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Portfolio Optimization Using Short Look Back Period Volatility: An Application of Modern Portfolio Theory

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Abstract
One of the major advances in the investment field during the past few decades has been the recognition that the creation of an optimum investment portfolio is not simply a matter of combining a lot of unique individual securities that have desirable risk-return characteristics. Specifically, it has been shown that the relationship among the investments must be considered to build an optimum portfolio to further meet the investment objectives of an investor. This paper attempts to solve the allocation problem while creating an equity portfolio. Markowitz reward risk ratio optimization technique has been used to find out optimal weights and construct a portfolio from the stocks of NIFTY 50. The research has been done on the data from 2020-2022. It is very much evident from the results that the optimal portfolio has outperformed the NIFTY 50 on the basis of reward to risk ratio. The results suggest that efficient selection of securities and weight allocation on the basis of optimized Sharpe Ratio can enhance the returns for individual investors and for the fund manager's portfolios as well.

Keywords: Optimal Portfolio, Diversification, Allocation, Index, Short-term Volatility

Introduction

In 1952, Harry Markowitz published an article "Portfolio Selection" in the Journal of Finance. His seminal work laid the groundwork for what is now generally refered as 'Modern Portfolio Theory (MPT)'. The model proposed calculates the optimal portfolio based on risk and return of individual assets in a portfolio. MPT proposes to consider all asset classes to be a part of the portfolio. The model can suggest up zero allocation to some asset classes or can even show negative allocation which may mean short selling the asset. Allocation to assets can further be adjusted by adding constraints to the model. The most important aspect of the theory is that it considers the relationship of movement of individual assets along with the risk and return in silos. The essence of the theory lies in combining the negatively or low correlated assets to reduce the risk while maintaining the expected returns. This leads to creation of the optimal portfolio for a given risk.

However, it is widely known that 'beating the index' is easier said than done. Globally, only 20% of fund managers have been able to beat their benchmark index. A stock index can also be considered as a portfolio of shares. The selection of the stocks in the index portfolio is generally done based on the market capitalisation. The allocation of the the weights is also done based on the market capitalisation. Generally, a benchmark index is well diversified and has representation of many sectors. Hence this portfolio is also considered less risky as the risk is spread out across the sectors. Only a secular fall based on macro economic factors in the country, can really impact the index. These macroeconomic risks are also known as systemic risks. All micro or company level risks are temporary as the index portfolio is rebalanced from time to time. If any company of the index portfolio loses its market capitalisation, it will be replaced with a company with higher market cap. Thus, the index portfolio is automatically churned and usually always buoyant. Although the indices have seen

their share of value erosion periodically, they have always created value & grown exponentially over the years.

Purpose of the Study

Considering the two fundamental theories, one wonders if the MPT can be applied on the stock universe comprising of only the benchmark index stock components and can create an optimal portfolio that can beat the index consistently. In this paper, we comapare two portfolios:

- The index portfolio in which weight allocation to stocks is done on basis of market capitalisation.

versus

- A portfolio of similar stocks with weight allocation done on the basis of optimum portfolio as derived from MPT.

The challenge here is what look back period should be considered while ascertaining risk to a stock. No concrete conclusion is available on the look back period. In this research, short term volatility (very small look back period) is being considered on the basis of the premise that markets generally tend to discount the future and does not remember too much of the past. It has been interesting to see the results of comparing an optimum portfolio created with look back period of just 10 days and churning the portfolio on a daily basis, with the benchmark Nifty portfolio.

Literature Review

Theoretical Background

Markowitz, along with Sharpe & Miller, won the Nobel Prize in Eco in 1990 for their theory of portfolio optimization. Markowitz said that portfolio management is not much about financial statement analysis but it is more about the optimization problem. The objective of optimization is to maximize returns for a given level of risk or to minimize risk for a given level of returns.

Markowitz Theory which is also known as Theory of portfolio optimization states that a single asset or portfolio of assets is considered to be efficient/optimal if no other asset or portfolio of assets offers higher expected return with the same (or lower) risk, or lower risk with the same (or higher) expected return.

The risk and return of a portfolio depends on return of the individual stocks, risk of the individual stocks, correlation among the stocks and most importantly the weights in which different stocks are combined. It has been quantitatively researched that lower the correlation among stocks, lower would be the risk of portfolio; negative correlation reduces portfolio risk to a very large extent and weight allocation among stocks is crucial making an optimal portfolio.

Review of Papers

Many scholarly articles, reviews, criticisms and updations have been written about Markowitz's Modern Portflio Theory. However, the MPT still remains fairly important while creating Portfolios. The MPT selects the assets based on its risk-return and its correlation to other assets in the portfolio. The quest for an optimal portfolio has been enduring and many models like Shapre's, Markowitz and others have been developed.

Using the Mean Variance (MV) efficient portfolio, the optimal holding period was investigated taking Istanbul stocks for the period January 2000 to November 2004. The results showed that MV efficient investment portfolio performed better for long term period (Ulucan, 2007).

Many studies have used risk and return, (based on past performance) as an important factor to construct optimal portfolios. Saravanan et al (2012) created an optimal portfolio with 4 stock from Nifty 50 stocks. KavithaLal and SubbaRao (2016) created an optimal portfolio using sector analysis and included 5 sectors out of 11 based on the historic risk and return in their optimal portfolio.

Joshi & Parmar (2020) conducted a study to understand Markowitz model and its applicability in the BSE (Bombay Stock Exchange). It aims to identify the efficient portfolio using the efficient frontier

and provides an investment alternative to the investors. The study is conducted for the period of January 2008 to December 2016 for the stocks which generate risk higher than the risk-free rate of return. Out of the 2850 pairs of possible portfolios only 50 have been selected for the analysis. The portfolios with negative correlation are considered as they are more capable to reduce risk. Post these 5 efficient portfolios are identified whose Sharpe and Treynor ratios are calculated. The paper validates the theory and believes that investors can pick out the best portfolios using the Markowitz portfolio theory and reduce their overall risk.

Yogesh & Ayre (2022) conducted a study to construct an optimal portfolio by calculating the optimal weights of individual securities to be invested using the Markowitz portfolio theory to calculate the risk and return of the securities. The data of closing prices of securities is collected from the website of NSE for the period of January 2020 to January 2022. Return and risk of the stocks are calculated and excess return to beta ratio is obtained to determine the cut-off point. During the period of study Grasim generated the highest returns coupled with highest risk and Sun Pharmaceuticals was the least volatile stock. The model chooses 5 out of 14 companies based on the Single Index Model which are suitable for investment and gives the optimal weights.

Looking at the trends of scholarly articles and papers, one can infer that the MPT or the Sharpe's single index model can help create an optimum portfolio. However, objective of beating the index and creating alpha in long and short run is unclear.

Nageswari et al (2013) determined future risk and return of securities to form an optimal portfolio which significantly reduces the variability of returns. Anangnostopoulos et al (2009) formulated the portfolio optimization problem by optimizing the objectives involving tradeoffs between risk, return and the number of securities for inclusion in an optimum portfolio. Limits are set regarding the proportion of the investments in assets, so that the chances of having smaller proportions of holdings or investments in assets having similar characteristics is avoided.

The literature survey broadly indicates that the portfolio optimization models are more used for asset selection rather than solving the asset allocation problem. Although the models show the weights assigned to each asset, it is not considered as a major challenge. Impact of churning of portfolio and the duration for rebalancing the portfolio is also not widely discussed. Moreover, the performance of these optimal portfolios have not been compared over any time period to confirm the actual risk and returns.

Research Gap

The review of literature revealed that the portfolio theory developed by Markowitz is of a lot of relevance in Indian and Global markets and is widely used to formulate portfolios. The theory was developed decades ago but the relevant of the same can be proved by the fact that till date a lot of research has been conducted on the model. The gap is observed gap in conformation of the MPT in practical portfolio management over time.

This study attempts to solve the allocation problem in creating an optimum portfolio. Currently, the broader market indices are designed based on the market capitalization weights of the securities. This paper tries to find the way in which the weights can be assigned to securities in a broader portfolio to maximize the returns for a given level of risk. There is a need to compare an optimum portfolio created from the benchmark index, with the benchmark index over a longer time frame. This would also confirm the importance of the past volatility and risk- return of the asset in the portfolio.

Research Objective

- To solve the problem of asset allocation for a given universe of stocks.
- To create an optimum portfolio based on the Markowitz model of Mean variance optimisation from the universe of Nifty50 stocks based on look back period of 10 days and daily churning, and compare it with the returns of Nifty50 index from 2020-2022.

- To determine whether short term volatility or long dated past volatility based risk and return calculations should be considered in portfolio management.

Research Design

Since the objective of the study is to explore if there is a more efficient way of allocating funds to assets other than based on market capitalization, Markowitz portfolio theory technique has been used to evaluate the same.

The research is conducted considering the COVID-19 and post COVID period from 2020-2022. This period has been chosen to conduct the portfolio research to understand if the technique is validated even during one of the worst crashes in the history of the financial markets. The research work is based on the secondary data from the published sources. The data was sourced from NSE, SEBI and Bloomberg. Primarily, NIFTY 50 Index is considered to conduct the research.

Look back period of 10 days was considered for calculating returns and standard deviations of all the stocks in NIFTY 50 for the said period. Further the returns were used to calculate the annual return and risk and correlation among the stocks.

Macros were built to optimize the Sharpe Ratio based on 10 days moving average data. The resultant weights for different stocks are then used to construct a portfolio for the following day. The same technique is followed for a period of 3 years.

The overall returns from this portfolio construction technique are further compared to NIFTY 50 returns over the same period.

Findings

For the research period, optimised portfolio return and risk are compared to the return and risk of the broader Index i.e. NIFTY. The results are as follows:

CY2020			
	Return	**Risk**	**Reward-Risk Ratio**
NIFTY	14.50%	33.09%	0.44
Optimised Portfolio	51.56%	33.11%	1.56
FY2022			
	Return	**Risk**	**Reward-Risk Ratio**
NIFTY	17.35%	16.25%	1.07
Optimised Portfolio	31.69%	20.20%	1.57

The constructed portfolio differs from NIFTY mainly in the weight allocation to each company in NIFTY Index. The weights have been allocated on the basis of short-term reward risk ratio optimization. The results clearly show that the portfolio constructed using the Markowitz theory has beaten the broader markets substantially during the research period.

Implications

A radical change has been done to the conventional research methodology of having long look back period to ascertain volatility of a stock and hence the risk in it. It has been replaced with a short term look back period and the results show that the optimal portfolio constructed from the universe of 50 stocks of NIFTY50 gave better returns than the index itself. The research suggests that Markowitz portfolio theory can solve the asset allocation problem and is not to be simply used for asset selection. The model requires past data and is herewith proved that short term data helps if the churning of the portfolio can be done in short term. For the ultimate aim of every fund manager, to beat the index, the short look back period volatility based MPT is a good way to create a positive alpha.

Limitations and Further Scope of the Study

- The research has been conducted only for COVID and Post COVID period.
- The study can be extended to a longer period to further validate the outcome of the research.

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