Introduction
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Introduction

The rapidly increasing growth of voluminous literature on portfolio selection in the recent years indicates the widespread interest of the academic and business communities in this area. It emphasises the importance of investor’s investment decision in today’s world. Sacrifice of current money and other resources for future benefits are referred to as Investment. Investment is done to earn returns. This involves two key aspects namely time and risk. The present outflow of funds is certain but the future gains involve risk and are uncertain. A deliberate and careful investment decision leads to creation of a portfolio of assets. These decisions are to be taken within the framework provided by the complex of financial institutions and intermediaries comprising the capital market. The capital market also provides mechanism for channelling current savings into investment in productive uses. The portfolio analysis starts with information concerning individual securities and ends with conclusions concerning portfolios as a whole.

The primary objective of this study is to develop and test a portfolio optimisation model for a real life investor facing a single objective with multiple constraints, by making use of the potentials of quadratic programming approach. This chapter introduces the concept of portfolio selection and its relevance in today’s world. It discusses the research gaps, significance of study, objectives of the study, research methodology, research hypothesis, sources of data, chapter scheme and possible limitations.

Background

Introduced more than 60 years ago in the pioneering work by Markowitz (1952) the Mean-Variance optimization is one of the most popular approaches to portfolio selection. The basic assumptions of his theory are a rational investor with either multivariate normally distributed asset returns or, in the case of arbitrary returns, a quadratic utility function. In the validity of these assumptions, Markowitz has shown that the optimal portfolio for the investor lies on the Mean-Variance Efficient Frontier. The portfolio of financial assets has been defined as efficient, if and only if for any
given expected return, there is no other portfolio with lower variance, and for any given variance there is no other portfolio with higher expected return. The Efficient Frontier consists of all efficient portfolios.

Tobin (1958) based his theory of investment choice under conditions of uncertainty on the mean and variance of the distribution of returns. Markowitz-Tobin analysis remains the cornerstone of the work in the field of investment analysis.

The advantage of mean-variance criterion is that the investor can confine himself to the first two moments of the distribution of returns: the expected return (E) or mean and the variance (V). The investors tend to diversify risk by building portfolios comprising of a number of common stocks, or stocks and cash, bonds, derivative products etc. The desire to stabilize the income stream is *sine qua non* for investment diversification. Greater the number of securities included in a portfolio, the lower would be its variance. However, institutional restrictions and costs limit the actual size of portfolios.

Building an equity portfolio is more varied than building debt portfolios. This is due to the multiplicity of objectives. The primary objective of equity portfolios could be to generate absolute returns with low volatility over a long time period, or to generate long term capital growth from a diversified portfolio investing predominantly in equities, or to generate capital appreciation and income distribution from an investment which outperforms the specific indices such as Sensex or Nifty. The objective could also be to generate long term capital growth from an actively managed portfolio comprising equities, equity-related securities and equity derivatives. Another objective could be to generate higher than benchmark return and also long-term capital appreciation. Not only the objectives are multiple but also avenues for investment are many. While creating an equity portfolio, an investor can aim at benefiting from arbitrage opportunities, equity derivative strategies, pure equity investments and some small balance in debt and money market instruments also.

The various portfolio constraints faced by an investor include illiquidity, short-selling, minimum capital requirements, diversification, dividend, volatility, volume, turnover and many more. These constraints have an impact on the portfolio strategy. Martingale technique, Quadratic programming, Markovian chain process, Lagrange
multiplier, Riccati equations, mixed integer and heuristic approaches have been used by researchers worldwide to study such constraints.

Markowitz provided the direction to incorporate the multiple objectives of an investor and the creation of a multi decision framework. This forms the basis of current research. Limited empirical research work makes it imperative to develop a portfolio selection model which is best suited to Indian capital markets and accommodates for multiple objectives of the investor in this multi period dynamic world.

Substantial improvements in the availability of large data sets, real time information and software capable of performing complex computations is continuously contributing towards improved research work in portfolio selection. Better understanding of the markets and evolving economic models provide the base to add further to the Modern Portfolio Theory. A distinction however needs to be made between the real behaviour of an investor vis-à-vis rational behaviour. Investors should also be categorized into two subsets of being price sensitive and price insensitive investors, according to the differences in the decision rules they follow.

The present study is an effort not to test Capital Asset Pricing Model (CAPM) or the Fama and French Model but how we can use the existing portfolio selection models for searching undervalued securities and create efficient portfolios. An attempt has also been made to suggest possible improvements in the existing portfolio selection modelling framework by optimising across multiple constraints.

Understanding of the emerging Portfolio selection theories, prevailing portfolio management practices has paved the way for a new portfolio selection model. The model aims at enhancing the value of the portfolio while optimising across multiple constraints. The research work also compares and tests the performance of proposed portfolio selection model vis-à-vis the selected existing models for portfolio selection.

I.1 Review of Trends in Indian Economy and Indian Capital Markets

Global Financial crises, Sovereign Debt risk and downgrade by major credit rating agencies across the globe has affected the performance of a large number of stock indices including that of NSE’s Nifty and BSE’s Sensex. All possible efforts by the government and regulatory bodies to provide greater depth and liquidity to the financial markets have in fact taken a beating amidst weak global economic prospects. Despite all
possible odds, Indian economy has been able to maintain its position of being one of the fastest growing economies in the Asian Sub-Continent in 2011-12. Our Gross Domestic Product (GDP) is estimated to grow at the rate of 6.9 per cent in 2011-12. However, high amount of current account deficit of 3.6 per cent of GDP (2011-12) is affecting the exchange rate negatively. Even the Fiscal deficit was 5.9 per cent of GDP in 2011-12. The increasing deterioration of fiscal balance primarily is because of reduced direct tax revenue and increased subsidies which are also affecting the future economic prospects. The government is aware of these shortcomings and to an extent is trying to limit the damage by effective implementation of the Fiscal Responsibility and Budget Management (FRBM) Act. Tax reform measures related to the Direct Tax Code and Goods and Service Tax (GST) are also expected to contribute to improving the current fiscal situation. The disinvestment policy of the government of raising Rs. 30,000 crores (in 2012-13) and ensuring minimum public shareholding by central public sector enterprises is also expected to boost the capital markets and bring back retail investors to the equities market. The Rajiv Gandhi Equity Saving Scheme is a novel idea of ensuring increased participation by retail investors. Other measures like the simplification of the issue of Initial Public Offers, allowing Qualified Financial Institutions to access Indian Bond Market etc. are also expected to yield positive results for Indian Capital Markets.

In primary securities market, measures by Securities and Exchange Board of India (SEBI) like (1) Increase in the monetary limit for retail investors from Rs. 1 lakh to Rs. 2 lakhs; (2) Reduction in the process time lines from 22 days to 12 working day between issue closure and listing; (3) Improvement in the refund process of Application Supported by Blocked Amount Process (ASBA); (4) Introduction of Pre-Announced Fixed Pay Date for Payment of Dividends and for Credit of Bonus Shares; (5) Requirement of Minimum Public Shareholding; (6) Voluntary Adoption of International Financial Reporting Standards (IFRS) and (7) Disclosure of change in shareholding pattern within 10 days of +/- 2 percent change and many others are expected to restore the confidence of investors. Some of the measures in Secondary Securities Market like (1) Trading in securities using wireless technology; (2) Smart Order Routing; (3) Extension of contract tenure for Securities Lending and Borrowing from 30 days to 120 days; (4) Setting up of trading platform for Small and Medium Enterprises (SMEs); (5)
Mandatory certification for Risk Managers and (6) Enhanced norms for Credit Rating Agencies and a host of changes in Derivative markets are expected to improve the internal control and efficiency of these markets. Some of the technology based measures have yet not been implemented in some of the world’s most advanced stock exchanges. Most of these measures have been well implemented but some of them are still facing operational bottlenecks.

Despite a robust economic performance and a host of measures implemented by the regulatory body, the resource mobilization in primary market sharply declined from Rs. 48,654 crores in 2010-11 to Rs. 9,683 crores (up to 31st December 2011). Even the number of Initial Public Offers (IPOs) reduced from 53 (2010-11) to 30 (up to 31st December 2011). However, Mutual funds exhibited a substantial increase in resource mobilization in 2011-12. Poor performance was also exhibited by major stock indices like NSE Nifty (20.7 percent decline) and Nifty Junior (22.6 percent decline). Even the free float market capitalization for Nifty (20 percent) and Nifty Junior (21.8 percent) decreased. From Table 1.1, it may be observed that Nifty Index had negative returns in 2008-09 (-36.2 percent) and in 2011-12 (-20.7) with extreme volatility in returns for remaining years. Market Capitalization has exhibited sustainable increase over the years except for 2008-09. The daily volatility has also remained largely range bound between 1.1 (2010-11) and 2.6 (2008-09). Price-to-earnings ratio has been around 20 showing neither over nor under valuation. Nifty Junior also exhibited a similar trend.

| Table I.1: Index Returns, Volatility, Market Capitalization and P/E ratio |
|-----------------|----------|----------|----------|----------|----------|
| **Index**       | 2007-08  | 2008-09  | 2009-10  | 2010-11  | 2011-12  |
| Nifty           |          |          |          |          |          |
| Return (per cent) | 23.9     | -36.2    | 73.8     | 11.1     | -20.7    |
| Market capitalization (Rs. Crore) | 1240071.0 | 771483.0 | 1525162.0 | 1755468.0 | 1405066.0 |
| Daily volatility | 2.0      | 2.6      | 1.9      | 1.1      | 1.3      |
| P/E ratio       | 20.6     | 14.3     | 22.3     | 22.1     | 16.8     |
| Nifty Junior    |          |          |          |          |          |
| Return (per cent) | 16.0     | -45.6    | 148.4    | 4.7      | -26.1    |
| Market capitalization (Rs. Crore) | 202809.0 | 113523.0 | 292316.0 | 316529.0 | 247531.0 |
| Daily volatility | 2.4      | 2.8      | 2.0      | 1.2      | 1.1      |
| P/E ratio       | 16.7     | 8.7      | 15.8     | 17.6     | 13.5     |

Sources: NSE and Economic Survey 2011-12
Notes: Market Capitalization is calculated on free float basis. P/E ratio is price earnings ratio.
# as on 31 December 2011.
I.2 Research Gaps

Markowitz has explained the concept of diversification for creating efficient portfolios. With expected return on one axis and risk on the other, he drew the first efficient frontier. The riskiness of a portfolio was defined in terms of covariance. The major limitation of Markowitz model is the large amount of inputs required by the Model. For a portfolio analysis of N securities it requires:

1. N expected returns,
2. N expected variance, and
3. \((N^2 - N)/2\) co-variances.

On a whole it requires \([N (N+3)/2]\) separate pieces of information. Thus, data input became a limiting factor. This was solved by Sharpe’s One Factor Model. The model linearly related the return on security with return on the index. This reduced the data requirement to only \(3N+2\).

The Arbitrage Pricing Theory (APT) has been extensively researched as an alternative to mean variance portfolio selection models and Capital Asset Pricing Model. The approach proposed by Ross (1976) provided a consistent and robust method for pricing the risk associated with different assets, on the assumption that each asset’s return is a function of factors such as interest rates, yield structures, and the return on market portfolio. However, the testability of the APT still remains questionable and arbitrary in terms of the factors. Dybvig and Ross (1985) himself tried to prove the testability of APT refuting Shanken (1982) objection and explained the irrelevance for testing of the approximation error. Testability of Arbitrage Pricing Theory was explained on subsets and was not able to overcome the limitations of the Capital Asset Pricing Model in the Arbitrage Pricing Theory\(^4\).

I.3 Raison d’être of the Study

The limitations of existing portfolio selection models by Markowitz, Sharpe, Ross, Fama and French to accommodate for multiple constraints in a portfolio optimisation model is the primary reason for undertaking this research. Most of the existing models have focussed on optimality in terms of one or two key variables ignoring minimum performance of the portfolio across other financial variables. The focus on multiple financial variables becomes increasingly important in the light of the
contagion effect if financial crisis of United States (US) and European Union (EU) on the performance of stock markets across the globe. Individual investment and portfolio decisions in the capital market, are also socially significant as they shape the pattern and growth of real output of the economy.

Two indicators based on distribution of returns are often used to evaluate investments. The profitability of an investment is measured by expected return i.e. the mean of probability distribution of returns. The other indicator is based on the dispersion of returns. Investors desire high returns but are averse to a high variance which is an indicator of investment’s risk.

This research work raises the important issue of creation of optimal equity portfolios in the presence of many constraints faced by investors. A balanced portfolio which provides an investor with protections and opportunities with respect to a wide range of contingencies needs to be created. The current research develops a model for creation of optimal portfolios which best suit the needs and objectives of an investor.

A systematic and rational financial investment decision in a rapidly changing world of investment alternatives forms the core of this thesis. The focus of this research work would be to create mean-variance efficient portfolios from the available pool of securities of companies listed on the National Stock Exchange (NSE). The contrary thinking abilities, patience, composure, flexibility, openness and decisiveness of a person may make him a successful investor. The study is relevant in the current scenario as it reviews the existing modelling framework for portfolio selection which has been developed by Markowitz, Sharpe, Fama and French and Ross. The advantages that individual and institutional investors derive from diversification by building portfolios composed of a number of common stocks selected as per the mean-variance criterion, beta, book to market ratio, market capitalisation etc. has been presented.

The present work empirically tests the relevance of portfolio selection models on the stocks listed at the National Stock Exchange. Portfolios are created by employing alternate portfolio selection model formulations for listed stocks part of NSE Nifty. The crucial role of portfolio attributes like expected return, variance, the responsiveness of stock’s return to index return, market capitalisation, book-to-equity ratio and other such factors are identified in creation of efficient portfolios. Asset combinations are formed based on the learning’s from the existing literature on portfolio modelling. The resulting
portfolios created using alternate portfolio selection model formulations have been compared using Sharpe and Treynor ratio. Quantitative and qualitative comparison of the alternate portfolio selection models enables the researchers to rank them in terms of their effectiveness in the present day Indian securities market. Further, this work has been able to develop a portfolio selection model that can capture valuable statistical information in asset mean returns and variance.

The principle objective of the study is to determine the Mean-Variance efficient sets and to provide a quadratic programming model to compute them. The objective function of the investor is to minimise the risk i.e. variability of returns as defined by Markowitz. The real world financial markets impose a number of constraints that have been incorporated in this study. In all, thirty such constraints have been identified. Empirical testing of this model has been also undertaken. The model is expected to be of immense help to the Financial Institutional Investors (FII’s), Qualified Institutional Buyers (QIB’s), Mutual Funds and other Indian investors in selecting the optimal portfolio in presence of the plethora of real life constraints.

An attempt has been made to identify and suggest the alternate parameters for practical application of the developed model. Efforts have been made to reduce the gap that generally exists between theoretical model and its possible industrial application. Investors can create efficient portfolios using the model developed. The risk and return of these portfolios created is compared with the risk and return of portfolios created using other portfolio selection models and with Nifty 50. The actual scenario faced by an Indian investor, his set of constraints and the objective of risk minimisation is simulated in the model formulations.

The mean-variance analysis undertaken in this research work will be of immense use for the Indian investors both individual and institutional, brokerage houses, mutual fund managers, banks, high net worth individuals, portfolio management service providers, financial advisors, regulators, stock exchanges and research scholars in the area of Portfolio Selection.

I.4 Problem Statement

The selection of optimal set of securities that form a portfolio is indeed a tedious task. In the portfolio creation process, investors may inadequately comprehend return
and risk. Investors may vaguely formulate investment policies, make untimely entries and exits, pay high transaction costs, over diversify or under diversify. Investors may not effectively incorporate changes in expectations while extrapolating the past. All these errors in investment management make an investor prone to losses. This most often results in destruction of wealth of a retail investor in an attempt to create it. Review of existing theories and empirical studies on portfolio management outlined the following research problems:

1. Despite a large number of empirical studies in the area of market efficiency and Capital Asset Pricing Model, there has been a dearth of research in analysing mean-variance efficient portfolio selection for Indian securities market.

2. Mathematical complexity of some of the recently developed international models limits the applicability of their contribution. In some cases, the non stationary data makes the empirical testing of the model rather complicated. The testing of models for their robustness and optimality in emerging markets like India has not been investigated in detail.

3. The large numbers of portfolio selection models are a simplified work of correlating risk and return without adding non market factors e.g. inflation, interest rate, purchasing power etc. or employing techniques such as Generalised auto regressive conditional hetroskedasticity or Auto regressive conditional hetroskedasticity to model the variability of returns. Even till date most of the models do not incorporate the effect of taxes, transaction costs, short sales, borrowing and lending despite the fact that a large number of scholars have proved the significant explanatory power of each of these factors.

4. Not much empirical evidence exists in India on investigating the impact of corporate governance practices, habits of investors and learning effect on the portfolio selection decisions.

5. The modelling framework needs to be extended to include the futures and options of securities. The existing models could be extended to include other parameter settings to represent large numbers of securities and other forecast models, such as Auto regressive conditional hetroskedasticity (ARCH) type models.
I.5 Research Objectives

The primary objective of this research work is to create a mean-variance efficient portfolio selection model for an investor in the presence of the plethora of real life constraints he/she faces while selecting a portfolio of assets.

Sub-Objectives

1. To review emerging issues in portfolio selection modelling framework including the foundations laid by classical works of Markowitz, Sharpe, Fama and French, Ross etc.

2. To provide alternate measures of aspiration values which could serve a guide to create portfolios for different types of investors.

3. To find an algorithm/ algorithms that optimises across multiple constraints while minimising the variance of the efficient equity portfolio. For developing this algorithm the thesis intends to:
   a) Identify the multiple constraints for portfolio selection decision;
   b) Set the aspiration values [Quartile three (Q₃), Median, Quartile one (Q₁) or mean] for investors with different risk profiles;
   c) Recommend investment portfolios for different types of investors;
   d) To understand and investigate the relationship between portfolio returns, excess return to standard deviation and portfolio selection variables;
   e) To find causation between security returns and portfolio variables;
   f) To identify the relevance of security variables on security returns using the multivariate and causality analysis;
   g) Recommend the Ideal portfolio with the most relevant constraints;

4. To graphically compare and plot all the resultant portfolios from alternate portfolio selection model formulations with portfolios on the Markowitz’s Efficient Frontier for the same level of upper bounds.

5. To undertake a utility analysis of the resultant portfolios using arithmetical and graphical technique.

6. To measure the performance of the resultant portfolios using Sharpe ratio and Treynor ratio.

7. To conduct tests for equality of risk, return and portfolio utility between Markowitz’s portfolio, Index portfolio and the best performing portfolio.
I.6 Research Hypotheses

In the process of creation of a model for portfolio selection, the existing Markowitz’s model providing maximum expected utility to an investor needs to be tested and compared with the performance of the theoretical model recommended in this work. An attempt to test the relevance of Markowitz’s model of portfolio selection and the portfolios created on National Stock Exchange has been made. The hypotheses are as follows:

Hypothesis 1 (H₁)

The objective is to compare the mean return of the proposed model with the mean return of Markowitz’s model.

**H₀:** There is no difference in the expected return of the portfolio created by the proposed model and the Markowitz’s model.

\[ \mu_E = \mu_M \]  \hspace{1cm} (1.1)

**H₁:** Expected return of the portfolio created by the proposed model is superior to the return of portfolio created by the Markowitz’s model.

\[ \mu_E > \mu_M \]  \hspace{1cm} (1.2)

The expected return on the security has been calculated by the formulae using models given by Markowitz (1952).

Hypothesis 2 (H₂)

The objective is to compare the risk (variance) of the proposed model with that of the Markowitz’s model.

**H₀:** There is no difference in the risk (variance) of the portfolio created by the proposed model and the Markowitz’s model.

\[ \sigma_E^2 = \sigma_M^2 \]  \hspace{1cm} (1.3)

**H₁:** Expected risk of the portfolio created by the proposed model is lower than the risk (variance) of portfolio created by the Markowitz’s model.

\[ \sigma_E^2 < \sigma_M^2 \]  \hspace{1cm} (1.4)

The variance of a portfolio has been calculated using the formulae given by Markowitz (1952).
Hypothesis 3 (H₃)

The objective is to compare the portfolio utility of the proposed model portfolio with that of the Markowitz’s portfolio.

\( H_0: \) There is no difference between the utility derived by investors from the portfolio created by the proposed model and the Markowitz’s portfolio selection model.

\[ U_E = U_M \]  \hspace{1cm} (1.5)

\( H_1: \) Portfolio utility in the portfolio created using the proposed model is higher than the utility of the portfolio created using Markowitz’s portfolio selection model.

\[ U_E > U_M \]  \hspace{1cm} (1.6)

In hypothesis one, two and three a comparison has been made between the portfolios created using the proposed theoretical portfolio selection model and the Markowitz’s model. An attempt has been made further to compare the return, risk and portfolio utility of the proposed model with the return, risk and portfolio utility of the benchmark portfolio (Nifty 50). All these hypotheses have been tested using t test at five percent level of significance.

I.7 Research Methodology

(a) Quadratic Programming Portfolio Optimisation

Alternate portfolio selection model formulations which attempt to minimise variance in the presence of real-life constraints have been solved using quadratic programming. The conceptual framework for using quadratic programming method for portfolio selection has been discussed in detail. An attempt has been made to provide the rationale for single objective multiple constraints portfolio optimisation and quadratic programming framework to achieve an optimal portfolio. A theoretical model of portfolio selection for an investor faced with multiple constraints has been developed. Empirical analysis of the Markowitz’s model (1952) and model developed provide further insights as regards single objective multiple constraints portfolio optimisation. Model improvements are also recommended by suggesting, selected constraints mean-variance efficient ideal portfolio selection model.

(b) Multivariate Regression Analysis

Multiple regression analysis has been undertaken to find the important portfolio variables significantly explaining the cross section of returns. Two multiple regression equations have been estimated with returns and excess returns to standard deviation.
ratio as the dependant variable respectively. The list of independent variables included earnings per share, dividend, free float, impact cost, institutional holding, market capitalisation, net profit, price to book value ratio, price-earnings ratio, promoter’s shareholding, sales, turnover, unsystematic risk and volume. The model forecasts have been presented graphically.

(c) Granger Causality Tests

Granger causality tests are run to examine whether any of the independent variables considered in multiple regression equation cause returns and to find how much of current returns can be explained by past values of returns. Also, whether adding lagged values of independent variable improves the explanation of returns or not.

(d) Portfolio Utility Analysis for various Types of Investors

Utility analysis is undertaken quantitatively and graphically. Portfolio utility has been calculated by subtracting risk penalty from expected return for different levels of risk tolerance of an investor. For the graphical analysis, the portfolio return and variance of all the constructed portfolios are plotted over the indifference curves of various types of investors.

The first type of investor is a ‘diversifier’ a more risk-averse investor whose indifference curves are concave to the y-axis. He expects increasing return for equal increments in risk (along the X-axis). He is known as the ‘normal’ investor. The diversifier would be willing to take more risk only for a more than proportionate increase in return to compensate for the additional risk. The second category of investor is a ‘plunger’ a less risk averse investor whose indifference curves are flatter as smaller risk premiums are expected by them. A plunger would be willing to take additional risk even for less than proportionate incremental returns. The third category of investor is a risk neutral, an investor who is indifferent to risk. He is more concerned about the expected return on an investment rather than the risk. The indifference curve of such an investor is a straight 45 degree line from the origin. At the end of the continuum lies the risk lover, a risk seeker investor in search for greater volatility and uncertainty in investments for anticipated abnormally higher returns. He exhibits irrational behaviour characterised by straight line indifference curves moving from right to left.

By superimposing the risk-return combination of portfolios on the indifference curves, the choice of portfolio by an investor is determined graphically.
(e) Performance Evaluation of Portfolios

To sum up the performance of portfolios and rank them, portfolio evaluation measures as given by Sharpe (1966) and Treynor (1965) have been used. The ratios summarise risk and return of a portfolio in a single measure, categorising the performance of a portfolio on a risk adjusted basis. A larger value denotes better performance of the portfolio. All the modelled portfolios have been ranked accordingly to compare their performance.

(f) Tests of equality

Tests of equality for mean, variance and portfolio utility between the Markowitz’s portfolio and other modelled portfolios have been conducted. Values and probability figures for F-test, Seigel-Tukey test, Levene test and Bartlett-Forsythe test are reported. The category statistics and Bartlett weighted standard deviation have been also calculated for analysis.

1.8 Sources of Data

The study uses secondary data sources for monthly stock returns, beta, free float, promoter’s holding, institutional holding, trading volume, turnover and impact cost (a measure of liquidity) for firms at the National Stock Exchange Nifty, 91 days Treasury bill rates, and monthly returns on Nifty (NSE’s value weighted Index) over a period of twelve years starting from April 2000 to March 2012. Also, annual accounting data such as book-to-market equity, market capitalisation, sales, net profit, dividend, earnings per share and price to earnings ratio, total assets and other variables from the annual report of the constituent companies have been used.

The data has been collected from the official website of National Stock Exchange Limited (www.nseindia.org), annual reports of companies and Centre for Monitoring Indian Economy (CMIE) database PROWESS. The measure for risk-free rate of interest, 91 days T-bill rate has been taken from the official website of Reserve Bank of India (www.rbi.org.in). All the assets included in the sample are equity shares part of NSE Nifty.

The software used for the research includes Statistical Package for Social Sciences (SPSS 16), E-views 5.1 and Lingo 13. Transpose of matrices of security returns and covariance matrices were attempted using SPSS. The generation of covariance matrix (50x50) of the assets from the series of return, multiple regression estimation, correlation matrix, granger causality tests and tests for equality have all been
attempted through E-views. The eight scenarios based non-linear portfolio selection models have been programmed using the Lingo 13. The local solver and global solver of this software were used to generate solution to these portfolio selection problems.

I.9 Plan of the Study

The thesis has been divided in six Chapters. Chapter one introduces the concept of portfolio selection and its relevance in today’s world. It discusses the research gaps, problem statement, objectives of the study, research methodology, research hypothesis, sources of data, plan of the study and possible limitations. It also discusses the significance of the study and main purpose of taking up this research. The discussion on problem statement is based on the following questions. What problems have given rise to research on this topic? What problems still remain to be tackled in existing literature? What are the emerging problems faced by a small retail investors today? Do the portfolio managers really understand their investors? What are the objectives and constraints in making an investment in equities? The research objectives are framed in a manner so as to test the relevance of Investment Management and various theories developed in it and how they can be used for making portfolios in a developing securities market like that of India. An attempt to mention the existing gaps in literature and how they can be filled by this research endeavour has been made.

Chapter two focuses on the Theoretical Underpinnings in the area of Mean-Variance Efficient Portfolio Selection. The important models forming the pillars in the field of portfolio selection are discussed. The utility assumptions, quadratic programming framework, emerging issues and challenges in the Indian capital markets are a few areas discussed in this chapter. This chapter provides the conceptual framework for this thesis.

Chapter three discusses the review of literature and how existing literature can be used for making gains in equities market. An extensive review of Indian as well as international studies relating to asset pricing theories, variance-covariance matrix, theories on diversification, mean-variance efficient portfolios and lead-lag relationship has been undertaken. The major findings, methodology, important variables and observations have been discussed. The changing paradigms of portfolio selection, changing trends and major developments in portfolio management have been outlined. A comparative analysis of the relevant studies reviewed has been presented at the end of this chapter.
Chapter four discusses the research design and methodology. A theoretical mean-variance efficient portfolio selection model is developed taking in view the multiple objectives and limitations of an investor. In all thirty constraints have been identified in the theoretical model. The methodology for multivariate analysis, causality tests, utility analysis and tests of equality has been discussed.

This is followed by empirical testing of the model for benchmark index NSE’s Nifty in Chapter five. The sources for data collection and software used for analysis have been mentioned. Aspiration values for different types of investors are outlined for creating optimal portfolios. The mean-variance efficient portfolio selection model is programmed in the Lingo 13. The resultant portfolios are presented graphically through bar graphs and pie charts. A comparison of these portfolios with the Markowitz’s efficient frontier has also been attempted. Multivariate analysis and granger causality tests have been undertaken. An empirical analysis of the eight portfolios achievements across the multiple constraints has been discussed in detail. A utility analysis for the alternate portfolios made has been attempted using arithmetical and graphical techniques. The portfolio performance evaluation measures as proposed by Sharpe (1966) and Treynor (1965) have been used to evaluate and rank the portfolios. Tests of equality for return, variance and portfolio utility between the Markowitz’s portfolio, ideal portfolio and index portfolio has also been discussed towards the end.

Chapter six includes the summary, conclusions and recommendations for future research. This is followed by endnotes, references and annexure.

I.10 Limitations of the Study

1. The study suffers from the assumptions of various statistical methods which are used for hypothesis testing.
2. The model formulations are for a single period and do not incorporate the continuous changes in the environment and its effect on portfolio selection.
3. The Quadratic Programming portfolio selection analysis is based on ex post data which may not be truly representative of the future scenario.
4. Certain constraints originally included in the theoretical model were excluded in the empirical analysis due to unavailability of data and programming limitations.
5. Minute by minute real time data incorporating immediate changes may substantially improve the reliability of results. This has not been undertaken in this study.