

A Review of Portfolio Optimization using Modern Portfolio Theory and Single Index Model.

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**Abstract:** The present study is conducted to review the two standard approaches of portfolio optimization. The study reviewed the literature in three parts; first part is related to Modern Portfolio Theory propounded by Harry Markowitz, second part of literature review is related to studies conducted using Sharpe's Single Index and lastly third part consists of comparison between both the models for portfolio optimization. After reviewing the literature, it was found out that some of the studies that were conducted to compare the optimal portfolio using Markowitz and Sharpe's single index approaches have come to conflicting conclusions. While some of the studies have concluded that there is difference in the characteristics of the portfolios constructed using Markowitz and Sharpe model, others have concluded that there is no difference in the characteristics of the portfolios formed by any of these models.

**Keywords:** *Investment, portfolio optimization, Modern portfolio Theory, Sharpe's Single Index Model.*

## **1. Introduction**

Investments play an important role in present dynamic environment and the craze of investing is flourishing day by day. In the era of modernization, numerous opportunities are available for investors to invest. But as per as investment decision is concerned, it depends upon different things but there is no denying the fact that risk and return play a prominent role in investment decision making. These are the two main factors that investors are looking for, at the time of making decision regarding investment. Thus, Investment opportunity is what we all are looking for every now and then, a course of action that leads to generate maximum return with minimum of risk. Now a days, many of the investment alternatives are

available offering good returns but preference to avail any of these alternative depends upon investors' capacity and some other factors such as need of income and financial goals, age group and sex, knowledge and awareness about opportunities, risk appetite, motivation etc. One of the most widely used alternatives is investing in equity market. In equity market itself, investors have number of choices such as individual securities, debt instruments or ETF's that holds assets such as stocks, commodities, or bonds. But investors are not interested in investing whole amount in single security as they are realizing the importance of the phrase: "Don't put all your eggs in one basket"(Cervantes, 1605). This is the concept of portfolio. When an investor distribute his money to be invested among various investment instruments i.e. mutual funds, bonds, equity, cash and treasury bills and this combination of different instruments makes it a "Portfolio". The motive behind the diversification of complete investment among various instruments is to get the maximum return at minimum risk as making investment in more than one security could bring down the variation in the return of overall portfolio. Thus, risk from one security can be offset by the return of another security which ultimately reduces the portfolio risk. Portfolio theory is an investment approach developed by University of Chicago economist Harry M. Markowitz (1927), who won a Nobel Prize in economics in 1990. (greekshares.com)

### **1.1 Portfolio Optimization**

The investments come across various classes of investment. The decision process seems quite confusing due to considering the number of possible assets and the various possible proportions in which each can be held. The process of investment consists of two tasks viz. Construction of optimal portfolio and management of optimal portfolio. Investors with portfolios of equities and bonds are generally aware that their asset allocation decisions and the proportions of funds they invest in the asset classes of different companies. While deciding the appropriate allocation, the investors usually make the simplifying assumption that their objective is to maximize expected return for a given level of risk. The questions of how to optimize the returns by investing in appropriate asset classes and constructing optimal portfolios and how to manage the optimal portfolios by selecting a proper portfolio management strategy have always attracted the attention of the investors. The appropriate solutions for investment decisions pave the way for perfect achievements. To construct the optimal portfolios, the first step is defining an opportunity set and delineating the efficient frontier and the next step is selection of the optimal portfolio according to investor's attitude toward risk. In the management of optimal portfolios, it is necessary to analyse alternative

portfolio management strategies and find the most profitable investment strategy. Rational choice among the alternatives helps to achieve optimal results.

## **2. Literature Review**

With a view to understand the concept of portfolio optimization through Modern portfolio theory propounded by Harry Markowitz and Single Index Model by Sharpe, it is obvious to understand about what was the past so that present can be linked and a strong future knowledge can be built. This course of action is essential so as to derive maximum benefits from present research. Keeping this point in view, an attempt has been made to help investors as well as researchers by reviewing the existing literature on Modern portfolio theory and Sharpe's Single index model for optimizing portfolio in order to get domain knowledge about the theories and further to find out the gaps for future research.

### **2.1 Modern Portfolio Theory**

*Markowitz (1952)* developed the portfolio theory or modern portfolio theory. In general, portfolio theory is grounded on diversification concept which aims to reduce the total risk of portfolio without sacrificing portfolio return. He rejected the rule that investors should maximise expected returns because it never implied the superiority of diversification. In addition, he rejected the law of large numbers which states that the investor should diversify his funds among all those securities which give maximum expected return. He mathematically formulated the concept of diversification but emphasised that the adequacy of diversification does not depend only on the number of securities held. The components of portfolio must be related to different sectors, if most of the stocks which are components of portfolio related to the same industry they are more likely to do poorly at the same time. He demonstrated that the portfolio risk comes from covariance of the securities which are portfolio constituents and it should be avoided to invest in securities with high covariance among themselves. He stated that the firms in different industries have a lower covariance than firms within the same industry and if allocation is done across different industries, it minimises the portfolio risk in different economic situations. He quantified risk variable under certain assumptions. He formulated portfolio risk and showed that the risk of the portfolio may be less than the risk of each security in the portfolio taken individually. He developed the expected return-variance of return (E-V) rule which states that the investors would be interested to select portfolio with maximum expected return for a given variance or minimum variance for a given expected return. He introduced the efficient frontier and provided mathematical framework in which risk and return can be optimised according to

risk profile of each investor. *Sharpe (1964)* remarked that Markowitz developed an analysis based on the expected utility maxim and proposed a general solution for the portfolio selection problem. *Sharpe (1966)* stated that the portfolio theory defines efficient techniques for portfolio selection by predictions about the performance of each security. He also stated that the portfolio theory emphasises on both expected return and risk and optimal portfolio is selected among the efficient portfolios based on investor's preferences about risk and expected return. *Levy and Sarnat (1970)* remarked that Markowitz portfolio selection provides a positive explanation and normative rules for the diversification of risky assets but effectiveness of diversification to reduce risk depends on the correlations among security returns. They argued that in the absence of perfect positive correlation, diversification could reduce risk but in the presence of perfect positive correlation, no amount of diversification can reduce risk. *Witt and Dobbins (1979)* briefly explained in their study the contribution of Markowitz to Portfolio theory. The study explained the major contribution of Harry Markowitz towards Maximising the Investors' wealth subject to risk with an imaginary example and also constructed an efficient frontier for better understanding of concept. *Elton and Gruber (1997)* reviewed "Modern Portfolio Analysis" and discussed history and future of portfolio theory, the key inputs necessary to perform portfolio optimization, specific problems in applying portfolio theory to financial institutions, and the methods for evaluating how well portfolios are managed. *Bhullar and Gupta (2016)* empirically tested Markowitz theory on realised return and risk as well as on realized return and expected return and showed a significant relationship between expected return and beta but no significant relationship between the risk and realised return. The study concluded that Markowitz Model is not possible to implement in the real world as it is based upon only expected return. *Kalayci, Ertenlice and Akbay (2019)* presented a review of deterministic models and applications for Mean-Variance Portfolio optimization (MVPO). The author deeply analysed the classification of models and application on MVPO and the proposed algorithms based on various data and performance indicators in depth but didn't reviewed the powerful approaches under uncertainty, robust, fuzzy and dynamic optimization.

## **2.2 Sharpe's Single Index Model**

*William F. Sharpe (1963)* described about the advantages of using a particular model for analysing the securities that is using a computerized model, where 2000 securities can be analyzed. This model emphasizes on low-cost analysis with little amount of the basic information to make it an attractive tool for investor's portfolio selection. It deals with probabilistic estimates of the future performances of securities, analysing them, and then

selecting the optimum portfolio from them. This paper extends the work of Markowitz in portfolio analysis. *Taneja, Dr. Yashpal and Shipra Bansal (2011)* evaluated Sharpe's Single index Model and Treynor Model to reach at optimum portfolio. To have the efficient Sharpe's Single Index Portfolio Evaluation Model, more and more stocks were added to reduce unsystematic risk and increasing portfolio weighted average return. The author summarised that systematic risk is the major concern for portfolio evaluation. As compared to Treynor Model; Sharpe's Single index Model is more efficient model for portfolio selection. *Naveen, Ch. (2014)* made an attempt to test whether the Sharpe's Single index Model really improving the investment performance. For this purpose, 30 blue chip companies of BSE were taken into consideration for optimal portfolio construction using Sharpe's Single index Model. Only four securities qualified for portfolio construction. The author also calculated portfolio risk and return which could be helpful for investors to invest at a given point of time. *Sathyapriya, M (2016)* author analysed four year's asset value from 2008 to 2012 of companies picked from infrastructure sector and pharmaceutical sector by using Sharpe's single index model for optimal portfolio construction. The study aimed at evaluating portfolio risk-return and compared with cut off point resulted that pharmaceutical sector performed 80% better than infrastructure sector. *Murthy, J. (2018)* conducted a Descriptive study to construct an optimal portfolio using Sharpe Single Index Model for portfolio construction. The author found Model proposed by Sharpe simplest and most widely used one.

### **2.3 Comparison between Modern Portfolio Theory and Single Index Model**

*Wallindford (1967)* conducted a study for selecting portfolios of securities using various techniques. The author firstly reviewed Markowitz Theory in general terms and also explained computational simplification of Sharpe and two-index work of Cohn and Pogue. With the help of small sample of 20 securities, the author compared Multi- index (Markowitz) model and Single index model with two index model using efficient frontier. The author concluded that at least under certain conditions Multi index diagonal model outperformed the Single Index Model and the great achievement of the Markowitz portfolio selection Model was its ability to explain the phenomenon of diversification theoretically. *Frankfurter et al. (1976)* viewed the Markowitz and Sharpe portfolio selection approaches as alternative analytic processes of portfolio selection. The authors experiment the two approaches by selection of portfolios from a universe consisting of only four securities. The study concluded that the Sharpe process performs nowhere worse

than the Markowitz process, and gives superior results when only short data histories are available. *Bowen (1984)* stated that because of the numerous inputs required; it is difficult to apply the Markowitz model and opined that Sharpe single index model helps to alleviate this difficulty. He outlined the difference between theory and practice of portfolio analysis in the context of risk. He concluded that because of existing semantic and statistical barriers, the regular businessman avoids grappling the portfolio theory approach. *Chopra and Ziemba (1993)* conducted a study to examine the relative impact of estimation of errors in mean, variance and covariance while applying Markowitz model and argued that mean-variance optimization is very sensitive to errors in the estimates of the inputs. The study showed that small changes in the inputs parameters can result in large changes in the composition of the optimal portfolio. *Paudel and Koirala (2006)* tested whether Markowitz Model and Sharpe Single Index Model for portfolio optimization offer better investment alternatives to Nepalese investors by applying these models to a sample of 30 stocks traded in Nepalese stock market from 1997-2006. The author opined that application of the elementary model offered better options for making decision in the choice of optimum portfolio in Nepalese stock market. *Maleki, Mahsa and t Mallikarjunappa (2014)* evaluated the two prominent approaches of optimal portfolio construction i.e. Markowitz approach and Sharpe's Single-Index Model (SIM) in Indian context. The author concluded that there is no significant difference between the two approaches. *Yuwono, Tri and Dadan Ramdhani (2017)* aimed at establishing the optimal portfolio of stocks listed on the Jakarta Islamic Index (JII) in Indonesia stock Exchange. The study concluded that there was no significant difference from the portfolio earned by using SIM compared with Markowitz Model. The results proved that there is nothing better between Markowitz model and SIM. *Chasanah, S.I.U. et al. (2017)* conducted a study to compare Markowitz and Sharpe single Index Model based on mean-variance criterion in optimal portfolio formation in Jakarta Islamic Index (JII). The author compared the optimal portfolio formation with Single Index Model and Markowitz Model by taking into consideration the variance for the same level of expected return value and then comparing both models with M-V criterion. The study calculated that the optimal portfolio formulated by Markowitz gave same return with less variance than Sharpe single Index. So it is concluded by the study that Markowitz Model is more dominant than Single Index Model.

### **3. Conclusion:**

The present study is conducted to review the literature available for portfolio optimization using two standard models viz. Modern portfolio theory by Harry Markowitz and Sharpe's

Single Index Model. According to the available literature, it can be concluded that both Markowitz approach and Sharpe single index model are the prominent approaches to construct optimal portfolios. Therefore, it was necessary to understand whether there is any difference between the results obtained by these approaches. Some of the studies that were conducted to compare the optimal portfolio using Markowitz and Sharpe single index approaches have come to conflicting conclusions. While some of the studies have concluded that there is difference in the characteristics of the portfolios constructed using Markowitz and Sharpe model, others have concluded that there is no difference in the characteristics of the portfolios formed by any of these models.

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