe developed a new and simpler model to analyze the portfolio. According to his model, security's return is correlated to a single index which is usually a market index. All securities that are traded on the exchange will be a part of the market index. The index movement will also indicate the changes in the security prices. Sharpe's Single Index Model (SIM) demands only (3n+2) bits of information whereas it is (n (n+3)/2) bits of information in Markowitz model. In SIM, optimal portfolio is constructed by analysing the reason behind inclusion of a particular stock based on the associated variables under consideration.

The present paper seeks to construct an optimal portfolio using Sharpe's Single Index model and taking into consideration stocks of Nifty 50. The study is relevant in present times because the composition of stocks included in Nifty 50 has changed in recent years and not many authors have constructed optimal portfolio during the period considered for study. This study gains more importance as stocks included in Nifty 50 represent majority of market capitalization of NSE. With the boom in stock market operations post economic reforms and increasing investment in securities in recent years, it would be of great help to present and prospective investors for constructing optimum portfolio and diversify their risk effectively.

Conceptual Framework of Sharpe Index Model (SIM)

Unlike Markowitz's model, this simplified model states that, by comparing return of individual securities with a single index like 'Market Index', relationship existing between each pair of securities can be determined indirectly. The requirements of large data inputs and tedious calculations requirements in Markowitz model is largely reduced (Mandal, 2003). SIM needs only (3n+2) bits of information or simply each security's Alpha and Beta estimates. For SIM, variance of market index, each security's expected return and unsystematic risk also need to be assessed. It has become more popular as compared to Markowitz Model due to its simplicity.

Assumptions underlying Sharpe Index Model

1. All investors have homogeneous expectations.
2. A uniform holding period is taken into consideration for determining the risk and return of eachsecurity.
3. The price movements of securities are greatly influenced by prevailing3economic and businessconditions.
4. The indices, to which the securities return is correlated, are some securities markets proxies.Symbols and notations used:

Ri = return of individual security
Rm = return of market index
Rf = risk free rate of return

Risk or variance of a security comprises of two components

a)systematic risk
b)unsystematic risk.

Variance due to index is the systematic risk and the residual variance is unsystematic risk.

Systematic risk = βi2*variance of market index = βi2σ2m Unsystematic risk = σ^2ei =Total variance-systematic risk
Total risk = Systematic risk + unsystematic risk
Portfolio variance is = σ ^2p
The variance of the return of the security is **σ^2i = βi ^2σ^2m + σ^2ei**

Advantages of Sharpe Index Model

The main benefit of SIM is that it simplifies portfolio construction model and has fewer datainput requirements as compared to Markowitz. It requires (3n+2) data requirements as compared ton(n+3)/ 2 data inputs of Markowitz. It provides an estimate of security's return Aswell return of index. It is an important and easy to use method for calculating optimal portfolio (Chauhan, 2014). Sharpe simplified the numerous and complicated calculations for optimal portfolio construction asrequired in Markowitz model (Nalini, 2014). As compared to its other portfolio counterparts. Sharpemodel incurs lesser daily capital charges as per Basel Capital Accord penalties (McAleer and Veiga ,2008).

Review Of Literature

Jensen (1968) found portfolio performance can be measured by finding the difference between actual and expected returns of a portfolio at a given point of time, taking into account expected returns, risk less rate of return, systematic risk and return on market portfolio. Investors are generally risk averse and they prefer certain rather than uncertain incomes. If they are holding a stock for a longer period or taking additional risks, they want to be compensated through extra return over and above the risk-free rate of return, which is the risk premium.

Edwin et al., (1978) believed that under alternative sets of assumptions about variance and co variance, common stock returns the optimal portfolio can be easily devised by simple ranking. The advantages of using simple ranking are that portfolio managers can easily understand the unique characteristics of stock, which are to be included in the portfolio and the optimal portfolio can be very easily devised without much efforts.

Alexander & Resnick, (1985) stated that the construction of optimal portfolio is based on the composition and location of efficient frontier. To determine these, investors need to find estimates of variance, co variance and expected returns, co variances and variances must be found by the investor. They further conclude that in the presence of a risk-free asset, the efficient portfolio will consist of a combination of both, risk free asset and tangency portfolio.

Naveen (1997) constructed an optimal portfolio using stocks of 30 blue-chip companies listed in BSE. It was found in his study that unsystematic risk or residual variance plays a significant role in determining the proportion of investment in optimal portfolio. He further emphasized that portfolio must be evaluated periodically owing to the volatile nature of stock markets.

Hopkins & Acton, (1999) described a new measure of Risk- adjusted performance of portfolio of assets based on Sharpe ra□o, a widely used methodology for evaluating portfolios.

Bilbao et al., (2006) found that approach to the portfolio selection problem based on Sharpe's single-index model and onFuzzy Sets Theory. Here, Value, ambiguity and fuzziness are three basic concepts involved, representing information on expert Betas. Here, a real portfolio selection problem is presented. In order to select an optimal portfolio, a Goal Programming model has been proposed including imprecise investor's aspirations concerning assets proportions of both, high-and low-risk assets.

Scholz (2006) discussed on overcoming the problems in evaluating fund performance based on ex post Sharpe ratios during periods of declining markets and measure fund performance. This paper presents sample data from US equity mutual funds and establishes refinements to the Sharpe ratio and compares them with the original Sharpe ratio and show normalized Sharpe ratio produces meaningful results, not only for bear markets, butfor any other market period as well.

Achour et al., (2006) described the investment performance of a Canadian portfolio of Canadian public real estate companies is analyzed over the period 1971– Using Sharpe's index of performance, it appears at first sight th5at the portfolio exhibited remarkable superior performance. Moreover, this conclusion is not due to some peculiarity of the Sharpe measure: results using Treynor's measure suggest a similar conclusion.

Francis et al., (2007) examined the performance of funds using wavelet analysis and applies it to an Australian dataset. This method, applied to a multi-horizon Sharpe ratio, shows that the wavelet variance at the short scale is higher than that of the longer scale, implying that an investor with a short investment horizon has to respond to every fluctuation in the realized returns, while for an investor with a much longer horizon, the long-run risk associated with unknown expected returns is not as important as the short-run risk. This is supported by a set of six groups of study.

Taneja & Bansal (2011) found that Single Index Model successfully diversifies almost all unsystematic risk. Andrade and Pratibha Jenifer (2012) studied a sample of six top performing IT companies traded in BSE and the data related to the daily returns of the securities and the market index has been collected through secondary sources. Information has been gathered for a time of three years i.e., 2009 to 2011. It was discovered that the optimal portfolio has been built with five organizations.

Tripathy (2011) applied the model on selected Indian banks' scrips. The author assumed that there is a positive relationship between the banked and individual stocks. Fifteen securities selected of the banks comprised in BANKEX as a sample. The data is based on secondary source for the period from 1st April 2011 to 31st march 2012. It was found that there is a linear relationship between security returns and the common factor that there is no difference among the return of all the banks from the ANOVA.

Andrade & Jenifer, (2012) aimed at developing an optimal portfolio of equity of IT sector through Sharpe's Single Index Model. In this study, a sample of six top performing IT companies traded in BSE has been chosen. The data is related to the daily returns of the securities and the market index has been collected through secondary sources. Data has been collected for a period of three years i.e., 2009 to 2011. It was found that the optimal portfolio has been constructed with five companies.

Debasish et al., (2012) selected a sample fourteen stocks from the various manufacturing sectors like automobiles, cement, paints, textiles oil& refineries and these are traded in the NSE. The daily data for all the stocks for the period Jan 2003 to November 2012 has been considered. Percentage of investment in each of selected stock is decided based on respective beta value, stock movement variance unsystematic risk, return on stock risk free return. Among the fourteen selected companies an optimal portfolio using Sharpe's Single Index Model constituted only three stocks. The proportion of investment to be made was also calculated using Single Index Model. Thus, the literature survey made for the present study showed that there is enough scope for studying the utility of Sharpe's Single Index Model under the Indian conditions especially considering the securities of companies traded through the BSE which is one of the oldest stock exchanges in the world and which is considered as one of the major attractions to any investor, either individual or institutional.

Table 1. Showing The Average Return, Beta and Variances

Security Name	Mean Return (Ri)	Variance	Rf	Market Risk	Unsystematic Risk	Excess Return (Ri-Rf)	Beta^2	Beta^2 Market Var
Adani Enterprise	0.236058	10.5578353	0.0642	1.181081281	9.093975084	0.171858	2.142886741	2.530923417
Adani Ports and Special Economic Zone Ltd	0.087624277	5.802076661	0.0642	1.181081281	4.609263878	0.023424277	1.422802336	1.680445205
Apollo Hospital	0.091998214	4.628003641	0.0642	1.181081281	3.904901753	0.027798214	0.52287634	0.617559458
Asian Paints	0.090961114	2.840714296	0.0642	1.181081281	2.053577041	0.026761114	0.619585057	0.731780313
Axis Bank	0.071578037	5.176786289	0.0642	1.181081281	3.749965614	0.007378037	2.035817238	2.404465631
Bajaj Auto	0.049320702	2.589759701	0.0642	1.181081281	1.801901417	-0.014879298	0.620720676	0.733121571
Bajaj Finserv	0.136449552	4.655895092	0.0642	1.181081281	3.513957258	0.072249552	1.304022016	1.540155994
Bajaj Finance	0.187261857	5.77820122	0.0642	1.181081281	4.492812289	0.123061857	1.652224704	1.95141167
Bharti Airtel	0.060446487	4.056488099	0.0642	1.181081281	3.219844002	-0.003753513	0.699973344	0.826725414
BPCL	0.081648085	4.9588033	0.0642	1.181081281	3.916244415	0.017448085	1.086929029	1.28375153
Brirannia Industries Ltd	0.139420764	2.832245153	0.0642	1.181081281	2.198350145	0.075220764	0.401822881	0.474585483
Cipla	0.053179425	2.840357896	0.0642	1.181081281	2.30126513	-0.011020575	0.29062101	0.343247035
Coal India	0.0330952	3.566510245	0.0642	1.181081281	2.830518207	-0.0311048	0.541684281	0.639773164

Divis Lab	0.099344815	3.965359733	0.0642	1.181081281	3.327598972	0.035144815	0.406738788	0.480391569
Dr.Reddy's Lab	0.036710096	3.366244182	0.0642	1.181081281	3.389417612	-0.027489904	0.000537008	0.00063425
Eicher Motors	0.122868815	4.36541635	0.0642	1.181081281	3.443834802	0.058668815	0.849312549	1.003107154
Grasim Industries	0.070545621	3.540403049	0.0642	1.181081281	2.471998811	0.006345621	1.141487617	1.348189657
HCL Tech	0.101238927	3.135704108	0.0642	1.181081281	2.477542712	0.037038927	0.433176423	0.511616565
HDFC	0.073825806	3.816442728	0.0642	1.181081281	2.754870664	0.009625806	1.126935249	1.331002127
HDFC Bank	0.080123629	2.255810689	0.0642	1.181081281	1.226883077	0.015923629	1.05869203	1.250401339
Hdfc Life Insurance	0.049472501	4.113609457	0.0642	1.181081281	4.202184993	-0.014727499	0.007845626	0.009266321
Hero Motocorp	0.044258708	3.175905313	0.0642	1.181081281	2.299296651	-0.019941292	0.768442746	0.907593343
Hindalco	0.095706057	6.876361322	0.0642	1.181081281	5.436554061	0.031506057	2.073044947	2.448434582
Hindustan Unilever	0.088416042	2.354313013	0.0642	1.181081281	1.755192759	0.024216042	0.358945079	0.423943314
ICICI Bank	0.082728577	4.518495377	0.0642	1.181081281	3.08743195	0.018528577	2.047942533	2.41878659
Indusind Bank	0.073241556	6.90450196	0.0642	1.181081281	5.446305649	0.009041556	2.12633648	2.511376214
Infosys	0.08601873	3.033380001	0.0642	1.181081281	2.297913404	0.02181873	0.540911115	0.638859993
ITC	0.045067108	2.697999481	0.0642	1.181081281	1.951477862	-0.019132892	0.557294528	0.658210135
JSW Steel	0.120005974	5.325711972	0.0642	1.181081281	4.068828106	0.055805974	1.579757051	1.865821481
Kotak Mahindra Bank	0.082598414	3.12475004	0.0642	1.181081281	2.066870635	0.018398414	1.119108837	1.321758499
Larsen & Toubro	0.069118892	3.265279481	0.0642	1.181081281	2.103832727	0.004918892	1.348958564	1.593229709
Mahindra & Mahindra	0.207796243	3.204162778	0.0642	1.181081281	3.014639881	0.143596243	0.035918928	0.042423174
Maruthi Suzuki	0.090046087	3.432934249	0.0642	1.181081281	2.395073914	0.025846087	1.077154074	1.272206514
Nestle	0.07398478	2.269615983	0.0642	1.181081281	1.786498305	0.00978478	0.23340269	0.275667548
NTPC	0.04249795	2.9300003	0.0642	1.181081281	2.197861727	-0.02170205	0.536026891	0.633091327
ONGC	0.025206639	4.816193287	0.0642	1.181081281	3.844632096	-0.038993361	0.943931146	1.114859408
Power Grid Corp	0.065544469	2.463431298	0.0642	1.181081281	1.863931022	0.001344469	0.359400582	0.424481299
Grasim Industries	0.070545621	3.540403049	0.0642	1.181081281	2.471998811	0.006345621	1.141487617	1.348189657
HCL Tech	0.101238927	3.135704108	0.0642	1.181081281	2.477542712	0.037038927	0.433176423	0.511616565
HDFC	0.073825806	3.816442728	0.0642	1.181081281	2.754870664	0.009625806	1.126935249	1.331002127
HDFC Bank	0.080123629	2.255810689	0.0642	1.181081281	1.226883077	0.015923629	1.05869203	1.250401339
Hdfc Life Insurance	0.049472501	4.113609457	0.0642	1.181081281	4.202184993	-0.014727499	0.007845626	0.009266321
Hero Motocorp	0.044258708	3.175905313	0.0642	1.181081281	2.299296651	-0.019941292	0.768442746	0.907593343
Hindalco	0.095706057	6.876361322	0.0642	1.181081281	5.436554061	0.031506057	2.073044947	2.448434582
Hindustan Unilever	0.088416042	2.354313013	0.0642	1.181081281	1.755192759	0.024216042	0.358945079	0.423943314
ICICI Bank	0.082728577	4.518495377	0.0642	1.181081281	3.08743195	0.018528577	2.047942533	2.41878659
Indusind Bank	0.073241556	6.90450196	0.0642	1.181081281	5.446305649	0.009041556	2.12633648	2.511376214
Infosys	0.08601873	3.033380001	0.0642	1.181081281	2.297913404	0.02181873	0.540911115	0.638859993
ITC	0.045067108	2.697999481	0.0642	1.181081281	1.951477862	-0.019132892	0.557294528	0.658210135
JSW Steel	0.120005974	5.325711972	0.0642	1.181081281	4.068828106	0.055805974	1.579757051	1.865821481
Kotak Mahindra Bank	0.082598414	3.12475004	0.0642	1.181081281	2.066870635	0.018398414	1.119108837	1.321758499
Larsen & Toubro	0.069118892	3.265279481	0.0642	1.181081281	2.103832727	0.004918892	1.348958564	1.593229709
Mahindra & Mahindra	0.207796243	3.204162778	0.0642	1.181081281	3.014639881	0.143596243	0.035918928	0.042423174
Maruthi Suzuki	0.090046087	3.432934249	0.0642	1.181081281	2.395073914	0.025846087	1.077154074	1.272206514
Nestle	0.07398478	2.269615983	0.0642	1.181081281	1.786498305	0.00978478	0.23340269	0.275667548
NTPC	0.04249795	2.9300003	0.0642	1.181081281	2.197861727	-0.02170205	0.536026891	0.633091327
ONGC	0.025206639	4.816193287	0.0642	1.181081281	3.844632096	-0.038993361	0.943931146	1.114859408
Power Grid Corp	0.065544469	2.463431298	0.0642	1.181081281	1.863931022	0.001344469	0.359400582	0.424481299
Reliance Industries	0.087467967	3.260042757	0.0642	1.181081281	3.128844733	0.023267967	0.017212921	0.020329859
SBI Life	0.060413439	3.383261572	0.0642	1.181081281	3.362433532	-0.003786561	0.000433807	0.000512362
SBI	0.060492401	4.848260783	0.0642	1.181081281	3.52452695	-0.003707599	1.752271261	2.069574786
Sun Pharma Industries	0.065063969	3.775491367	0.0642	1.181081281	3.103101565	0.000863969	0.452108046	0.53397635
Tata Consumer Products Ltd	0.09144532	4.042772065	0.0642	1.181081281	3.075333182	0.02724532	0.935937992	1.105418843
Tata Motors	0.056474685	7.537524753	0.0642	1.181081281	6.106346994	-0.007725315	2.048269779	2.419173094
Tata Steel	0.130190957	10.03983263	0.0642	1.181081281	8.790758755	0.065990957	1.56018555	1.842705949
TCS	0.087132157	2.426273199	0.0642	1.181081281	1.800008833	0.022932157	0.392207056	0.463228412
Tech Mahindra	0.084395922	3.55818238	0.0642	1.181081281	2.828317213	0.020195922	0.532703162	0.629165733
Titan Co	0.109846543	4.378935591	0.0642	1.181081281	3.468268297	0.045646543	0.829314921	0.97948833
Ultratech Cement	0.071440112	3.22079741	0.0642	1.181081281	2.203679161	0.007240112	1.034529532	1.221863465
UPL	0.11898173	5.398342419	0.0642	1.181081281	4.385599528	0.05478173	1.025648162	1.211373846
Wipro	0.056784369	2.735859336	0.0642	1.181081281	2.117963183	-0.007415631	0.381795655	0.450931702

It is found from Table 1 that stocks like Bajaj Auto, Bharti Airtel, Cipla, Coal India, HDFC Life Insurance, Hero MotoCorp, ITC, NTPC, ONGC, SBI Life, SBI, Tata Motors, and Wipro have negative returns. The negative returns may be due to macroeconomic events taking place inthe economy. Most of the banks listed in Index have Beta either equal to or more than 1. Banks like Axis Bank, HDFC, IndusInd Bank, Kotak Mahindra and SBI have Beta more than 1. ICICI has the highest beta of 1.43. Some securities like Nestle (0.48), Hindustan Unilever (0.59), Britannia (0.63), Divis Lab (.64), Apollo (.72) and Sun Pharma (.67) have beta less than 1. It can be seen that majority of securities

have beta lessthan 1. The movement of such securities is slow than market movement, hence called defensive securities. The investors who are risk averse preferto invest in such securities.

As proposed by Sharpe, stocks which have negative returns should be ignored for selection in optimal portfolio. The securities on the basisof their returns are ranked from (highest to lowest) for selection. Fischer and Jordan (1995) state that stocks to be included in optimal portfolio aredetermined on the basis of their 'excess return to beta ratio.' As per the rule of ranking, security having highest 'excess return to beta ratio 'will beplaced in the first position, followed by the security with second highest beta ratio, and so on and so forth.

Table 2. Showing the Cut-Off Point Calculation

Security Name	Mean Return (Ri)	Variance	Beta	Rf	Market Risk	Beta ^2	Sha rpe	(Ri-Rf) Beta	(Ri-Rf) Beta / Var	Sum (Ri-Rf) Beta / Var	Var market	(Sum (Ri-Rf) Beta / Var) * Var M	Beta ^2/ Var i	Sum Beta ^2/ Var i	(Sum Beta ^2/ Var I) * Var m	1+(Sum Beta ^2/ Var I) * Var m	Cut-off Rate	Ri-Rf	
Dr.Reddy's Lab	0.037	3.36624	-0.023	0.064	1.18108	0.000537	1.186	0.00006	0.00002	0.00002	1.1811	0.00022	0.00018	0.00018	0.00021	1.00021	0.00002	-0.03	yes
Mahindra & Mahindra	0.208	3.20416	0.1895	0.064	1.18108	0.035919	0.758	0.02072	0.00085	0.00087	1.1811	0.01026	0.11551	0.11769	0.13381	1.13381	0.009	0.144	yes
Reliance Industries	0.087	3.26004	0.1312	0.064	1.18108	0.017213	0.177	0.00031	0.00009	0.00096	1.1811	0.01136	0.00561	0.173	0.20043	1.20043	0.00094	0.023	N0
Hdfc Life Insurance	0.049	4.11361	- 0.089	0.064	1.18108	0.007846	0.166	0.00013	0.00003	0.00099	1.1811	0.01174	0.00323	0.20053	0.24025	1.24025	0.00094	-0.01	yes
Britannia Industries Ltd	0.139	2.83225	0.6339	0.064	1.18108	0.401823	0.119	0.04077	0.01668	0.02668	1.1811	0.03162	1.13181	1.34433	1.58066	2.58066	0.01022	0.075	yes
Adani Enterprise	0.236	10.5578	1.4639	0.064	1.18108	2.142887	0.117	0.25216	0.02438	0.05006	1.1811	0.05976	22.624	23.968	28.308	29.308	0.002	0.172	yes
Bajaj Finance	0.187	5.7782	1.2854	0.064	1.18108	1.652225	0.096	0.15582	0.02674	0.078	1.1811	0.09021	9.5469	33.514	39.583	40.583	0.00023	0.123	yes
Eicher Motors	0.123	4.36542	0.9216	0.064	1.18108	0.849313	0.064	0.05541	0.01024	0.09004	1.1811	0.10672	3.7076	37.222	43.962	44.962	0.00024	0.059	yes
Bajaj Finserv	0.136	4.6559	1.1419	0.064	1.18108	1.304022	0.063	0.08025	0.01677	0.10081	1.1811	0.12765	6.0714	43.293	51.133	52.133	0.00024	0.072	yes
HCL Tech	0.101	3.1357	0.6582	0.064	1.18108	0.433176	0.056	0.02044	0.00478	0.11559	1.1811	0.13684	1.3583	44.652	52.737	53.737	0.00025	0.037	Yes
Divis Lab	0.099	3.96536	0.6378	0.064	1.18108	0.406739	0.055	0.02224	0.00557	0.12215	1.1811	0.14351	1.6129	46.265	54.642	55.642	0.00026	0.035	yes
UPL	0.119	5.39834	1.0127	0.064	1.18108	1.025648	0.054	0.05555	0.01003	0.13318	1.1811	0.15565	5.5368	51.801	61.182	62.182	0.00025	0.055	yes
Tata Steel	0.13	10.0398	1.2491	0.064	1.18108	1.560186	0.053	0.08024	0.00082	0.14	1.1811	0.16535	15.664	67.465	79.682	80.682	0.002	0.066	yes
Titan Co	0.11	4.37894	0.9107	0.064	1.18108	0.829315	0.05	0.04016	0.00095	0.14095	1.1811	0.17656	3.6315	71.097	83.971	84.971	0.00021	0.046	yes
JSW Steel	0.12	5.32571	1.2569	0.064	1.18108	1.579757	0.044	0.07001	0.01032	0.16027	1.1811	0.19211	8.4133	79.51	93.908	94.908	0.002	0.056	yes
Hindustan Unilever	0.088	2.35431	0.5991	0.064	1.18108	0.358945	0.04	0.01545	0.00062	0.16888	1.1811	0.19939	0.8451	80.355	94.906	95.906	0.00021	0.024	yes
Apollo Hospital	0.092	4.628	0.7231	0.064	1.18108	0.522876	0.038	0.02001	0.00043	0.17932	1.1811	0.20452	2.4199	82.775	97.764	98.764	0.00021	0.028	yes
TCS	0.087	2.42627	0.6263	0.064	1.18108	0.392207	0.037	0.01544	0.00059	0.17991	1.1811	0.21151	0.9516	83.727	98.888	99.888	0.00021	0.023	yes
Asian	0.09	2.840	0.78	0.0	1.18	0.619	0.03	0.02	0.00	0.18	1.18	0.22	1.76	85.4	100.	101.	0.00	0.0	yes

Paints	1	71	71	64	108	585	4	11	74	65	11	027	01	87	97	97	22	27	
Infosys	0.086	3.03338	0.7355	0.064	1.18108	0.540911	0.03	0.016	0.0053	0.1918	1.18111	0.22652	1.64 08	87.128	102.9	103.9	0.0022	0.022	yes
Tata Consumer Products Ltd	0.091	4.04277	0.9674	0.064	1.18108	0.935938	0.028	0.0264	0.0065	0.1983	1.18111	0.23422	3.7838	90.911	107.37	108.37	0.0022	0.027	yes
Tech Mahindra	0.084	3.55818	0.7299	0.064	1.18108	0.532703	0.028	0.0147	0.0041	0.2025	1.18111	0.23911	1.8955	92.807	109.61	110.61	0.0022	0.02	yes
Maruthi Suzuki	0.09	3.43293	1.0379	0.064	1.18108	1.077154	0.025	0.0268	0.0078	0.2103	1.18111	0.24834	3.6978	96.505	113.98	114.98	0.0022	0.026	yes
Hindalco	0.096	6.87636	1.4398	0.064	1.18108	2.073045	0.022	0.0454	0.0066	0.2169	1.18111	0.25613	14.255	110.76	130.82	131.82	0.0019	0.032	**no**
Nestle	0.074	2.26962	0.4831	0.064	1.18108	0.233403	0.02	0.0047	0.0021	0.2189	1.18111	0.25859	0.5297	111.29	131.44	132.44	0.002	0.01	yes
Adani Ports	0.088	5.80208	1.1928	0.064	1.18108	1.422802	0.02	0.0279	0.0048	0.2238	1.18111	0.26428	8.2552	119.54	141.19	142.19	0.0019	0.023	yes
Kotak Mahindra Bank	0.08	3.12475	1.0579	0.064	1.18108	1.119109	0.017	0.0195	0.0062	0.23	1.1811	0.27164	3.4969	123.04	145.32	146.32	0.0019	0.018	yes
BPCL	0.08	4.958	1.04	0.0	1.18	1.086	0.01	0.01	0.00	0.23	1.18	0.27	5.38	128.	151.	152.	0.00	0.0	yes
HDFC	0.08	2.255	1.02	0.0	1.18	1.058	0.01	0.01	0.00	0.24	1.18	0.28	2.38	130.	154.	155.	0.00	0.0	yes
ICICI	0.08	4.518	1.43	0.0	1.18	2.047	0.01	0.02	0.00	0.24	1.18	0.29	9.25	140.	165.	166.	0.00	0.0	**no**
HDFC	0.074	3.81644	1.0616	0.064	1.18108	1.126935	0.009	0.0102	0.0027	0.2495	1.18111	0.29464	4.3009	144.37	170.52	171.52	0.0017	0.01	**no**
Ultratech Cement	0.071	3.2208	1.0171	0.064	1.181.18	1.03453	0.0074	0.0074	0.0023	0.2518	1.1811	0.29734	3.332	147.71	174.45	175.45	0.0017	0.007	**N0**
Indusind bank	0.071	6.9045	1.4582	0.064	1.18108	2.126336	0.007	0.0132	0.0023	0.2518	1.1811	0.29734	14.681	162.39	191.79	192.79	0.0016	0.016	NO
Industries	0.071	3.5404	1.0684	0.064	1.18108	1.141488	0.006	0.0068	0.0010	0.2556	1.1811	0.30186	4.0413	166.43	196.37	197.57	0.0015	0.006	NO
Axis Bank	0.072	5.17679	1.4268	0.064	1.18108	2.035817	0.005	0.0105	0.0005	0.2576	1.1811	0.30426	10.539	176.97	209.01	210.011	0.0014	0.007	NO
Larsen &Toubro	0.069	3.26528	1.1614	0.064	1.18108	1.348949	0.0027	0.0025	0.0017	0.2594	1.1811	0.30633	4.4047	181.37	214.22	215.22	0.0014	0.005	no
Power Grid Corp	0.065	2.46349	0.5995	0.0108	1.18108	0.359	0.0056	0.0077	0.0088	0.2597	1.18108	0.3056	0.8826	182.28	215.23	216.23	0.00456	0.078	no
Sun Pharm	0.065	3.77549	0.6724	0.064	1.18108	0.452	0.00567	0.0045	0.00258	0.2545	1.1824	0.3038	1.70345	183.234	217.23	218.24	0.00456	9E-04	no
SBI	0.06	4.84826	1.3237	0.064	1.18108	1.752271	-0.003	-0.005	-0.001	0.2588	1.1811	0.3057	8.4955	192.46	227.31	228.31	0.0013	-0	**no**
Bharti Airtel	0.06	4.05649	0.8366	0.064	1.18108	0.699973	-0.004	-0.003	-8E-04	0.2581	1.1811	0.30478	2.8394	195.3	230.66	231.66	0.0013	-0	**no**
Tata Motors	0.056	7.53752	1.4312	0.064	1.18108	2.048 27	-0.005	-0.011	-0.001	0.2566	1.1811	0.30305	15.439	210.74	248.9	249.9	0.0012	0.01	**no**
Wipro	0.057	2.73586	0.6179	0.064	1.18108	0.381796	-0.012	-0.005	-0.002	0.2549	1.1811	0.30107	1.0445	211.78	250.13	251.13	0.0012	00.1	**no**

Bajaj Auto	0.049	2.58976	0.7879	0.064	1.18108	0.620721	-0.019	-0.012	-0.005	0.25 04	1.1811	0.29573	1.6075	213.39	252.03	253.03	0.0012	- 0.01	**no**
Cipla	0.053	2.84036	0.5391	0.064	1.18108	0.290621	-0.02	-0.006	-0.002	0.24 83	1.1811	0.29326	0.8255	214.22	253.01	254.01	0.0012	- 0.01	**no**
Hero Motocorp	0.044	3.17591	0.8766	0.064	1.18108	0.768443	- 0.023	- 0.017	- 0.006	0.24 28	1.1811	0.28676	2.4405	216.66	255.89	256.89	0.0011	- 0.02	no
ITC	0.045	2.698	0.7465	0.064	1.18108	0.557295	- 0.026	- 0.014	- 0.005	0.23 75	1.1811	0.28 05	1.5036	218.16	257.66	258.66	0.0011	- 0.02	no
NTPC	0.042	2.93	0.7321	0.064	1.18108	0.536027	- 0.03	- 0.016	- 0.005	0.23 21	1.1811	0.27 41	1.5706	219.73	259.52	260.52	0.0011	- 0.02	no
ONGC	0.025	4.81619	0.9716	0.064	1.18108	0.943931	- 0.04	- 0.038	- 0.008	0.22 42	1.1811	0.26481	4.5462	224.28	264.89	265.89	0.001	- 0.04	no
Coal India	0.033	3.56651	0.736	0.064	1.18108	0.541684	- 0.042	- 0.023	- 0.006	0.21 78	1.1811	0.25723	1.9319	226.21	267.17	268.17	0.001	- 0.03	no
SBI Life	0.06	3.38326	0.0208	0.064	1.18108	0.000434	- 0.182	-8E- 05	-2E- 05	0.21 78	1.1811	0.25 72	0.0015	226.21	267.17	268.17	0.001	-0	no

It is seen from Table 2 that Mahindra & Mahindra occupies the first place as per ranking, followed by Britannia Industries. Stocks with negative returns are excluded. Out of 50 stocks considered, only 27 stocks are finally selected for consideration which is shown below:

Table 3. Showing the Cut-off point

Security Name	**Mean Return (Ri)**	**Variance**	**Beta**	**Rf**	**Market Risk**	**Beta^2**	**Sharpe**	**(Ri-Rf) Beta**	**(Ri-Rf) Beta / ar**	**Sum (Ri-Rf) Beta / Var**	**Var market**	**(Sum (Ri-Rf) Beta / Var) * Var M**	**Beta^2/ Var i**	**Sum Beta^2/ Var i**	**(Sum Beta^2/ VarI) * Var m**	**1+(Sum Beta^2/VarI) * Var m**	**Cut-off Rate**	**ri-rf**
Mahindra & Mahindra	0.208	3.204	0.19	0.064	1.181	0.036	0.758	0.03	0.008	0.009	1.181	0.01	0.12	0.117	0.138	1.138	0.00901	0.14
Reliance Industries	0.087	3.26	0.131	0.064	1.181	0.017	0.177	0	9E-04	0.01	1.181	0.01	0.06	0.173	0.204	1.204	0.00943	0.02
Brirannia Industries Ltd	0.139	2.832	0.634	0.064	1.181	0.402	0.119	0.05	0.017	0.027	1.181	0.03	1.14	1.343	1.587	2.587	0.01222	0.08
Adani Enterp rise	0.236	10.56	1.464	0.064	1.181	2.143	0.117	0.25	0.024	0.051	1.181	0.06	22.6	23.97	28.31	29.31	0.00204	0.17
Bajaj Financ e	0.187	5.778	1.285	0.064	1.181	1.65 2	0.096	0.16	0.027	0.078	1.181	0.09	9.55	33.51	39.58	40.58	0.002 27	0.12
Eicher Motors	0.123	4.365	0.922	0.064	1.181	0.849	0.064	0.05	0.012	0.009	1.181	0.11	3.71	37.22	43.96	44.96	0.00237	0.06
Bajaj Finserv	0.136	4.656	1.142	0.064	1.181	1.304	0.063	0.08	0.018	0.108	1.181	0.13	6.07	43.29	51.13	52.13	0.00245	0.07

HCL Tech	0.101	3.136	0.658	0.064	1.181	0.433	0.056	0.02	0.008	0.116	1.181	0.14	1.36	44.65	52.74	53.74	0.00255	0.04
DivisLab	0.099	3.965	0.638	0.064	1.181	0.407	0.055	0.02	0.006	0.122	1.181	0.14	1.61	46.26	54.64	55.64	0.00258	0.04
UPL	0.119	5.398	1.013	0.064	1.181	1.026	0.054	0.06	0.001	0.132	1.181	0.16	5.54	51.8	61.18	62.18	0.0025	0.05
TataSteel	0.13	10.04	1.249	0.064	1.181	1.56	0.053	0.08	0.008	0.14	1.181	0.17	15.7	67.47	79.68	80.68	0.00205	0.07
TitanCo	0.11	4.379	0.911	0.064	1.181	0.829	0.05	0.04	0.009	0.149	1.181	0.18	3.63	71.1	83.97	84.97	0.00208	0.05
JSW Steel	0.12	5.326	1.257	0.064	1.181	1.58	0.044	0.07	0.013	0.163	1.181	0.19	8.41	79.51	93.91	94.91	0.00202	0.06
Hindustan Unilever	0.088	2.354	0.599	0.064	1.181	0.359	0.04	0.01	0.006	0.169	1.181	0.2	0.85	80.36	94.91	95.91	0.00208	0.02
Apollo Hospital	0.092	4.628	0.723	0.064	1.181	0.523	0.038	0.02	0.004	0.173	1.181	0.2	2.42	82.78	97.76	98.76	0.002 07	0.03
TCS	0.087	2.426	0.626	0.064	1.181	0.392	0.037	0.01	0.006	0.179	1.181	0.21	0.95	83.73	98.89	99.89	0.00212	0.02
Asian Paints	0.091	2.841	0.787	0.064	1.181	0.62	0.034	0.02	0.007	0.186	1.181	0.22	1.76	85.49	101	102	0.00216	0.03
Infosys	0.086	3.033	0.735	0.064	1.181	0.541	0.03	0.02	0.005	0.192	1.181	0.23	1.64	87.13	102.9	103.9	0.00218	0.02
Tata Consumer Products Ltd	0.091	4.043	0.967	0.064	1.181	0.936	0.028	0.03	0.007	0.198	1.181	0.23	3.78	90.91	107.4	108.4	0.00216	0.03
Tech Mahindra	0.084	3.558	0.73	0.064	1.181	0.533	0.028	0.01	0.004	0.202	1.181	0.24	1.9	92.81	109.6	110.6	0.00216	0.02
Maruthi Suzuki	0.09	3.433	1.038	0.064	1.181	1.077	0.025	0.03	0.008	0.21	1.181	0.25	3.7	96.5	114	115	0.00216	0.03
Hindalco	0.096	6.876	1.444	0.064	1.181	2.073	0.022	0.05	0.007	0.217	1.181	0.26	14.3	110.8	130.8	131.8	0.00194	0.03
Adani Ports	0.088	5.802	1.193	0.064	1.181	1.423	0.02	0.03	0.005	0.224	1.181	0.26	8.26	119.5	141.2	142.2	0.00186	0.02
Kotak Mahindra Bank	0.083	3.125	1.058	0.064	1.181	1.119	0.017	0.02	0.006	0.23	1.181	0.27	3.5	123	145.3	146.3	0.001 86	0.02
BPCL	0.082	4.959	1.043	0.064	1.181	1.087	0.017	0.02	0.004	0.234	1.181	0.28	5.39	128.4	151.7	152.7	0.00181	0.02
HDFC Bank	0.08	2.256	1.029	0.064	1.181	1.059	0.015	0.02	0.007	0.241	1.181	0.28	2.39	130.8	154.5	155.5	0.00183	0.02
ICICI Bank	0.083	4.518	1.431	0.064	1.181	2.048	0.013	0.03	0.006	0.247	1.181	0.29	9.25	140.1	165.4	166.4	0.00175	0.02

The securities are arranged in descending order on the basis of their 'excess return to beta ratio.' finally the value of C* for each of the securities are calculated using the formula

$$Ci=\sigma^2m\sum(Ri-Rf)\ \beta/\sigma^ei\ 1+\ \sigma^2m\sum\ \beta i^2/\sigma^ei.$$

From the table it is found that excess return to beta ratio of 27 securities exceed the value of C*. The cut off rate is .19. Out of total 50 stocks considered for the study, only 24 stocks having their 'excess return to beta ratio 'above cut off rate of (.0122) are eligible for inclusion in optimal portfolio. It can be seen from the (Table 2) that in the optimal portfolio maximum stocks are from banks. Banks like HDFC, ICICI and Kodak Mahindra are part of the optimal Portfolio. The stocks of companies like Adani Enterprise, Bajaj Finance, Eicher Motors, Bajaj Finserv, Divis Lab are also a part of this portfolio. Once the composition of stocks included in optimal portfolio is determined, the final step is to find proportion of each of these selected stocks in portfolio. The proportion of amount to be invested in each stock gives a fair idea to the investor. It describes as to how the total investment needs to be allocated amongst the various selected stocks to get the maximum benefits of the optimum portfolio. Table 3 shows the proportion to be invested in various stocks which comprise of the optimal portfolio.

Table 4. Showing the Weightage calculation of Optimal Portfolio

Security Name	Mean Return (Ri)	Variance	Beta	Rf	Cut-off Rate	Market Risk	Beta/var	Ri-Rf/Beta	Ri-Rf/Beta - C	Zi = Beta/Var * Ri-Rf/Beta - C	Wi =zi/sumzi	% 0f investment
Mahindra & Mahindra	0.21	3.2	0.19	0.06	0.009	1.18	0.06	0.76	0.75	0.04409	0.19841	19.84
Reliance Industries	0.09	3.26	0.13	0.06	0.009	1.18	0.04	0.18	0.17	0.00665	0.02990	2.99
Brirannia Industries Ltd	0.14	2.83	0.63	0.06	0.012	1.18	0.22	0.12	0.11	0.02382	0.10720	10.72
Adani Enterprise	0.24	10.6	1.46	0.06	0.002	1.18	0.14	0.12	0.11	0.01458	0.06562	6.562
Bajaj Finance	0.19	5.78	1.29	0.06	0.002	1.18	0.22	0.1	0.08	0.01858	0.08360	8.36
Eicher Motors	0.12	4.37	0.92	0.06	0.002	1.18	0.21	0.06	0.05	0.01086	0.04886	4.886
Bajaj Finserv	0.14	4.66	1.14	0.06	0.002	1.18	0.25	0.06	0.05	0.01252	0.05634	5.634
HCL Tech	0.1	3.14	0.66	0.06	0.003	1.18	0.21	0.06	0.04	0.00925	0.04161	4.161
Divis Lab	0.1	3.97	0.64	0.06	0.003	1.18	0.16	0.06	0.04	0.00690	0.03104	3.104
UPL	0.12	5.4	1.01	0.06	0.003	1.18	0.19	0.05	0.04	0.00785	0.03534	3.534
Tata Steel	0.13	10	1.25	0.06	0.002	1.18	0.12	0.05	0.04	0.00505	0.02273	2.273
Titan Co	0.11	4.38	0.91	0.06	0.002	1.18	0.21	0.05	0.04	0.00788	0.03547	3.547
JSW Steel	0.12	5.33	1.26	0.06	0.002	1.18	0.24	0.04	0.03	0.00759	0.03417	3.417
Hindustan Unilever	0.09	2.35	0.6	0.06	0.002	1.18	0.25	0.04	0.03	0.00717	0.03229	3.229
Apollo Hospital	0.09	4.63	0.72	0.06	0.002	1.18	0.16	0.04	0.03	0.00410	0.01843	1.843
TCS	0.09	2.43	0.63	0.06	0.002	1.18	0.26	0.04	0.02	0.00630	0.02833	2.833
Asian Paints	0.09	2.84	0.79	0.06	0.002	1.18	0.28	0.03	0.02	0.00603	0.02715	2.715
Infosys	0.09	3.03	0.74	0.06	0.002	1.18	0.24	0.03	0.02	0.00423	0.01903	1.903
Tata Consumer Products Ltd	0.09	4.04	0.97	0.06	0.002	1.18	0.24	0.03	0.02	0.00381	0.01716	1.716
Tech Mahindra	0.08	3.56	0.73	0.06	0.002	1.18	0.21	0.03	0.02	0.00317	0.01426	1.426
Maruthi Suzuki	0.09	3.43	1.04	0.06	0.002	1.18	0.3	0.02	0.01	0.00383	0.01725	1.725
Hindalco	0.1	6.88	1.44	0.06	0.002	1.18	0.21	0.02	0.01	0.00202	0.00910	0.91
Adani Ports	0.09	5.8	1.19	0.06	0.002	1.18	0.21	0.02	0.01	0.00152	0.00686	0.686
Kotak Mahindra Bank	0.08	3.12	1.06	0.06	0.002	1.18	0.34	0.02	0.01	0.00175	0.00787	0.787
BPCL	0.08	4.96	1.04	0.06	0.002	1.18	0.21	0.02	0	0.00095	0.00427	0.427
HDFC Bank	0.08	2.26	1.03	0.06	0.002	1.18	0.46	0.02	0	0.00148	0.00667	0.667

ICICI Bank	0.08	4.52	1.43	0.06	0.002	1.18	0.32	0.01	0	0.00023	0.00103	0.103
									Sum Zi =	0.22223		

Findings

1. It is found that out of 50 stocks considered for study, only 27 stocks are chosen for inclusion in optimal portfolio (Fig 1). The 'excess return to beta ratio' of only 27 stocks was above the calculated cut off rate of .0122.
2. Out of 27 stocks selected, the maximum number of stocks is from the Software industry. Stocksof HCL Tech, TCS, Infosys are a part of optimal portfolio. Stocks of companies like Kotak Mahindra,ICICI Bank, HDFC Bank from the Banking sector are also included in the optimal portfolio.
3. It was found in the study that maximum proportion of 19.84 percent should be invested in Mahindra & Mahindra and 10.71 percent in Britannia Industries and least .10 percent is to be invested in ICICI Bank.
4. Systematic risk is less than Unsystematic risk in SIM. It can be reduced through diversification.
5. In the study it was found beta of most of the banks was more than 1 with ICICI having beta of
6. 1.43. These stocks are said to be aggressive as their returns change more than proportional change in market.
7. Majority of the stocks are found to have their beta less than 1 and hence can be termed as defensive securities. Investors who are risk averse may prefer to invest in such type of securities.

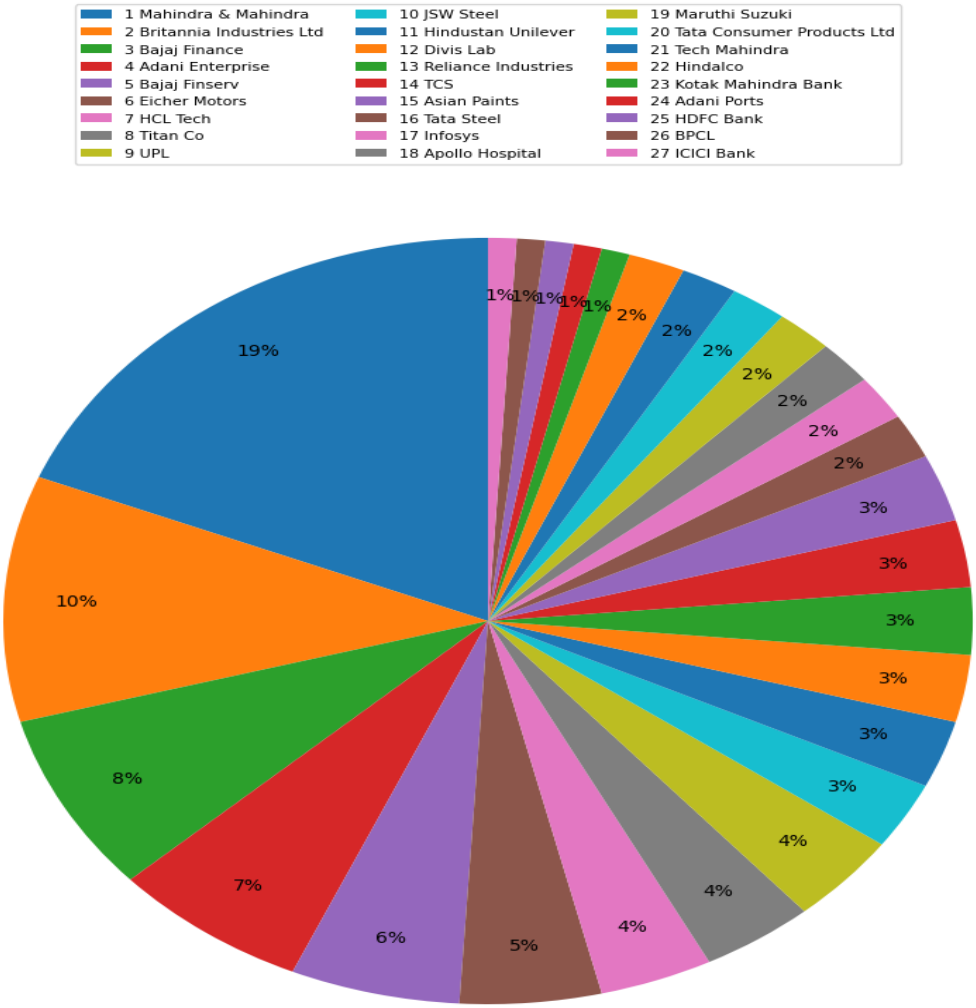


Fig.1. Percentage Allocation of Investments Across the Portfolio

Suggestions

a) Based on the percentage of investment calculated in table 4, a pie chart is created as shown below
b) The highest proportion of investment of 19.84 percent can be made in Mahindra&Mahindra and investment of 10.71 percent in Britannia, followed by 8.36 percent in Bajaj Finance.
c) An investment of 6.56 percent can be invested in Adani Enterprise, 5.63 percentin Bajaj Finserv, 4.88 percent in Eicher Motors, 4.16 percent in HCL Tech, 3.54 percent in Titan Co and 2.99 in Reliance Industries.
d) The lowest proportion of 0.10 percent has to be invested in ICICI Bank.

Conclusion

The task of construction of optimal portfolio is tough and challenging both for institutional as well as individual investors. This paper attempts to construct an optimal portfolio taking 50 stocks of Nifty 50 Index. As evident from the above study, only 27 stocks fulfill the selection criteria of being included in Optimal portfolio. Majority of the stocks who are part of the optimal portfolio are Banking & Financial Services. This indicates that financial sector is growing rapidly and stocks of financial sector are providing consistent and assured returns. There are macro and general economic factors which also affect the securities movement and their selection. These factors should also be considered while selecting securities for optimal portfolio. In emerging economies like India where Foreign Institutional Investors are investing through stock markets, the role of this model has increased manifold. In recent years the rising Sensex and Nifty have also attracted potential investors towards stock market for consistent returns and assured returns. It has become a lucrative avenue for investment. This study can be helpful in the field of investment finance. Further studies can be made on other indices and a variety of optimal portfolio can be created.

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