THE EFFECT OF PORTFOLIO OPTIMIZATION ON THE RETURNS OF LISTED COMPANIES AT THE NAIROBI SECURITIES EXCHANGE

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DECLARATION

This research project is my original work and has not been presented for any degree in any other university.

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DEDICATION

To the memory of my cornerstones:

Late grandparents: Jeckonia Omotto & Silpah Atyang,

Parents: Late father Joash Ogutu and mother Catherine Ogutu,

Role model: The Late Yashon Audo.

ABSTRACT

Portfolio optimization is the practice of determining the 'best' allocation of assets within a portfolio in order to maximize returns at a given level of risk. The study aimed at establishing the effect of portfolio optimization on returns of listed companies at the Nairobi Securities Exchange. Markowitz' mean-variance optimization model was used to analyze the risk and returns of the portfolios. Secondary data of consistently trading companies' stocks at the NSE during the period July 2008 to June 2013 were used to compute risk and returns thereafter construction of portfolios.Risk was based on beta of the stocks. The risks and returns of the constructed portfolio was compared to the benchmark portfolios, GMVP and naïve (1/N) portfolio, to check significance of the differences between the returns and risk of portfoliosby conducting T-tests. The study was descriptive in nature. Monthly stock prices risk and returns were computed. Single Index model was used to select stocks to the optimal portfolio with 2 out of the 45 stocks in the sample selected to the portfolio. The study found significant difference between return, risk and risk adjusted returns of optimal portfolio and the GMVP and naïve (1/N) portfolio thus portfolio optimization leads to better absolute and risk adjusted returns. The results are consistent with research findings in the literature review. Investors are recommended to optimize their portfolios to maximize the returns of their portfolio and the regulatory authorities such as the Capital Markets Authority and Insurance Regulatory Authority put in place policies that encourage portfolio optimization.

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LIST OF ABBREVIATIONS

ANOVA   Analysis of Variance

AIMS   Alternative Investment Market Segment

ATS   Automated Trading Systems

CBK   Central Bank of Kenya

CAPM   Capital Asset Pricing Model

CEO   Chief Executive Officer

CRSP   Center for Research in Security Prices

DCC   Dynamic Conditional Correlation

FISMS   Fixed Income Securities Market Segment

FTSE   Financial Times Stock Exchange

GARCH   Generalized Autoregressive Conditional Heteroskedasticity

GDP   Gross Domestic Product

GMVP   Global Minimum Variance Portfolio

IRA   Insurance Regulatory Authority

MBA   Master of Business Administration

MIMS   Main Investment Market Segment

MOU   Memorandum of Understanding

MWRR   Money Weighted Rates of Return

NSE   Nairobi Securities Exchange

SAS   Statistical Analysis System

TWRR   Time Weighted Rates of Return

UK   United Kingdom

VaR   Value at Risk

NYSE   New York Stock Exchange

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Portfolio optimization is the process of choosing the proportions of various assets to be held in a portfolio, in such a way that the portfolio perform better than any other according to some criterion. The determination of weights of securities in a portfolio need to be guided by an objective which exploits each stock's characteristics efficiently, for example maximize return for a given risk. Often portfolio optimization is done subject to constraints such as short sale restrictions, transaction costs, liquidity constraints and turnover constraints (Jorion, 1992), which may be regulatory constraints, the lack of a liquid market, or any of many others. Portfolio optimization seeks to maintain desired portfolio risk, return or both by varying each asset's weight in a systematic manner (Rasmussen, 2003). Nature of optimization differs with the desired outcome, either maximization of returns or minimization of risk or both while maintaining portfolio efficiency: the maximum attainable return for a given level of volatility, or alternatively, the minimum attainable volatility for a given level of return (Rasmussen, 2003).

Markowitz (1952a) recognizes portfolio optimization as a process that involves two stages; first, observation and experience leading to belief of future performance and, secondly the future performance belief leading to the choice of a portfolio.Portfolio choice therefore involves processing of information.Markowitz (1952a)proposed selection of a portfolio based on expected (mean) return and variance of return. Diversification eliminates some, but not all, of the risk associated with a risky investment. The reason being unsystematic risks, which are unique to individual assets,

tend to reduce in a large portfolio, but systematic risks which affect all of the assets in a portfolio to some extent, do not (Ross, Westerfield & Jordan, 2002). Due to free elimination nature of the unsystematic risk through diversification, the systematic risk principle states that the reward for bearing risk depends only on the level of systematic risk. On average, a diversified portfolio will have the same expected return (but less risk/volatility) as a less diversified portfolio with similar characteristics (Ross, Westerfield & Jordan, 2002). The rationale behind this technique contends that a portfolio of different kinds of investments will, on average, yield higher returns and pose a lower risk than any individual investment found within the portfolio. Diversification strives to smooth out unsystematic risk events in a portfolio so that the positive performance of some investments will neutralize the negative performance of others. Therefore, the benefits of diversification will hold only if the securities in the portfolio are less than perfectly correlated (Van Horne, 2002). Tobin (1958) in introducing a risk free asset accentuated the nature of relationship to be exhibited by the returns of assets in a portfolio.

Stock market growth has been heralded as an important barometer of economic growth which leads to capital inflows from investors seeking value for their funds (Kaimba, 2010). The Nairobi Securities Exchange (NSE)facilitates investors' trade in stocks and other securities such as debt instruments. Portfolio optimization has been heralded over time to be a measure that would protect the value of investments made by both institutional and individual investors in different markets, the Kenyan case being the NSE. Empirical studies have shown portfolio optimization to either minimize the risk of portfolios or maximize the portfolios return and at the same time other portfolio

allocation mechanisms such as the 1/N naïve portfolio and global mean variance portfolio have also been shown to perform better than optimized portfolios. Therefore, it would be important to study the effect of optimization on returns to determine whether the same findings hold in Kenya.

1.1.1 Portfolio Optimization

A portfolio is an appropriate mix or collection of investments held by an investor. Portfolio is often designed to reduce the risk of loss of capital and/or income by investing in different types of securities available in a wide range of assets. Portfolio optimization problem is a well-known problem in the finance world. It involves choosing an optimal set of assets in order to minimize the risk and or maximize the returns of the investment. The investor's objective is to get the maximum possible return on an investment with the minimum possible risk. This objective is achieved through asset diversification (Singh, Sahu & Bharadwaj, 2010) which involves asset allocation.

The mean-variance framework for portfolio selection, developed by Markowitz (1952a), continues to be the most popular method for portfolio construction (Kale, 2009). It seeks the best allocation of wealth by enabling investors to incorporate their preferences as well as their expectation of return and risk. It is expected to efficiently allocate wealth to different investment alternatives by reducing overall portfolio risk and/or achieving the maximum anticipated profit (Chan, Karceski & Lakonishok, 1999).

A portfolio's abnormal performance is evaluated against a benchmark by broad reward to risk measures such as the Sharpe ratio, Treynor ratio, Jensen alpha, and the Information Ratio. These measures assume normal distribution of returns. Other performance

measures break down abnormal performance into factors such as market timing and security selection for example performance attribution.The difference in return between a portfolio and its benchmark is the active return of the portfolio.

1.1.2 Returns

Scott (1998) definesportfolio return as the change in value of the portfolio (capital gains or loss) plus any other income provided by the portfolio in the particular investment period.

Return can be measured by computation of arithmetic rate of return, the approximation method (Scott, 1998), whereby a stock/portfolio end value is deducted from the beginning value then divided by the beginning value. This measure ignores the withdrawals and additional investments made within the investment period. Time-Weighted returns is another return measurement method that compoundsthe rate of growth in a portfolio through elimination of the distorting effects created by inflows of new money. It is also referred to as geometric mean return as the reinvestment is captured by using the geometric total and mean, rather than the arithmetic total and mean.Weighted portfolio returns measurement approach recognizes the weight of securities in a portfolio at the beginning of the investment period which is then applied to the rates of returns achieved by the security or asset class at the end of the investment period (Scott, 1998).

1.1.3 Portfolio Optimization and Stock Returns

Markowitz (1952a) identified the tradeoffdecision that investors seeking diversification of their portfolios are faced with. He identified two elements that need to be balanced;

risk and return. It is important to either identify feasible portfolios that minimize risk (as measured by variance or standard deviation) for a given level of expected return or maximize expected return for a given level of risk.Portfolio optimization ensures areduction of portfolio risk for a given level of expected return or increment of expected return for a given level of risk in turn generating the efficient set of portfolios. Optimization matches the variability of portfolio return to the market return due to the elimination of the idiosyncratic risk.

Rational investors seek efficient portfolios, because these portfolios are optimized on the two dimensions most important to investors; return and risk. Markowitz (1952a) indicates that investors are able to choose optimal portfolios based on their attitudes towards risk which would reflect on the utility derived from the portfolio return or risk.

DeMiguel (2014) using the mean-variance model identified better covariance matrix, better mean and constraints as what leads to an improved portfolio performance. Different methods have been used by researchers to achieve the best of the three factors. To estimate a better covariance matrix methods; use of higher frequency data (Merton, 1980), factor models to "plug in" to the mean variance models (Chen et al., 1999), shrinkage estimators (Ledoit and Wolf, 2004b, Ledoit and Wolf, 2004a), robust optimization (Goldfarb and Iyengar, 2003) and robust estimation.

To obtain better means; ignoring means or use of longer time series to obtain more accurate estimators of means. Minimum-variance portfolio usually perform better out of sample than mean-variance portfolios; (Jorion, 1985, Jorion, 1986, Jagannathan and Ma, 2003),robust optimization, option-implied information, stock return serial dependence or

exploit anomalies e.g size: small firms outperform large firms, momentum: past winners outperform past losers, book-to-market: high book-to-market ratio firms outperform low book-to-market ratio firms.

Better constraints have been used to improve portfolio performance. Imposing shortsale constraints intuitively prevent extreme (large) positive and negative weights in the portfolio. Theoretically, imposing shortselling constraints is like reducing the covariances of the assets that would be sold short(Jagannathan and Ma, 2003).

1.1.4 Nairobi Securities Exchange

In Kenya, dealing in shares started in the 1920's when the country was still a British colony. The market was not formal as there were no rules and regulations to govern stock broking activities thus trading took place on a 'gentleman's agreement.' At that time, stock broking was done informally by accountants, auctioneers, estate agents and lawyers who met to exchange prices over a cup of coffee (Muga, 1974).

Francis Drummond established the first professional stock broking firm in 1951. In 1954 the Nairobi Stock Exchange was constituted as a voluntary association of stockbrokers registered under the Societies Act. Africans and Asians were not permitted to trade in securities, until after the attainment of independence in 1963.In 2011, the Nairobi Stock Exchange Limited, changed its name to the Nairobi Securities Exchange Limited. The change of name reflected the strategic plan of the Nairobi Securities Exchange to evolve into a full service securities exchange which supports trading, clearing and settlement of equities, debt, derivatives and other associated instruments (Nairobi Stock Exchange (NSE), 2013).

To enhance easy and faster access of accurate, factual and timely trading information, NSE offers data vending business through its website www.nse.co.ke. NSE has implemented Broker Back Office system that has the capability to facilitate internet trading improving the integrity of the Exchange trading systems and facilitate greater access to securities market. The NSE operates live trading on the Automated Trading Systems (ATS) for stocks and government bonds (NSE, 2013).

The NSE has four indices: All share index, 20 share index, the FTSE NSE Kenya 15 index and FTSE NSE Kenya 25 index. The launch of the indices was due to the growing interest in new domestic investment and diversification opportunities in the East African region. The indices also give investors the opportunity to access current information and provide a reliable indication of the Kenyan equity market's performance during trading hours (NSE, 2013).

There are three investment market Segments at the Nairobi Securities Exchange namely: Main Investment Market Segment (MIMS); Alternative Investment Market Segment (AIMS); and Fixed Income Securities Market Segment (FISMS). Shares at the NSE are grouped into 4 sectors namely Agriculture, Commercial and Services, Financial and Industrial & Allied sectors and into 10 further subsectors; Agricultural, Commercial and Services, Telecommunication and Technology, Automobiles and Accessories, Banking, Insurance, Investment, Manufacturing and Allied, Construction and Allied, and Energy and Petroleum sectors (NSE, 2013).

1.2   Research Problem

Portfolio optimization allows the reduction of the variability of portfolio performance and maximize expected returns at a given level of risk. Optimization of a portfolio can be realized through the changes in the allocation of financial assets, which affects exposure to the systematic and non-systematic risk, with the ultimate goal of achieving a better relationship between portfolio risk and return. Optimization should therefore lead to higher return (risk adjusted return) or lower risk of a portfolio than the constituent assets risk and return. However, allocation of equal weights to stocks in a portfolio, 1/N naïve portfolio, (DeMiguel, Garlappi and Uppal 2009)and Global Minimum Variance Portfolios (Disatnik 2009) have been observed to outperform mean-variance optimized portfolios thus inconsistent with portfolio optimization principle that requires consideration of both the assets risk and expected return in allocation of funds to the assets in an optimal portfolio.

Majority of investors use the stock market to invest their excess funds through trading in securities and with increased trading in stocks, not just by the foreign investors but also local institutional and individual investors, it has become increasingly important to safeguard the value of their investments by ensuring optimal performance of their holdings. Massive funds held by the pension, insurance and other industries are invested at the stock market. For example, of the Kshs. 522.6 Billion held by the retirement benefits sector as at June 2012, Kshs. 128.3 Billion (24.6%) was invested in quoted equities second only to government securities at Kshs. 184.1 Billion representing 35.2% of the funds (Retirement Benefits Authority, 2012). Performance of the retirement benefits schemes has been established to be reliant on the stock market evidenced bythe

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55% correlation between the retirement benefits scheme performance and stock market (Kipanga, 2012).

Kritzman, Page and Turkington (2010) looked at the performance of optimized portfolios against the naïve portfolio for the period 1926 to 2009 by building 50,000 portfolios that maximize the Sharpe ratio. The result of the study showed the optimized portfolios outperformed the market and naïve portfolio. Sen (2010) on constructing the optimal portfolio with and without short selling using Sharpe's Single Index Model built two optimal portfolios from 100 scrips of S&P CNX 500 analyzing data for the period November 2008 to November 2010 and found that short selling (allowing negative weights) leads to higher portfolio expected return due to addition of higher risk high return stocks to the existing without short sale stocks portfolio. Abankwa, Clarky and Dickson (2013) looked at the performance of portfolios constructed using sophisticated estimators against the naïve (1/N) portfolios. By using the dynamic conditional correlation (DCC) models to estimate covariance matrices on the CRSP returns (500CRSP) to minimize estimation risk. They found the optimized portfolios consistently outperform the 1/N portfolios with the DCC estimation improving the performance of optimized portfolios. They also concluded that the 1/N portfolio is not an optimal portfolio.

Kamanda (2001) while evaluating equity portfolios of insurance companies between January 1998 and December 1999 observed the deficiency in portfolio optimization in the insurance sector as the industry's portfolios underperformed against the market portfolio even though there wereregulatory constraints imposed by Insurance Regulatory Agency(IRA).Kamau (2002) sought to establish the difference in terms of risk and

returns of companies listed under MIMS and AIMS at the NSE by analyzing market data for the period January 1996 to December 2000. Sharpe ratios of companies listed under the two segments were found similar in terms of risk and return. Muriuki (2003) used the mean-variance model to compare the risk and returns of the Agricultural, Commercial, Finance and Industrial market sectors in the period 1997 to 2001 and found a significant difference in risks and returns of the different sectors from time to time. Imbenzi (2011) conducted a study on the NSE using Modigliani-Miller (1961) model to assess the risk of the four segments of the market for the period 2006 to 2010 using variance of returns from CAPM predictions and the variance from the mean of returns of a segment. The findings indicated NSE was improving in efficiency with differing risk levels over time for the four segments. Njuga (2011) using mean, standard deviation and mean-variance ratio (Sharpe ratios) to examine the risk-return relationship for the companies in the MIMS at the NSE, found the Agricultural sector to be the most risky while the Industrial sector the least risky. The study however found the difference in returns to be insignificant.

From the reviewed studies, the effect of optimization on portfolio returns has received little attentionlocally with most of the Kenyan studies focusing on the elements of optimization of risk and return separately for the segments of the market thus this study seeks to address the gap. The study sought to answer the research question: What is the effect of portfolio optimization on returns of listed companies at the NSE?

1.3 Research Objective

The study sought to establish the effect of portfolio optimization on returns of listed companies at the Nairobi Securities Exchange.

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1.4   Value of the Study

The study will enable investors, individual and institutional, to objectively diversify their portfolio. It will enable them allocate their funds in the process ensuring optimal returns from their investments.

The study will be beneficial to regulatory agencies such as Retirement Benefits Authority in enforcing proper diversification to safeguard investors' assets.

Investment companies and financial advisors will appropriately advice their clients on the performance and selection of listed securities at the NSE.

The study will stimulate interest in the area of portfolio optimization, contribute to the existing literature and provide a basis for further research. Researchers will be able to provide accurate policy guidelines that will strengthen the performance of the market.

CHAPTER TWO: LITERATURE REVIEW

2.1   Introduction

This chapter provides the theoretical foundation for the analysis of the theories in portfolio optimization. It captured the portfolio optimization process, determinants of portfolio returns and a review of empirical studies. A summary of the chapter was also presented.

2.2   Theoretical Review

Existing literature points out theories that explain the rationale of portfolio optimization. The main theories considered in this section are Mean-Variance Portfolio Theory, Safety First Theory, Separation Theorem and Customary Wealth Theory.

2.2.1 Mean-Variance Portfolio Theory

Markowitz (1952a) through the mean-variance portfolio theory proposed selection of a portfolio based on expected (mean) return, E, and variance of return, V. This formulation of the mean variance criterion is generally referred to as the risk minimization formulation. Markowitz's portfolio model expressed the optimal relationship between portfolio volatility and the expected return. It showed that under certain given conditions,

an investor's portfolio choice could be reduced to balancing based on two dimensions, which are the expected returns and variance of portfolio returns. He described the expected return on the portfolio as the weighted average of the expected returns on individual securities and the variance of return on the portfolio as the function of the variances and co-variances between securities and their weights in the portfolio. On distinction between the efficient and inefficient portfolios, he coined the phrase "Efficient frontier" which was a set of efficient mean-variance combinations. Therefore, due to the possibility of reducing risk through diversification, the risk of the portfolio as measured by the variance of portfolio returns depend not only on the individual variances of the return on different assets, but also on the pair-wise covariance (correlation) of returns on all assets.

Its success in matching risk and return, fund assets and liabilities, its ease of application across the various assets, and its compatibility various investment policies has been found to affirm its popularity among fund managers (Muendo, 2006).

The mean-variance model has been criticized majorly on its assumptions and the magnitude of inputs it requires. Kritzman (2011) while marking 60 years of the mean-variance optimization existence noted three major criticism points that were used by "old technology" investors against the model. First one was "Garbage in, Garbage out" mentality individuals who expected the model to produce great portfolios yet they used poor inputs that would go against theory. Second, was that the optimizers were sensitive to input errors leading to overstatement of returns and understatement of risk. The last was the dependence of the model to false assumptions particularly the normality of returns distribution.

Practitioners' major hurdle was in determining inputs into the optimizer especially those managing huge funds. As the number of assets increases, the number of distinct elements of the covariance matrix increases at a quadratic rate, as it has $N(N + 1)/2$ independent elements. A 100 asset portfolio manager would require 5,050 covariance matrix elements and for 500 assets the number grows to 125, 250 elements. This led to the formulation of a simplified structure of the inputs to the optimization model to reduce estimation errors. Factor models were developed with the first and simplest being Single Index Model (SIM) by Sharpe (1963). The simplified model assumed that the fluctuations in the value of stock relative to other stocks do not depend on the characteristics of those two securities alone but with the market that they operate in. This market was represented by a common denominator of the stock market. The performance and movements in the market would therefore indicate the individual stocks expected performance. This considerably reduced the number of covariance estimates to $3N+2$ thus easing analysis of portfolios.

2.2.2 Safety-First Theory

Roy (1952) in an attempt to move away from utility functions as determinants of investment came up with the Safety-first theory. It involves creating a portfolio based on a minimum level of portfolio returns, which is called the minimum acceptable return. By setting up a minimum acceptable return, investors mitigate loss of the principal amount. He pointed out that investors prefer investment opportunities with the smallest probability of going below a certain target return termed the disaster level.

Norkin and Boyko (2010) identified the symmetry of variance as a measure of risk that the Mean-variance model suffered as a shortcoming of the model. They suggested the replacement of the variance with a mean shortfall of returns.

2.2.3 Separation Theorem

Tobin (1958) proved through the Separation theorem that in a world of one safe asset and a large number of risky assets, portfolio choice by any risk-averse portfolio holder can be described as a choice between the safe asset and the same portfolio of risky assets. The proportion of safe asset in a portfolio is determined by the level of risk-averseness of the investor.

The theory proposes two steps of finding an optimal portfolio for a given level of risk: first, finding an optimal portfolio of market securities using the mean-variance model. Second, combine the market portfolio with a risk free asset. The allocation between the efficient market portfolio and the risk free asset will be dependent on an investor's risk appetite.The separation theorem offers optimization opportunity to investors as the consideration of the volatility of the portfolio based on the correlation between the risky assets and the risk-free asset forms the basis of inclusion of an asset(s) into a portfolio.

2.2.4 Customary Wealth Theorem

Markowitz (1952b) in his customary wealth theorem explains Friedman & Savage (1948) paradox by noting that people aspire to move up the current social class or "customary wealth" which is the level of wealth to which one is used to for example actual wealth or in case of a windfall gain or loss this might be added to actual wealth to get the

customary wealth. He observes that utility changes for an individual and is strongly linked to what the person has already achieved in his life.

The level of customary wealth will be equal to an individual's actual wealth but can be distorted by windfall gains or losses. This implies that an individual's utility function will constantly change as one advances in life and also according to the level of wealth that he has from time to time. Markowitz also recognized individuals change in risk appetite given the level of gains or losses one is experiencing. Investors are seen to become increasingly risk seeking when gaining and increasingly risk averse when making losses.

The customary wealth theorem recognizes the changes that come with time due to changes in status, level of income etcetera that would vary the utility one derives from what they achieve with their investment. Portfolio optimization too is not static as the changes in an investors utility would be reflected in the composition of their portfolio.

Alchian (1953) observes that Markowitz notion of customary wealth was not clear as he did not define it and left it to future researchers. Markowitz was indicating varying tastes with different level of wealth which was against the usual economists' assumption of constant taste (utility).Kahneman and Tversky (1979) "prospect theory" shared Markowitz's line of thought in terms of the framing issue and the asymmetric treatment of gains and losses.

2.3   Portfolio Optimization Process

Ramani(2009) identified three steps in optimization of portfolios. First, the identification of the assets to be considered. Secondly, the forward-looking assumptions are modelled which involves estimating the required inputs into the model such as the expected returns,

risk and correlations. Lastly, the optimization algorithm is specified such as the mean-variance optimization model.

Expected returns of the assets and a covariance matrix from the standard deviation of each asset and their correlation to each other are estimated from historical returns data. The optimizer then goal seeks to find a set of asset allocation weights that either minimizes the risk of the portfolio for a specific return or maximizes return for a specific or target risk. Michaud (1989) observes that the optimizers can magnify the level of errors due to historical data inability to accurately predict future returns leading to impractical portfolios: portfolios with large short positions and asset allocation weights that are not well diversified.

To address the practical issues with the Markowitz model Black & Litterman (1992) made the model more practical by combining investors' views with equilibrium returns, leading to potentially more reasonable, flexible and stable optimal portfolios. Optimization in the Black Litterman model begins with defining the equilibrium market weights and covariance matrix leading to calculation of the equilibrium-expected excess returns through reverse optimization. The optimizer expresses investor views and confidence level of view then computes combined equilibrium view adjusted expected returns and finally run mean variance optimization.

The effect of an investor's view on the asset allocation is to tilt the portfolio towards outperforming stocks and away from underperforming ones.If the investor has no view, the model returns the optimal market capitalization weights. Once the equilibrium returns are calculated and the views expressed, the Black Litterman model forms a set of new

combined expected returns. These returns are then used as inputs to the Markowitz mean-variance optimization technique.

2.4   Determinants of Portfolio Returns

Brinson, Hood and Beebower (1986) attributed a portfolios returns to the investment policy, active asset allocation (market timing) and security selection. They used data from 91 U.S pension plans over the period 1974 to 1983 to measure the performance of the benchmark portfolio, which had long term assets classes weighted by their long term allocations, against actual returns of a portfolio made from combination of investment policy of weighting relative to the plan benchmark and security selection. They found that 93.6% of the variability in returns were due to investment policy with asset allocation and security selection contributing the remaining 6.4%.Hoernemann, Junkans, and Zarate (2005) also found strategic asset allocation contribute significantlyto variability of portfolio returns, 77.5%, thus confirmed asset allocation as a major determinant to the investment performance but highlighted the value of managers through tactical asset allocation and security selection. Craig (2003) confirmed Brinson, Hood and Beebower (1986) and Brinson, Singer and Beebower (1991) findings on the significance of asset allocation policy with own findings of over 90% variation in total portfolio return and risk adjusted returns.

Ibbotson (2010) set to clarify the notion that over 90% of a portfolio's performance is due to investment policy in terms of return level as opposed to variation in returns. He concludes by indicating the misunderstanding of Brinson, Hood and Beebower (1986) and subsequent researchers' findings to imply that portfolio returns were explained majorly by investment portfolio policy instead of the variation in returns and maintaining

asset allocation to be important in determining performance.Staub (2006) observed that asset allocation and security selection perform completely different roles thus their comparison is misguided. James, Ibbotson, Idzorek and Chen (2010) affirmed the importance of asset allocation in portfolio performance by declaring "Asset Allocation is King".

2.5   Empirical Studies

Kamau (2002) sought to establish the difference in terms of risk and returns of companies listed under MIMS and AIMS at the NSE by analyzing market data for the period January 1996 to December 2000. Individual companies Sharpe ratios were computed and analyzed with the difference in Sharpe ratios of companies listed in the two market segments analyzed using Wilcoxon Rank Sum test. The performances of companies listed under the two segments were found to be the same in terms of risk and return. This was attributed to poor market segmentation. Kamau found the NSE market segmentation ineffective in addressing the interest of the rational investors who seek diversification of their portfolios.

Muriuki (2003) used the mean-variance model to compare the risk and returns of the Agricultural, Commercial, Finance and Industrial market sectors. Weekly sector performance was evaluated for the period 1997 to 2001. SAS optimizer (investment software) was used to set target return and determine the proportion of stock to be included in each of the stock market in order to achieve the expected return. Each portfolio's risk was also determined for the period. The results were plotted in a graph to determine the efficient frontier for each of the market sector then the efficiency frontiers across the market sectors was compared using descriptive statistics and ANOVA.

Significant difference in risks and returns of the different sectors from time to time was observed. The conclusion was that the difference in risk and returns is a manifestation of the differences in market conditions and sector characteristics.

Gupta and Basu (2009) sought to determine sector relationships and their impact on portfolio optimization in the Indian stock market. They used Asymmetric DCC GARCH model as in the original model of Engle (2002) as modified by Sheppard (2002) as a general model. Monthly returns of the National Stock Exchange and monthly returns of 10 randomly selected sector indexes over a 10 year period was analyzed. They found that a portfolio constructed using different industry sectors performed better than the benchmark index.

Rudd (1981) observed that constraints introduce biases to a portfolio which impact on co-variation in returns leading to poor performance of socially responsible portfolios.

Black and Litterman (1992) observe that quantitative models produce unreasonably large short positions on optimization without constraints or large weights in a few assets with many given zero on disallowing short sales (constrained optimization). Disatnik and Benninga (2006) find the portfolio weights obtained when constraints are imposed on a portfolio are not practical as there is no relation between the optimal asset weights and asset statistics (variance-covariance matrix).

Fletcher (2009) while examining the performance of the Global minimum variance (GMV) and minimum tracking error variance (TEV) portfolios in UK using different models of the covariance matrix found that they deliver risk reduction benefits by reducing the volatility relative to the benchmarks of the covariance matrix used.

However, the GMV (TEV) portfolios do not provide significantly superior Sharpe (1966) performance relative to passive benchmarks except for the restricted GMV portfolios.

Kritzman, Page and Turkington (2010) looked at the performance of optimized portfolios against the naïve portfolio that at the time several previous researchers (Jobson and Korbie, 1981; DeMiguel, Garlappi and Uppal, 2009; Duchin and Levy, 2009) had found to outperform many other portfolios. The equally weighted portfolio was popular due to its ease in implementation as it did not require returns and risk. Using data for the period 1926 to 2009 they built 50,000 portfolios that maximize the Sharpe ratio. The result of the study showed the optimized portfolios outperformed the market and naïve portfolio.

Sen (2010) on constructing the optimal portfolio with and without short selling using Sharpe's Single Index Model built two optimal portfolios from 100 scrips of S&P CNX 500. Data analysed was for a period of two years starting November 2008 to November 2010. He arrived at two different portfolios by short selling certain scrips in the first portfolio and sieving out certain scrips out of the investment basket in the second portfolio. The portfolio with short sales had an expected return of 64.25% while the portfolio without short sales had 56.61% thus short selling leads to addition of higher risk high return stocks to the existing without short sale stocks portfolio.

Imbenzi (2011) conducted a study on the Nairobi Securities Exchange using Modigliani-Miller (1961) model to assess the risk of the four segments of the market. The study used two approaches in calculation of risk, the first being variance of returns from CAPM predictions and the other the variance from the mean of returns of a segment. The research was based on Wednesday stocks volume per company, their corresponding

prices, the dividends of the 51 companies and the T-Bill rates for the period 2006 to 2010. The T-Bills were collected from the CBK while the stocks data from the NSE databank electronically.The findings were that NSE was improving in efficiency according to CAPM and variance reduced with time. Also, the four segments had differing risk levels over time with Agricultural & Allied Market Segment having the highest risk with FISMS and MIMS showed equally low and reducing levels of risk but AIMS did not show a trend.

Njuga (2011) using descriptive statistics tools of mean, standard deviation and mean-variance ratio (Sharpe ratios) to examine the risk-return relationship for the companies in the MIMS at the NSE, found the Agricultural sector to be the most risky with the highest Sharpe ratio of 3.756 while the Industrial sector the least risky with the lowest Sharpe ratio of 1.553. He concluded by acknowledging the existence of a relationship between the sectors in MIMS as when one sector is experiencing poor returns another has good returns.He however found the difference in returns to be insignificant thus recommending better ways of segmenting the market.

Behr, Guettler and Miebs (2013) while studying imposing right constraints on a portfolio to achieve minimum variance and higher Sharpe ratios, studied four different portfolios representing different cuts of the U.S. stock market using20 years data from the CRSP database.They used two sets of benchmark portfolios to assess the performance of their constrained portfolio;Simple portfolio strategies which do not rely on historical data (equally-weighted (1/N) and value-weighted (VW) portfolio) and minimum-variance portfolio strategies.The rolling sample approach was adapted to test the performance of constrained minimum-variance strategy in comparison to the considered benchmark

portfolio strategies. Their findings showed significantly lower out-of-sample variance and higher Sharpe ratios of about 32.5% for their constrained minimum-variance portfolio than the 1/N portfolio. The constrained minimum-variance strategy achieved the goal of improving the Sharpe ratio of 1/N consistently and significantly.

Abankwa, Clarky and Dickson (2013) looked at the performance of portfolios constructed using sophisticated estimators against the naïve (1/N) portfolios. By using the dynamic conditional correlation (DCC) models to estimate covariance matrices on the same data used by DeMiguel, Garlappi and Uppal (2009) to minimize estimation risk. They found the optimized portfolios consistently outperform the 1/N portfolios with the DCC estimation improving the performance of optimized portfolios. They also conclude that the 1/N portfolio is not an optimal portfolio.

2.6   Summary of Literature Review

Theories have shown that optimization increases returns of portfolio while reducing their risks. Studies have shown the influence of optimization on equity portfolios returns as indicated bySen (2010), Kritzman, Page and Turkington (2010), Abankwa, Clarky and Dickson (2013). The risk reduction effect was captured by Fletcher (2009) and on risk adjusted returns by Behr, Guettler and Miebs (2013). Although these studies offered insight into portfolio optimization in markets other than Nairobi Securities Exchange, generalization of their findings to the Kenyan context would be limited due to the difference in the level of development of the markets.

Rasmussen (2003) argues that asset allocation decision is the most important decision in a portfolio's life. Portfolio optimization being a mechanism that seeks to better the

performance of a portfolio by among other means aiding the choice of asset proportions objectivelyis of great importance to an investor. Studies at the NSE have focused on risk and return of the segments in the market. This study seeks to fill the gap by establishing the effect of optimization on the returns of portfolios of listed companies at the NSE.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that was employed in the research project. It details the research design, the population studied, the sample and sampling design, the nature of data collected and data analysis technique employed.

3.2 Research Design

The research was based on descriptive research. Descriptive research attempts to describe, explain and interpret conditions of the present i.e. "what is'. The purpose of a descriptive research is to examine a phenomenon that is occurring at a specific place and

time.The researcher has no control over the variables and can only report what has happened or what is happening (Kothari, 2004).

3.3 Population

All the companies listed at the Nairobi Securities Exchange as at 30th June 2013 formed the population of study. As at 30th June 2013sixty one (61) companies were listed at the Nairobi Securities Exchange (Appendix I). The companies were grouped into 10 sectors which included Agricultural, Commercial and Services, Telecommunication and Technology, Automobiles and Accessories, Banking, Insurance, Investment, Manufacturing and Allied, Construction and Allied, and Energy and Petroleum.

3.4 Sample and Sampling Design

The sample consisted of 45companies (Appendix I) that hadactively traded at the NSE for the period 1st July 2008 up to 30th June 2013. Suspended and newly enlisted (entrants) companies within the period were excluded from the population of 61 companies. Purposive sampling was used as it involves deliberate selection by a researcher of a sample that possesses required characteristic for the study (Cooper & Schindler, 2006).

3.5 Data Collection

The study relied on secondary data obtained for the period July 2008 to June 2013 from the NSE, and the CBK. The listed companies'stock prices wereobtained from the NSEwith the 91 day Treasury bill rates from the CBK.The secondary data was found valid for the study as the sources were reliable and they are as a result of the day to day trading thus practicable in nature.

3.6 Data Analysis

The research being quantitative in nature, descriptive and inferential statistics was used. Once the data was collected and checked for completeness it was then analyzed .Analysis was done using Microsoft Office Excel 2007 with the descriptive statistics generated presented in tables and figures.

The study used Markowitz (1952a) model that seeks to maximize total portfolio return:

$$r_p = \sum_{i \in I} r_i(x_i)$$

Subject to;

Budget constraint (weights),

$$\sum_{i=1}^{N} x_i = 1$$

$$x_i \geq 0, i = 1, \ldots \ldots \ldots N$$

The portfolio variance was obtained by

$$Var\ (r_p) = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i\, x_j \sigma_{ij}$$

Where

r_p is the return of portfolio

r_i is the return of stock i

x_i is fraction of portfolio to invest in stock i

σ_{ij} is covariance between stocks i and j, and

N is the Number of stocks forming a portfolio.

The average stock prices from one month to another were used to compute the stock's return as below

$$R_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) x \ 100\%$$

Where

R_{it} is the stock i return at time t,

P_{it} is the price of stock i at time t,

Sharpe's Single Index model (1963) was used to form portfoliosby selecting stocks based ontheirdesirability in relation to their excess return to beta (ERB) ratio. The ERBwas used to rank the stocks from highest to lowest.To form optimum portfolio stocks whose excess return to beta ratio was greater than a cutoff point C_i were selected into the portfolio. The cutoff point C_i was determined as below

$$C_i = \frac{\sigma_m^2 \ \sum_{j=1}^{i} \frac{(R_j - R_F)\beta_j}{\sigma_{ej}^2}}{1 + \sigma_m^2 \ \sum_{j=1}^{i} \left(\frac{\beta_j^2}{\sigma_{ej}^2}\right)}$$

Where

C_i is the Cutoff point

R_j is the return of stock j

R_F is the risk free rate return (average 91 day Treasury bill rate)

σ_{ej}^2 is the unsystematic risk of stock j

β_j is the Beta of stock j, and

σ_m^2 is the market variance (NSE 20 Share Index).

Stocks were added to the portfolio as long as the excess return to Beta was greater than the cutoff value;

$$\frac{(R_i - R_F)}{\beta_i} > C_i$$

Once the optimum portfolio stocks were identifiedtheir weights (x_i) were determined by solving $X_i = \frac{Z_i}{\sum Z_j}$

Where $Z_i = \frac{\beta_i}{\sigma_{ei}^2} \left(\frac{R_j - R_F}{\beta_i} - C^* \right)$

The performance of the portfolios were assessed using the Sharpe ratio,Treynor ratio and Jensen alpha portfolio measures which enabled the comparison of the portfolios with different risk-return characteristics.

To test the significance of the optimized portfolio'smean returnand risk (beta) against the benchmark portfolios, Global Minimum Variance Portfolio (GMVP) and 1/N, a t-test was conducted to validate the hypothesis:

H_0: There is no difference between the risk and returns of the portfolios

H_1: There is a difference between the risk and returns of the portfolios.

GMVP was chosen as a benchmark portfolio based onDisatnik (2009) suggestion while the 1/N was used as recommended by DeMiguel et al. (2009).The GMVP is the portfolio,$x = \{x_1, x_2 \ldots \ldots x_N\}$, which has the lowest variance from among all feasible portfolios and the only portfolio that does not require the stocks expected returns to determine asset allocation. GMVP is determined by Merton's (1973) formulae. It is computed by multiplying the stocks variance-covariance matrix with a unit vector matrix then dividing with the sum of the products of variance-covariance matrix and unit vector.

$$x_i = \frac{V(I)}{\sum V(I)}$$

Where; V is the Variance-covariance matrix, and

I is the Unit vector (vector of 1's).

The second benchmark portfolio 1/N naïve portfolio was obtained by equally allocating weights to the stocks in the portfolio.

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter detailed the data analysis, findings and interpretations of the research study.

4.2 Findings

4.2.1 Portfolios

The optimal portfolio's performance was analyzed against the benchmarks of Global Minimum Variance portfolio (GMVP) and the naïve portfolio (1/N portfolio).

Using the stocks' average monthly prices, the monthly log returns were computed and converted to annual returns by multiplying the returns by 12. The monthly standard deviations thereon computed were converted to annual standard deviations through multiplication of thesame by the square root of 12.All stocks excess return were determined by deducting the study period's average 91 day Treasury bill rate of 8.81% from the stocks return. The stocks excess return were divided by their beta obtained by

regressing their returns to the market return (NSE 20 share index). The stocks were then ranked by excess return to beta in the ascending order that is from the highest to the lowest value. The cutoff point of each stock was calculated using the equation for determining C_i.

The optimal portfolio was composed of stocks whose excess return to beta was greater than their C value as shown in Table 1 in Appendix III.Imposing a non-negative constraint of the form $x_i \geq 0, i = 1, \ldots\ldots\ldots N$ effectively permitted only positive weights allocation to the stocks forming the portfolio with the sum of the weights set at one. The non-negative weight (no short selling) constraint is consistent with the prohibition of short selling at the NSE by the Capital Markets Authority.

Out of the 45 sampled stocks only 2, which is a 4.44% representation, made the optimal portfolio with the remaining 43 stocks eliminated. To determine the stocks weight in portfolio the Z_i were calculated then aggregated. BAT computed weighting was 72.08% and Limuru Tea 27.92%. In the GMVP portfolio BAT had a weight of 39.14% while Limuru Tea 60.86%. In the 1/N portfolio each of the stocks got 50% weight.

4.2.2 Portfolios Risk and Return

Stocks returns for the period 2008 to 2013 were used in the computation of the two portfolios risk and return usingMarkowitz (1952) model. The portfolios risks were determined in terms of their standard deviation and beta. Table 4.1 shows the two portfolios risks and returns.

Table 4.1 Portfolios Return, Standard Deviation and Beta

	Optimal Portfolio	GMVP	1/N
Return	23.22%	21.89%	22.33%
Standard Deviation	5.48%	6.34%	6.06%
Beta	0.3410	0.3077	0.3187

Source: Computations from NSE Data

All the three portfolios gave positive returns with a range of 1.33%. The optimal portfolio had the highest return than both benchmarks of the GMVP and naïve portfolio (1/N) portfolio. The 1/N portfolio had the second highest return with the GMVP having the lowest. In terms of total risk (standard deviation) the optimal portfolio was the best with the lowest standard deviation, the 1/N being second best with the GMVP being the most risky but on variability to the market (Beta) the optimal portfolio was the worst followed by 1/N portfolio with the GMVP being the best with the lowest variability.

4.2.3 Portfolio Performance measures

Table 4.2 Portfolios Sharpe ratio, Treynor Ratioand Jensen Alpha

	Optimal Portfolio	GMVP	1/N
Sharpe Ratio	2.6306	2.0611	2.2309
Treynor Ratio	0.4224	0.4249	0.4240
Jensen Alpha	0.1803	0.1634	0.1690

Source: Computations from NSE Data

The optimal portfolio had the highest Sharpe ratio thus a higher reward to volatility than the GMVP and 1/N portfolios. The 1/N portfolio had the second best Sharpe ratio with the GMVP being the third best. The GMVP had the highest Treynor ratio indicating a

higher excess return per unit of systematic risk while the optimal portfolio returned a higher Jensen Alpha indicating a better stock picking (selection) than the GMVP and 1/N.

4.3 Determining Significance of the difference between Risk and Return of the Optimal Portfolio and Benchmark Portfolios

T tests were carried out to determine whether there are significant difference between the risks and return of the optimal portfolio with the GMVP and the 1/N portfolio.

Given the H_0: There is no difference between the risk and returns of the portfolios

H_1: There is a difference between the risk and returns of the portfolios.

At 5% significance level the t critical value was 4.3026. The t-statisticsfor risk adjusted returns and beta were as in table 4.3below.

Table 4.3Portfoliost-statistics

| Measure | t-statistics | |
	Optimal Portfolio vs GMVP	Optimal Portfolio vs 1/N Portforlio
Returns	0.3178	0.2186
Beta	0.7960	0.5475
Sharpe Ratio	13.5909	9.7892
Treynor Ratio	-0.0600	-0.0398
Jensen Alpha	0.4023	0.2767

Source: Computations from NSE Data

The optimal portfolio's t values for its returns, Beta, Treynor ratio and Jensen alpha were within the confidence interval of -4.3026> t > 4.3026. These values thus indicated significant difference between the returns, Beta, Treynor ratio and Jensen alpha of the optimal portfolio and those of the GMVP and 1/N portfolios. However, the Sharpe ratio

had t values of 13.5909 and 9.7892 against the GMVP and 1/N portfolios respectively thus indicating no significant difference in their total risk adjusted return (Sharpe ratios).

4.4 Summary

The Single index model was used to select stocks into the optimal portfolio. The optimal portfolio had only 2 of the 43 stocks which was only 4.44% representation of the stocks in the sample.

The optimal portfolio outperformed the GMVP and 1/N naïve portfolio as it was the best in 4 out of the 6 measures. It had the highest returns, lowest standard deviation, Sharpe ratio and Jensen alpha while underperformed on Beta and Treynor ratio.In terms of the efficiency in selection of stock the optimal portfolio was the best of the three portfolios as it had a higher and significant Jensen alpha.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarized the analysis in chapter four and underlined the key findings. It also drew conclusions and implications from the finding. Limitations of the study were discussed. Finally, recommendations and suggestions for further studies were outlined.

5.2 Summary

Share prices of 45 companies that consistently traded at the NSE were used to compute the share returns. To analyze the performance of constructed portfolio, the optimal portfolio wasconstructed based on the Single Index model criterion with its performance measured against the benchmark portfolios of GMVP and the 1/N naïve portfolio.

From the average monthly stock prices risk and returns were computed. Risk was based on standard deviation and beta of the stocks. The stocks excess return, return above the risk free rate, to beta ratio in comparison to the computed cut off rate was used to determine a stock's selection into a portfolio. Stocks with excess return to beta (ERB) greater than or equal to the computed cut off were selected into the portfolio and the stocks with ERB less than the cut off were rejected.

The optimal portfolio had the highest return, Sharpe ratio and Jensen alpha with the lowest standard deviation, while underperformed on Beta and Treynor ratio in comparison to the GMVP and 1/N naïve portfolio. It therefore outperformed the GMVP and 1/N naïve portfolio in terms of return and total risk (Sharpe ratio) and better stock

selection thus abnormal returns (Jensen alpha) but underperformed on return to systematic risk measure (Treynor ratio).

T tests were used to determine whether there was significant differences between the risk and returns of the optimal portfolio and the benchmarks of GMVP and 1/N portfolios. There was a significant difference between the risk and returns, Treynor ratio and Jensen alpha of optimal portfolio and the GMVP and the 1/N naïve portfolio. This showed a significant difference in risk adjusted returns and abnormal returns. However there was no significant difference between the Sharpe measure of the optimal portfolio and the GMVP and the 1/N portfolio thus no significant difference in terms of risk adjusted returns to total risk.

5.3 Conclusion

The study aimed at establishing the effect of portfolio optimization on returns of listed companies at the Nairobi Securities Exchange. Consistently trading companies stocks at the NSE were used to compute risk and returns thereafter construction of the optimal portfolio. The risks and returns of the portfolio was compared to that of the GMVP and 1/N naïve portfolios to check the significance of the differences between the risks and returns of the portfolios.

The study found significant difference between return, risk and risk adjusted returns of optimal portfolio and the GMVP and naïve (1/N) portfolio thus portfolio optimization leads to better absolute and risk adjusted returns. These results are consistent with Kritzman, Page and Turkington (2010) who looked at the performance of optimized portfolios against the naïve portfolio and their study showed the optimized portfolios

outperformed the market and naïve portfolio. Sen (2010)who constructed the two optimal portfolios using Sharpe's Single Index Model found optimization leads to higher expected returns and lower portfolio risks.

5.4 Recommendations

Portfolio optimization would ensure investors pick stocks which will lead to their desired portfolio objective of maximum return. The study recommends that both institutional and individual investors optimize their portfolio by allocation of their wealth among the desired stocks objectively. Using factor models such as the Single Index Models to estimate variables for optimization models such as the Markowitz mean-variance model simplifies the optimization process for investors. Regulators such as the Capital Markets Authority and Insurance regulatory Authority need to ensure their regulations safeguard investors assets by ensuring optimization is a key factor in institutions portfolios as it has been found to be of great value.

5.5 Limitations of the Study

CMC holdings had its share suspended from trading from October 2011 and was maintained as a stock in the NSE 20 share index. Although the stock was not part of the constructed portfolio, its retention in the index may have adversely affected the measurement of the market performance.

The study concentrated on listed companies as equities that can be used to form portfolios thus the exclusion of non-listed firms from the study would make it harder to generalize the findings of the study.

5.6 Suggestions for Further Studies

A study should be conducted on how well the NSE 20 share index represent a well-diversified market portfolio. This will give confidence in its use as a benchmark to constructed portfolios performance.The study can also be replicated but substitute the NSE 20 Share index with the FTSE NSE Kenya 15 Index or FTSE NSE Kenya 25 Index as the market portfolio.

A study on optimization of the portfolio returns can be conducted using the Black-Litterman model to alleviate the weakness of the mean-variance portfolio method.A study can also be done to establish the upper levels of amounts that can be invested in each security to achieve a diversified portfolio. This will act as the constraints to the optimizer.A well-diversified portfolio is mix of several stocks. For the optimizer to allocate weights to the stocks adequately then more realistic constraints need to be imposed on the amounts that can be invested in a single stock. Further analysis should be done to establish the upper levels of amounts that can be invested in each security to achieve a diversified portfolio. This will act as the constraints to the optimizer.

In portfolio optimization the estimation of returns is important in reducing estimation errors that lead to skewed weighting. To obtain more accurate estimators of mean return longer time period stock data say 20 years can be used (Behr, Guettler and Miebs, 2013).

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APPENDICES

APPENDIX I: LISTED COMPANIES BY SECTORS AT THE NSE

I. AGRICULTURAL

1. Eaagads Limited
2. Kapchorua Tea Company Limited
3. Kakuzi
4. Limuru Tea Company Limited
5. Rea Vipingo Plantations Limited
6. Sasini Limited
7. Williamson Tea Kenya Limited

II. COMMERCIAL AND SERVICES

1. Express Limited
2. Kenya Airways Limited
3. Nation Media Group
4. Standard Group Limited
5. TPS Eastern Africa (Serena) Limited
6. Scangroup Limited
7. Uchumi Supermarket Limited*
8. Hutchings Biemer Limited *
9. Longhorn Kenya Limited**

III. TELECOMMUNICATION AND TECHNOLOGY

1. AccessKenya Group Limited*
2. Safaricom Limited

IV. AUTOMOBILES AND ACCESSORIES

1. Car and General (K) Limited
2. CMC Holdings Limited*
3. Sameer Africa Limited
4. Marshalls (E.A.) Limited

V. BANKING

1. Barclays Bank Limited
2. CFC Stanbic Holdings Limited
3. Diamond Trust Bank Kenya Limited
4. Housing Finance Company Limited
5. Kenya Commercial Bank Limited
6. National Bank of Kenya Limited
7. NIC Bank Limited
8. Standard Chartered Bank Limited
9. Equity Bank Limited
10. The Co-operative Bank of Kenya Limited**

VI. INSURANCE

1. Jubilee Holdings Limited
2. Pan Africa Insurance Holdings Limited
3. Kenya Re-Insurance Corporation Limited
4. CFC Insurance Holdings/ Liberty Kenya Holdings Limited**
5. British-American Investments Company (Kenya) Limited**
6. CIC Insurance Group Limited**

VII. INVESTMENT

1. Olympia Capital Holdings Limited
2. Centum Investment Company Limited
3. Trans-Century Limited**
4. City Trust Limited**

VIII. MANUFACTURING AND ALLIED

1. B.O.C Kenya Limited*
2. British American Tobacco Kenya Limited
3. Carbacid Investments Limited*
4. East African Breweries Limited
5. Mumias Sugar Company Limited
6. Unga Group Limited
7. Eveready East Africa Limited

| 8 | Kenya Orchards Limited * |
| 9 | A.Baumann Company Limited* |

IX. CONSTRUCTION AND ALLIED

1	Athi River Mining
2	Bamburi Cement Limited
3	Crown Berger Limited
4	E.A.Cables Limited
5	E.A.Portland Cement Limited

X. ENERGY AND PETROLEUM

1	KenolKobil Limited
2	Total Kenya Limited
3	KenGen Limited
4	Kenya Power & Lighting Company Limited
5	Umeme Limited**

* Suspended- The Shares of the company have been suspended from trading at the Nairobi Securities Exchange

**New entrants

*Source:*Capital Markets Authority Annual Report 2013

APPENDIX II: COMPANIES IN THE NSE 20 SHARE INDEX

I. AGRICULTURAL

1. Rea Vipingo Plantations Limited

2. Sasini Limited

II. COMMERCIAL AND SERVICES

1. Express Limited

2. Kenya Airways Limited

3. Nation Media Group

III. TELECOMMUNICATION AND TECHNOLOGY

1. Safaricom Limited

IV. AUTOMOBILES AND ACCESSORIES

1. CMC Holdings Limited

V. BANKING

1. Barclays Bank Limited

2. Kenya Commercial Bank Limited

3. Standard Chartered Bank Limited

4. Equity Bank Limited

VI. INVESTMENT

1. Centum Investment Co Limited

VII. MANUFACTURING AND ALLIED

1. British American Tobacco Kenya Limited

2. East African Breweries Limited

3. Mumias Sugar Co. Limited

VIII.   CONSTRUCTION AND ALLIED

1. Athi River Mining

2. Bamburi Cement Limited

3. E.A.Cables Limited

IX.   ENERGY AND PETROLEUM

1. KenGen Limited

2. Kenya Power & Lighting Co Limited

Source: Nairobi Securities Exchange

APPENDIX III: SINGLE INDEX MODEL PORTFOLIOS

Table 1: Without Short Sale Portfolio

Market Variance (σ_m^2)=0.03915   **R_f =0.088117**

Company	$E(R_i)$	$E(R_i) - R_f$	β_i	$\dfrac{E(R_i) - R_f}{\beta_i}$	σ_I^2	σ_{ej}^2	C*	Status	Z_i	X_i
Limuru Tea Co. Ltd	0.2030	0.1149	0.2681	0.4287	0.0270	0.0053	0.1488	In	1.011303	0.2792
BAT	0.2435	0.1553	0.3693	0.4206	0.0714	0.0018	0.3269	In	2.610537	0.7208
Williamson Tea K Ltd	0.2305	0.1424	0.6047	0.2355	0.0652	0.0154	0.3111	Out		
Athi River Mining	0.2192	0.1311	0.9530	0.1376	0.0630	0.0020	0.1786	Out		
Nation Media Group	0.1736	0.0855	0.8029	0.1064	0.0939	0.0022	0.1546	Out		
Scangroup	0.1658	0.0777	0.9492	0.0818	0.0915	0.0050	0.1421	Out		
Kapchorua Tea	0.1103	0.0222	0.3569	0.0623	0.1459	0.0072	0.1408	Out		
Diamond Trust Bank	0.1524	0.0643	1.0340	0.0621	0.1019	0.0019	0.1138	Out		
Kakuzi	0.1529	0.0648	1.1001	0.0589	0.1237	0.0084	0.1093	Out		
EABL	0.1099	0.0218	0.9311	0.0234	0.0968	0.0024	0.0949	Out		
Jubilee	0.1076	0.0195	1.1033	0.0177	0.0161	0.0020	0.0778	Out		
Eaagads	0.0908	0.0027	0.3391	0.0078	0.0903	0.0186	0.0777	Out		
Pail Kn Equity	0.0835	-0.0046	0.7564	-0.0061	0.0928	0.0060	0.0749	Out		
NIC Bank	0.0721	-0.0160	1.2249	-0.0131	0.0385	0.0022	0.0578	Out		
Crown Berger	0.0511	-0.0370	1.4197	-0.0261	0.0826	0.0071	0.0515	Out		
Standard Chartered	0.0681	-0.0200	0.7440	-0.0269	0.0941	0.0014	0.0443	Out		
KCB	0.0506	-0.0375	1.0145	-0.0370	0.0597	0.0031	0.0383	Out		
Centum	0.0113	-0.0769	1.5708	-0.0489	0.1442	0.0043	0.0285	Out		
Equity Bank	0.0199	-0.0683	1.3421	-0.0509	0.0680	0.0027	0.0192	Out		

Kenya Reinsurance	0.0153	-0.0729	1.0232	-0.0712	0.0771	0.0045	0.0156	Out		
Sasini	-0.0089	-0.0970	1.3239	-0.0732	0.0381	0.0067	0.0119	Out		
Rea Vipingo	0.0251	-0.0630	0.8284	-0.0760	0.0937	0.0056	0.0102	Out		
Unga Group Ltd	0.0235	-0.0646	0.8376	-0.0771	0.1627	0.0059	0.0086	Out		
Barclays Bank of Kenya	-0.0128	-0.1009	1.0654	-0.0947	0.1156	0.0016	-0.0016	Out		
Safaricom Limited	-0.0150	-0.1032	1.0126	-0.1019	0.0775	0.0032	-0.0059	Out		
Kenol	0.0140	-0.0741	0.6870	-0.1079	0.1040	0.0063	-0.0069	Out		
Bamburi	0.0192	-0.0689	0.6296	-0.1095	0.0604	0.0026	-0.0089	Out		
HFCK	-0.0526	-0.1408	1.1693	-0.1204	0.0448	0.0032	-0.0147	Out		
TPSE.A Ltd	-0.0412	-0.1294	1.0026	-0.1290	0.1476	0.0071	-0.0166	Out		
Kengen	-0.0924	-0.1805	1.3403	-0.1347	0.0644	0.0022	-0.0270	Out		
Kenya Power	-0.0719	-0.1600	0.9512	-0.1682	0.0463	0.0018	-0.0344	Out		
National Bank of Kenya	-0.1378	-0.2259	1.2713	-0.1777	0.0858	0.0027	-0.0427	Out		
CFC Bank	-0.0962	-0.1843	0.9758	-0.1889	0.0967	0.0066	-0.0447	Out		
Mumias Sugar	-0.2164	-0.3045	1.3835	-0.2201	0.0626	0.0053	-0.0506	Out		
Sameer	-0.1327	-0.2208	0.9983	-0.2212	0.1471	0.0040	-0.0545	Out		
EA. Cables	-0.1648	-0.2529	1.0715	-0.2360	0.0490	0.0032	-0.0602	Out		
CMC Holdings	-0.0903	-0.1784	0.7091	-0.2516	0.1010	0.0021	-0.0641	Out		
Eveready	-0.1403	-0.2285	0.7840	-0.2914	0.1376	0.0065	-0.0660	Out		
Kenya Airways	-0.3073	-0.3954	1.2464	-0.3173	0.1961	0.0071	-0.0706	Out		
Car & General	-0.0649	-0.1530	0.4807	-0.3183	0.0565	0.0081	-0.0712	Out		
Standard Group	-0.1131	-0.2012	0.5679	-0.3543	0.0954	0.0031	-0.0737	Out		
E.A. Portland Cement	-0.1356	-0.2237	0.4413	-0.5070	0.0847	0.0051	-0.0750	Out		
Tknl Equity	-0.1179	-0.2060	0.3678	-0.5600	0.0516	0.0028	-0.0770	Out		
Express Kenya	-0.3212	-0.4093	0.7102	-0.5763	0.2238	0.0034	-0.0829	Out		
Marshals E.A Limited	-0.1685	-0.2566	0.0831	-3.0865	0.0926	0.0013	-0.0842	Out		
								TOTAL	**3.62184**	**1.0000**