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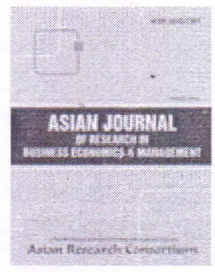
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N EMPIRICAL ANALYSIS OF OPTIMAL PORTFOLIO
SELECTION USING SHARPE'S OPTIMIZATION

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ABSTRACT

folio analysis considers the determination of future risk and return in holding various blends of individual securities. In the dly developing and changing capital markets an average investor finds himself in a fix to make decisions regarding the chase of securities. Therefore, the present study highlights the optimal portfolio selection using Sharpe's Single Index del, through which a significant reduction in the riskiness or variability of the return of securities can be obtained. It tries rovide guidance for investor's rescue from this situation. For the purpose of the study, BSE Sensex index and its securities y closing prices was collected and analyzed from April 2007 to March 2012. The proposed method formulates a unique cut point (Cut off rate of return) and selects stocks having excess of their expected return over risk free rate of return passing this cut-off point. Percentage of investment in each of selected stocks is then decided on the basis of respective ghts assigned to each stock depending on respective beta value, stock movement variance unsystematic risk, return on k and risk free return vis-a-vis the cut off rate of return. The optimal portfolio consists of six stocks selected out of 28 rt listed scripts, giving the return of 10.91 %.

words: Portfolio Analysis, Capital Market, Optimal Portfolio Selection, Risk and Return, Sharpe's Single Index model, BSE Sensex index

INTRODUCTION

Portfolio is a combination of securities such as stocks, s and money market instruments. The process of ding together the broad assets classes so as to obtain num return with minimum risk is called portfolio truction. Portfolio analysis considers the determination of e risk and return in holding various blends of individual rities. Investing and managing the investment is an area, has grown and changed rapidly over a period of time as array of investors-individual and institutional- has dened with the investment in portfolios ranging in asset from few thousands crores of rupees. Despite its ring stature, the subject of portfolio and investment agement is largely misunderstood.   In most cases folio management has been practiced an investment agement counseling in which the investors are advised to assets that would grow in value and/or provide income. ities carry differing degrees of expected risk leads most stors to the notion of holding more than one security at a , in an attempt to spreads risks by not butting all eggs in ne basket. Diversification of one's holding is intended to ice risk in an economy in which every asset's returns are ect to some degree of uncertainty.

Portfolio Diversification

rsification of investment helps to spread risk over many ts. Diversification is the strategy of combining distinct asset classes in a portfolio in order to reduce overall portfolio risk. In other words, diversifcation is the process of selecting the asset mix so as to reduce the uncertainty in the return of a portfolio. Diversification helps to reduce risk when one invest in different investment avenues, loss of one avenue would offset against the profit of another investment avenue. The combination of these assets will nullify the impact of fluctuation, thereby, reducing risk. Efforts to spread and minimize risk take the form of diversification.

1.2 Approaches in Portfolio Construction

Commonly there are two approaches in construction of the portfolio of securities viz traditional approach and modern approach.

1.2.1 Traditional Approach

In the traditional approach, investor's needs in terms of income and capital appreciation are evaluated and appropriate securities are selected to meet the needs of the investor. The common practice in the traditional approach is to evaluate the entire financial plan of the individual. It basically deals with two major decisions namely

1) Determining the objectives of the portfolio.2) Selection of securities to be included in the portfolio.

1.2.2 Modern Approach

The path-breaking mean variance portfolio theory of Markowitz published in 1952 together with the capital Asset pricing model of Sharpe brought about revolutionary changes

in analyzing investors' attitude towards risk and deriving equilibrium price of capital asset. It includes Markowitz's approach and Sharpe's Portfolio optimization.

a) Markowitz's Approach

According to Markowitz, investors are primarily concerned with two properties of asset, viz risk and return, but by diversification of portfolio it is possible to trade off between them. The essence of his theory is that risk of an individual asset hardly matters to an investor. Markowitz analyses the various possible portfolio of the given number of securities and helps in the selection of best or the most efficient portfolio. Markowitz model shows as to how an investor can reduce the risk i.e., standard deviation of the portfolio returns by choosing those securities, which do not move exactly together.

b) Sharpe's Portfolio Optimization

The construction of an optimal portfolio is simplified if a single number measures the desirability of including a stock in the optimal portfolio. If any person is willing to accept the standard of the single index model as describing the co-movement between the securities, the justification of any stock in the optimal portfolio is directly related to its excess return –to-beta ratio. Excess return is the difference between the expected return on the stock and the risk free rate of interest such as rate of return on the government securities.

In the traditional approach, the stocks are selected on the basis of need for income or appreciation where as in the Sharpe's single model; portfolio selection is based on the risk and return analysis.

II. REVIEW OF LITERATURE

Some of the select studies relevant to the present study are reviewed here. They are,

Saravan.A and **Natarajan.P,(2012)** analyzed the optimal portfolio construction using Nifty 50 stocks. The study found that the Nifty stocks were asymmetrical and heterogeneous. Out of 50 companies, 24 companies where market beta is above 1, show that the investments in these stocks are outperforming than the market. It concluded out of 50 stocks, four stocks are selected for the Optimal Portfolio. **Meenakshi Rani and Sarita Bahl(2012)** found that the eleven out of thirty stocks have expected return greater than risk free rate of return and these eleven stocks have been used for optimal portfolio construction. All the selected stocks have represented positive return. The study concluded that the Sharpe's single index model is of great importance and the framework of Sharpe's single index model for optimal portfolio construction is very simple and useful. The findings of the study will be useful for investors and practically related for the purpose of investing. **Varadharajan.P, Ganesh**

(2012), analyzed the optimum portfolio using Power, Shipping and Textile Sector. It found that portfolio of five stocks with maximum return for a given risk. The proportion of money to be invested in each of the securities is also found out. **Yash Pal Taneja** and **Shipra Bansal (2011)** found that the single index model has been successful to reach at the optimum portfolio by diversifying almost all the unsystematic risk. **Nanda et al(2010)** selected stocks from the clusters to build a portfolio, minimizing portfolio risk and compare the returns with that of the benchmark index i.e. Sensex. **Singh (2007), Bansal** and **Gupta (2000),** in their studies tested the efficiency of Sharpe Single Index Model to make optimum portfolio selection. Their results are similar as all concluded that Single index model is efficient in constructing optimal portfolio and portfolio return is much higher than the portfolio variance. **Paudel** and **Koirala (2006)** checked the efficiency of Sharpe portfolio optimization model in Nepalese Stock market and identified that portfolio beta is significantly lower than the market beta. **Gregory** and **Shapiro (1986)**, examined a cross- section of 464 stock and found that average return is more closely related to the beta measured with respect to a stock market index than to the beta measured with respect of consumption growth.

III. STATEMENT OF THE PROBLEM

"Stock market is an ocean, where dealing in stock market is just like sailing in a ship without a compass". In the current highly volatile economic scenario, every investor is worried about appropriate diversification of his investment portfolio. Most individual investors would engage in some amount of diversification, as they would normally invest in more than one security. But sufficient diversification is required to protect from undue risks that may occur due to unforeseen circumstances. Sharpe's single index model helps to investor to select an optimal portfolio that gives maximum return at minimum risk level. In optimal portfolio construction very few studies have been conducted in India. Therefore, the present study is going to fulfill the research gap in Indian Stock Market a fresh look.

IV. OBJECTIVES OF THE STUDY

The following are the objectives of the study

❖ To rank the securities based on excess return to beta.

❖ To calculate the optimum portfolio, and

❖ To find the Proportion of investment for each securities in the optimum portfolio.

❖ To examine risk and returns of the optimal portfolio of sample companies.

V. METHODOLOGY OF THE STUDY

5.1 Sample of the Study

The study used only 28' securities listed in the BSE 30 Sensex index. The closing prices of the sample securities for a period of five years from April 2007 to March 2012 and BSE 30 Sensex Index for the corresponding period were collected. For the non-availability data 2 securities of BSE Sensex Index excluded from the study. The study also used 364 days Treasury bill rate as a risk free rate.

5.2 Source of Data

The date pertaining to closing values of BSE, securities price have been collected from PROWESS database. The 364 days Treasury bill rates were collected from RBI website (www.rbi.org.in). Other information was collected from various books and journals of national and international repute.

VI. TOOLS USED FOR ANALYSIS

The following are the some of the tools used for the analysis

6.1 Excess Return to Beta

If any person is willing to accept the standard form of the single-index model as describing the co-movement between the securities, the justification of any stock in the optimal portfolio is directly related to its excess return-to-beta ratio. The numerator of this ratio of excess return-to-beta contains the extra return over the risk-free rate. The denominator is the measurement of the non-diversifiable risk that we are subject to by holding risky assets rater than riskless assets.

Excess return-to-beta ratio = $\dfrac{R_i - R_f}{\beta_i}$ 1

R_i = the expected return on stock i, R_f = return on a riskless asset

β_i = the expected change in the rate of return on stock i associated with a 1% change in the market return.

If the stocks are ranked by excess return-to-beta (from highest to lowest), ranking represents the desirability of any stock's inclusion in the portfolio. This implies that if a particular stock with a specific ratio of $(R_i-R_f)/\beta_i$ is included in the optimal portfolio, all stocks with a higher ratio will also be included. On the other hand, if a stock with a particular $(R_i-R_f)/\beta_i$ is excluded from an optimal portfolio, all stocks with a lower ratio will be excluded, when the single-index model is assumed to represent the covariance structure of security returns, then a stock is included or excluded, depending only on the size of its excess return-to-beta ratio. The number of stocks to be selected depends on a unique cut-off rate which ensure that all stocks with higher ratios of

$(R_i-R_f)/\beta_i$ will be included and all stocks with lower ratios should be excluded. We will denote this cut-off rate by C*.

6.2 Steps in Optimum portfolio

The following steps are necessary for selection of the stocks that are included in the optimum portfolio.

Step 1: Rank them from the highest to the lowest based on excess return to beta ratio.

Step 2: Proceed to calculate C for all the stocks according to the ranked order using the following equation

$$C_i = \frac{\sigma_m^2 \sum_{i=1}^{n} \dfrac{(R_i - R_f)\beta_i}{\sigma_{ei}^2}}{1 + \sigma_m^2 \sum_{i=1}^{n} \dfrac{\beta_i^2}{\sigma_{ei}^2}} \quad \text{..........................(2)}$$

Where,

$\sigma^2 m$ = Variance in the market index β_i = Beta of the Security i

$\sigma^2 ei$ = Variance of stock's movement that is not associated with movement of market index. This is the stock's unsystematic risk.

R_i = Expected return on security. R_f = Expected return on security

Step 3 : The cumulated values of C will steadily be rising up to a certain point and thereafter, it will start declining. The highest value of C is considered to be cut-off point. It is considered to be cut -off point. It is denoted as C*

All securities which make up the C* will be selected for constructing the optimal portfolio.

Step 4 : Construction of optimal portfolio does not stop with selection of securities .The proportion of investment in the selected securities also is required. This too is provided by Sharpe. The proportion to be invested in each of the selected securities is found using the following equation.

$$X_i = \frac{Z_i}{\sum_{i=1}^{n} Z_i}$$

.................................(3)

Where,

X_i = Proportion invested in Security i

$$Z_i = \frac{\beta_i}{\sigma_{ei}^2}[\frac{R_i - R_f}{\beta_i} - C^*]$$

Though the above process we could select the securities to form the optimal portfolio and also the proportion of investment to be made in each of the selected securities is determined.

Step 5: The portfolio return calculated by using the following equation:-

$$\text{Portfolio Return} = \sum_{i=1}^{n} X_i R_i$$

Where X_i = Proportion invested in Security i R_i = Return on security i

Step 6: portfolio beta is calculated by using the following equation

$$\text{Portfolio Beta} = \sum_{i=1}^{n} X_i \beta_i$$

Where, X_i Proportion invested in Security I β_i = Beta of Security i

6.3 Constructing Optimal Portfolio

An optimal portfolio is one that may diversify away almost all of the unsystematic risk. But diversification of risk depends on the inter relationship among the securities and their relationship with the market. William Sharpe has developed a model to construct optimal portfolio. The present study tries to form an optimal portfolio using this model.

VII. RESULTS AND ANALYSIS OF THE STUDY

The analysis of this study is arranged as noted below:-
    1. Ranking of securities.
    2. Selection of securities.
    3. Determinig the proportion of investment, and
    4. Return and risk of optimal portfolio.

7.1. Ranking of Securities.

According to the Sharpe model for Portfolio optimization, as a first step the securities should be ranked based on the excess return-to-beta ratio. The ratios were calculated for each of the sample securities using equation (1). **Table–1** shows ranking of sample securities taken for this study. Table also gives returns, risk free rate, beta and excess return-to-beta ratio. The excess beta ratio gives the risk premium (i.e., return- risk free rate) earned by security for one unit of market risk. According to Sharpe, in an efficient market, only the market risk (systematic risk) will be rewarded. The appropriate measure of systematic risk is beta. Therefore, the securities have been ranked in the descending order based on excess return-to-beta ratio. According to above Table, the security of Hero Motor Corp. Ltd, tops the list, followed by Dr. Reddy's Laboratories Ltd, State Bank of India, Jindal Steel & Power Ltd and so on.

7.2. Selection of Securities

The next step is to identify the securities included in the optimal portfolio. Table -1 gives the ranking of securities results; this step identifies the securities to be included in the optimal portfolio. For this purpose, Sharpe says that the value **C** (equation 2) is to be calculated for each of security. The results of C are presented in **Table-2.** The last column

gives result of C. The value C steadily increased from 0.006 to 0.026. Thereafter the value steadily declines. According to Sharpe, the highest value of C is the cut-off rate. All the securities with excess return to beta ratio greater than that of the security at the cut -off point are included in the optimal portfolio. As per these norms, all other securities let off. Only the first six securities are eligible for inclusion in the portfolio. Thus, a well diversified optimal portfolio be formed just with six stocks, namely Hero Motor Corpn. Ltd, Dr. Reddy's Laboratories Ltd, State Bank of India, Jindal Steel & Power Ltd, Hindustan Unilever Ltd and Maruti Suzuki India Ltd.

7.3. Determination of Proportion of Investment.

Construction of optimal portfolios does not end with selection of securities. Another equally important decision is determining the amount to be invested in the selected stocks. Sharpe also developed a model for this. The proportion of investment to be invested in the selected securities is computed applying equation (3). The determination of proportion of investment is given in **Table-3.** The result of X_i shows that the highest proportion goes to the top most stock, the next highest to the next stock, and so on. The construction of optimal portfolio consists of the six stocks. According to above Table, 33.60% of investment could be made in Hero Motocorp Ltd, while 23.42% in Dr. Reddy'S Laboratories Ltd, 25.09% in State Bank of India, 25.86% in Jindal Steel & Power Ltd., 1.14 in Hindustan Unilever Ltd and -9.06% in Maruti Suzuki India Ltd.

7.4. Return and Risk of Optimal Portfolio

After constructing the optimal portfolios, one would be curious to know the risk and return of the portfolio. The return and risk (Beta) of the portfolio is worked out in **Table-4.** The portfolio return was equal to 10.91% which is 2.5 times higher than the market portfolio that is 4.47%, BSE 30 companies combined returns.

VIII. DISCUSSION AND CONCLUSIONS

8.1. Optimum Portfolio with Short Sales

If the Z value is positive, the stock will be held long and if negative, it will be sold short. Stock which are having excess return to beta above C* are held long as in the case of the portfolio without short sales. Stocks with an excess return to beta below C* are sold short. In this study, the Z value is positive for first Five Securities and the last stock was recorded the negative Z value. It indicate that the above five securities namely Hero Motor Corpn. Ltd, Dr. Reddy'S Laboratories Ltd, State Bank of India, Jindal Steel & Power Ltd, Hindustan Unilever Ltd will be held long and Maruti Suzuki India Ltd will be sold short. Saravan.A

&Natarajan.P(2012), Singh (2007), Bansal and Gupta (2000), in their studies tested the efficiency of Sharpe Single Index Model to make optimum portfolio selection. Their results are similar and supported to this study, all concluded that Single index model is efficient in constructing optimal portfolio and portfolio return is much higher than the portfolio variance.

8.2. Findings of the Study

The following are the important findings of the study.

• During the study period, stock prices of sample companies highest mean return (0.1172) recorded by the Hero Moto Corpn. Ltd followed by SBI, Jindal Steel &Power Ltd and so, on.

• The Majority of the BSE stocks earned above the market return (0.0447). Few of the securities earned the negative return namely Bharti Airtel Ltd, Bharat Heavy Electricals Ltd, Sterlite Industries (India) Ltd and Oil & Natural Gas Corpn. Ltd with high beta(risk).

• The Top stocks were earned the high return with Minimum risk (low beta) except the SBI and Jindal Steel &Power Ltd. This shows that higher returns are associated with minimum risk.

• On the basis of excess return-to-beta analysis, the best combination of securities (Optimal Portfolio) is Hero Motor Corpn. Ltd, Dr. Reddy'S Laboratories Ltd, State Bank of India, Jindal Steel & Power Ltd, Hindustan Unilever Ltd and Maruti Suzuki India Ltd

• The optimal portfolio yields very high return (10.91 %) as compared to market return (4.47%)

• The beta of optimal portfolio is 0.813.

• The ranking of securities based on risk adjusted returns is different from ranking based on unadjusted return.

• An optimal portfolio consists of just around six stocks out of 28 stocks taken from BSE 30 during study period April 2007 to March 2012.

• The selected stocks belong to the following industrial sectors:-

• a) Two Wheeler   b)   Pharmaceuticals

• c)Banking   d) Steel
• e) Consumer Goods   f) Automobile

• The return of the optimal portfolio is very high, i.e, 2.5% higher than market return

• The constructed optimal portfolio will be held long period except the Maruti Suzuki India Ltd.

8.3. Suggestions of the Study

• Investors may be study the performance of the stock market in terms of risk, sensitivity and returns.

• To minimize the risk, investing in portfolio securities is good rather than investing in a single security.

• The present study suggests a combination of securities that give high rate of returns at minimum level of risk for the investors who wish to make an optimal portfolio.

• According to this suggested that the few of the sample companies namely Bharti Airtel Ltd, Bharat Heavy Electricals Ltd, Sterlite Industries (India) Ltd and Oil & Natural Gas Corpn. Ltd reported negative returns with high beta (risk). So these companies's management may take the necessary steps to remove/reduce this risk- return tradeoff.

• It also suggesting that investors who wish to hold the long term investment don't prefer Maruti Suzuki India Ltd shares.

IX. CONCLUSION

Portfolio analysis considers the determination of future risk and return in holding various blends of individual securities. The construction of an optimal portfolio is simplified if a single number measures the desirability of including a stock in the optimal portfolio. The present study is an effort to find an optimum portfolio and also the proportion of their investment. For the purpose of this study, it considered a sample of 28 stocks in BSE Sensex Index from April 2007 to March 2012. It applied the Sharpe Single Index model to generate an efficient combination of securities from amongst sample of shares and has come up with a subsequent investment pattern. The study found that, the return of the optimum portfolio is higher than the Market return with minimum risk. The analysis of the Portfolio provides enough evidence of the rationality for forming a portfolio of the securities instead of buying only single security. As optimal portfolio found highest weighted average return at low risk, hence, confirming the efficiency of Sharpe Single Index Portfolio Evaluation Model. Constructing a portfolio rather than a stand-alone stock may benefit an investor through diversification and utilization of different risk return combination.

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