AN ASSESSMENT OF THE RELATIONSHIP BETWEEN RISK AND RETURN AT THE NAIROBI SECURITIES EXCHANGE USING THE DOWNSIDE RISK CAPITAL ASSET PRICING MODEL

BY

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DECLARATION

I hereby declare that this project is my own work and effort and that it has not been submitted anywhere for any award.

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D61/61913/2010

This research project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

Dedicated to my loving family for their endless support

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TABLE OF CONTENTS

DECLARATION.....**ii**

DEDICATION.....**iii**

ACKNOWLEDGEMENT.....**iv**

ABBREVIATIONS AND ACRONYMS.....**viii**

ABSTRACT.....**ix**

CHAPTER ONE: INTRODUCTION.....**1**

1.1.Background of the Study 1

1.1.1. Return.....2

1.1.2. Risk 3

1.1.3 Risk and Return.....3

1.1.4 Downside Risk 5

1.1.5 The Nairobi Securities Exchange.....7

1.2. Research Problem 7

1.3. Objective of the Study 9

1.4. Significance of the Study 9

CHAPTER TWO **11**

LITERATURE REVIEW **11**

2.1 Introduction.....11

2.2 Theories Explaining the Risk-Return Relationship 11

2.2.1 The Capital Asset Pricing Model (CAPM).....11

2.2.2 The Arbitrage Pricing Theory (APT).....12

2.2.3 The Downside Risk Capital Assets Pricing Model (D-CAPM) 13

2.3 Determinants of Returns 14

2.4 Empirical Literature Review 14

2.5 Empirical Evidence on Risk-Return Relationship in Kenya 19

2.6 Conclusion 20

CHAPTER THREE 21

STUDY METHODOLOGY 21

3.1 Introduction 21

3.2 Study Design 21

3.3 Population and Sample 22

3.4 Data Collection 22

3.5 Data Analysis 22

3.5.1 Conceptual Model 23

3.5.2 Analytical Model 25

CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION OF FINDINGS 27

4.1 Introduction 27

4.2 Summary Statistics 27

4.2.1 The Sample Companies 27

4.2.2 Wednesday Returns 28

4.2.3 Market Returns 28

4.2.4 Summary Statistics of Returns 28

4.2.5 Downside Returns and Downside Company Betas 29

4.3 Predicted Returns 30

4.4 Comparing Predicted and Actual Returns 30

4.5 Summary and Interpretation of Findings 30

CHAPTER FIVE: SUMMARY AND CONCLUSIONS 34

5.1 Introduction 34

5.2 Summary 34

5.3 Conclusions 35

5.4 Recommendations 35

5.5 Limitations of the Study 36

5.6 Suggestions for Further Research 37

REFERENCES 39

APPENDICES 43

Appendix I: List of Listed Companies (As at 31st December 2014) 43

Appendix II: Summary Statistics of Assets Returns 46

Appendix III: Weekly Market Returns 48

Appendix IV: Asset Downside Betas 49

Appendix V: Test Results 51

ABBREVIATIONS AND ACRONYMS

AMEX	-	American Stock Exchange
APT	-	Arbitrage Pricing Theory
CAC	-	Cotation Assistée en Continu (Continuous Assisted Quotation)
CAPM	-	Capital Asset Pricing Model
C-CAPM	-	Consumption-CAPM
CML	-	Capital Market Line
CRSP	-	Center for Study in Security Prices
D-CAPM	-	Downside Capital Asset Pricing Model
FTSE	-	Financial Times Stock Exchange
KSE	-	Karachi stock exchange
LSE	-	London Stock Exchange
MAE	-	Mean Absolute Error
MAPE	-	Mean Absolute Percentage Error
MPT	-	Modern Portfolio Theory
MSB	-	Mean-Semi-variance-Behavior
MS-CAPM	-	Mean – Semi-variance CAPM
MV	-	Mean-Variance
MV CAPM	-	Mean-Variance CAPM
MVB	-	Mean–Variance Behavior
NASDAQ	-	National Association of Securities Dealers Automated Quotations
NSE	-	Nairobi Securities Exchange
NYSE	-	New York Stock Exchange
PASE	-	Paris Stock Exchange
RD-CAPM	-	Revised Downside CAPM
RMSE	-	Root Mean Squared Error
TIC	-	Theil Inequity Coefficient
UK	-	United Kingdom
USA	-	United States of America

ABSTRACT

This study was conducted with the aim of determining whether the D-CAPM accurately predicts the behavior of returns on the Nairobi Securities Exchange. The study was a time series analysis using data for the five-year period between January 2010 and December 2014. 47 out of 62 companies were studied depending on the availability of data. The data was analyzed by way of comparing returns as predicted by the D-CAPM against the actual returns of each company. The comparison was done using the Z-scores at 95 percent confidence level. The results indicate no significant difference between the actual and predicted returns for each of the 47 companies studied. The D-CAPM can, therefore, be applied as a model to predict the behavior of returns on the NSE. With this in mind, this study recommends that the investors on the NSE focus more on the downside returns for both the market and individual firms for these influence investment behavior more than the upside returns. The study recommends the use of the D-CAPM to assess the risk-return relationship on the NSE.

CHAPTER ONE
INTRODUCTION

1.1. Background of the Study

For over forty years finance scholars and practitioners have been debating the CAPM, focusing on whether beta is an appropriate measure of risk in stocks. Most of the discussions are empirical with focus on assessing the ability of beta to explain the cross-section of returns as compared to alternative risk variables. Most of these discussions, however, overlook the fact that beta as a measure of risk comes from, namely, an equilibrium in which investors display mean–variance behavior (MVB). In other words, the CAPM stems from an equilibrium in which investors maximize a utility function that depends on the mean and variance of returns of their portfolio (Artavanis, Diacogiannis, and Mylonakis, 2010).

The theory behind Downside Risk Capital Assets Pricing Model asserts that the variance of returns is a questionable measure of risk due to the fact that, firstly, it is only an appropriate measure of risk for symmetric distributions of returns. Secondly, it is straightforwardly applicable as a risk measure when the distribution of returns is normal. However, empirical evidence seriously questions both the symmetry and the normality of stock returns (Estrada, 2002).

The motivation behind the emergence of the Downside Risk Capital Assets Pricing Model approach to asset pricing was the weak ability of the classical CAPM's beta to accurately explain the variation in stock returns across markets and across time (Cheremushkin, 2009). In contrast to the standard mean-variance behavior (MVB)

approach, Estrada (2002) suggested to modify the CAPM using an alternative behavioral hypothesis he called the mean-semivariance-behavior (MSB). In this approach, the assertion is that the variance of returns is a questionable measure of risk because the symmetry and normality assumption of the distribution of returns was not practical (Estrada, 2002).

Indeed, Markowitz (1959) stated that semideviation produces efficient portfolios somewhat preferable to those of the standard deviation. Standard and variance treat deviations below the mean and deviations above the mean similarly whereas investors assign a higher weight to negative deviations than to positive ones. This argument provides justification for the replacement of variance with semivariance. The semivariance of security returns measures the dispersion of the distribution of returns that fall below a pre-specified target rate of return. Estrada (2002) noted that the reasons for Markowitz neglecting the downside measure of risk in subsequent analysis were that the semideviation was a relatively unknown measure of risk and mean-semivariance portfolios were difficult to obtain then.

1.1.1. Return

A return is the ultimate objective for any investor. General definition of return is the benefit associated with an investment. Many investments have two components of measurable return, namely, capital gain or loss and some form of income. A return is, therefore, the percentage increase or decrease in capital gain or loss and income from holding a certain asset in a given period of time called the holding period (Markowitz, 1952).

In a given period of time, return is equated to expected return. Expected return on an investment is the statistical measure of return, which is the weighted sum of all possible rates of returns for the same investment in the holding period. Each of the return is weighted by the probability of such a return being realized (Markowitz, 1952).

1.1.2. Risk

The term 'risk' means different things in different contexts. However, in all the contexts it indicates the possibility of a number of different outcomes resulting from a given action. While some definitions focus on the likelihood of a bad event occurring, others look at both upside and downside potential. Mullen and Roth (1991) argued that risk is the existence of states beyond the decision maker's control that affect the outcome of his/her choices. The degree of risk is a function of the size of the potential loss and the probability of that loss. With most investors and decision makers, the concept of risk is closely associated with the concept of return, and variations around a return.

The concept of risk as used in current portfolio analysis was provided by Markowitz (1952) who equated risk to the standard deviation from the expected return from a portfolio held by an investor. This is the standard deviation of the variation in weighted returns from the mean return of a portfolio. This study uses this statistical definition of risk as defined by Markowitz (1952).

1.1.3. Risk and Return

There are two distinct ways through which the risk-return relationship is presented in financial literature. In one approach the discussion centers on whether the relationship between risk and return is positive, negative, or curvilinear (Fiegenbaum, Hart, and

Schendel, 1996). In the second approach the focus is on the empirical anomalies that researcher are confronted with when examining the numerous studies in this area (Wiseman and Catanach, 1997).

One important foundation of the risk-return relationship is the idea that managers are generally risk averse. According to this approach, investment decision making is done in a context of individual rationality and maximization of utility. Formalist theories such as agency theory assume that investors are rational and aim to maximize utility. They, therefore, assume a linear positive relationship between risk and return. Risk averse behavior is manifest when low risk is associated with low return while high risk is rewarded by high return (Ross, 1973).

Bowman (1982) presented the 'Bowman's Paradox' which suggested a results between risk and return that were different from classical finance theory. The findings suggested a distinct and significant negative relationship between risk and return. These findings resulted from studying a large sample of firms from 85 industries and in which there was a negative relationship between risk and return among firms that were performing well, as well as a negative return between risk and return for firms performing poorly.

A third view of the relationship between risk and return is based on the prospect theory of Kahneman and Tversky's (1979). The prospect theory found a curvilinear relationship between risk and return. In this theory, investors outweigh outcomes that are probable compared with outcomes that are certain. As a consequence, investors prefer sure gains to likely gains while preferring likely losses to sure losses. The concept of a reference point is central to prospect theory explanations. Managers' assessment of risk and the consequent risk taking is determined by whether the managers' performance is below or

above the reference point. Managers, therefore adopt risk seeking behaviors when operating below the reference point, and adopt risk averse behaviors when operating above the reference point (Kahneman and Tversky, 1979).

1.1.4. Downside Risk

In the modern portfolio theory (MPT), Markowitz (1952) discussed portfolio selection and proposed the expected (mean) return and the variance of return of the whole portfolio as criteria for portfolio selection, both as a possible hypothesis about actual behavior and as an aphorism for how investors ought to act. The assumption was that investors' or projections concerning securities and portfolios follow the same probability rules followed by random variables. Based on this assumption it followed that the expected return on the portfolio is the weighted average of the expected returns on individual securities and that the variance of return on the portfolio is a particular function of the variances, the covariances between securities and their weights in the portfolio. Scholars like Sharpe (1964) used standard deviation, the square root of variance as a measure of risk.

The discussions of risk in finance focus on the systematic risk as opposed to the unsystematic risk since the unsystematic risk can be diversified away. This therefore necessitated the separation of total risk, as captured by standard deviation, into systematic and unsystematic risk. The focus on the systematic risk was therefore measured by beta of the asset or portfolio of assets. The beta of any security or portfolio return regressed against any Portfolio P is defined to be the quotient of the covariance of that asset or portfolio and portfolio P divided by the variance of the portfolio P. in many financial risk-return analyses, the beta of a portfolio is found by comparing with the return of a portfolio representing the market (Markowitz, 2005).

Downside risk is the chance of an unexpected decline in an asset value and occurs when investors fail to attain the expected return. Downside beta measures the downside systematic risk. Hogan and Warren (1974) and Bawa and Lindenberg (1977) developed the mean-semivariance CAPM (MS-CAPM) in which the expected return of a security was an exact linear function of its downside beta computed with respect to the market portfolio. The numerator of the downside beta is simply the cosemivariance between the security and market returns with the return of the risk free rate as the target return. The denominator is the semivariance of returns on the market portfolio with respect to the risk-free rate. The downside beta shows the co-movements with the market portfolio in a falling market (Artavanis, Diacogiannis, and Mylonakis, 2010).

The Downside Capital Asset Pricing Model (D-CAPM) is a version of the classic CAPM developed by Fama (1964) that uses semivariance as opposed to the variance used by CAPM (Estrada, 2002). The regular CAPM was extended into Downside CAPM by Hogan and Warren (1974), Bawa and Lindenberg (1977), Harlow and Rao (1989) and Estrada (2002). Bawa and Lindenberg (1977) suggested inclusion of downside beta (risk) instead of regular beta. The numerator in of the downside beta is referred to as the co-semivariance of returns and is the covariance of returns below the risk-free rate of the market portfolio with returns in excess of the risk-free rate on a given security. It is also argued that market participants often view risk as downside deviations below a target return level. The considered average return level is the risk-free rate (Harlow and Rao, 1989).

1.1.5. The Nairobi Securities Exchange

This study will be conducted on firms quoted on the Nairobi Securities Exchange (NSE). The NSE was registered under the Societies Act in 1954 originally meant for the Kenyan white community till independence in 1963. According to the NSE (2012), securities are divided into Agricultural investments market Segment made up of firms in the Agricultural sector, Commercial and Services sector, the Telecommunication and Technology Segment, Automobiles and Accessories, Banking, Insurance, Investment, Manufacturing and Allied, Construction and Allied, and Energy and Petroleum Segments. The other segment deals with Fixed Income Securities like bonds (NSE, 2012). Trading on the NSE is done on a five-day basis with Saturday, Sunday and the holidays making the non-trading days. There are currently fifty-eight registered companies on the NSE and all were considered for this study.

1.2. Research Problem

The issue of pricing of assets on the capital market has been contentious even before the rise of the CAPM (Fama, 1965). The CAPM, based on Markowitz's(1952) Mean-Variance (MV) approach and Tobin (1958) Two-Fund Separation theorem under the conditions of market equilibrium, posits that more expected return accompanied by more expected risk have linear risk-return relationship as portrayed by Capital Market Line (CML). Other later studies, basically, disagreed with the CAPM resulting in adjustments on the CAPM while others came up with totally new approaches (Abbas, Ayub, Sargana and Saeed, 2011). Other studies, such as that by Kahneman and Tversky's (1979) who presented the prospect theory suggest a curvilinear relationship. The theory suggests that investors prefer sure gains to likely gains while preferring likely losses to sure losses and

this is anchored upon a reference point. When returns are above expectation they adopt risk averse behaviors, but adopt risk seeking behaviors when operating below expectation.

In another view, Bowman (1982) suggested a distinct and significantly negative relationship between risk and return through the Bowman's Paradox. The Bowman's Paradox is based on the study findings on firms from 85 industries and in which there was a negative relationship between risk and return among both the firms that were performing well firms performing poorly.

The D-CAPM diverges from the CAPM, the prospect theory and Bowman's Paradox by focusing on the downside risk of returns and argues that the downside risk has more influence on investor behavior than the upside risks (Estrada, 2002). However, just like the CAPM, the relationship is linear with regard to downside risk. The findings of the D-CAPM are supported by the works of some scholars like Abbas, Ayub, Sargana and Saeed (2011) and Artavanis, Diacogiannis, and Mylonakis (2010) while criticized by works of scholars like Akbar, Rahman, and Mahmood (2012) and (Cheremushkin, 2009).

Investors in securities on the NSE have for a long time used trial and error speculation regarding which securities to invest in. This has been brought about by the lack of a method to help them estimate the behavior of the returns of the listed securities, especially the stocks of listed companies. As a result, investors undergo losses. A model that would effectively predict the return of a security is important in enabling an investor to choose the securities he or she wishes to invest in (Gatua, 2013).

The findings on the use of classic beta and the CAPM have indicated that the CAPM is not a good predictor of returns on the NSE. A study conducted by Mounded (2011) found the classic beta and CAPM not a good predictor of returns on the NSE. No study had been done to test the effectiveness of the D-CAPM on the NSE. This study was conducted to test this D-CAPM and provide an answer to the question: does the D-CAPM accurately predict the behavior of returns on the Nairobi Securities Exchange? This study was to show whether or not the D-CAPM is an accurate predictor of returns on the NSE.

1.3. Objective of the Study

This study aimed at determining whether the D-CAPM accurately predicts the behavior of returns on the Nairobi Securities Exchange.

1.4. Significance of the Study

Much study on the accuracy and applicability of the D-CAPM has been done but with focus on the developed markets in USA, Europe, Asia and Australia with mixed results. It is of scholarly interest to establish how the D-CAPM performs in developing securities markets as a contribution to the dialogue concerning asset pricing. A study on the NSE using D-CAPM provides the opportunity to assess how this model performs in developing market therefore filling up that knowledge gap.

Investors will get an opportunity to determine whether the D-CAPM provides a more accurate model to assess the behavior of the returns of stocks on the NSE. Since stock returns are information-based, there should be a mechanism to ensure that the information collected is accurate, and analyzed using accurate analysis techniques. Accurate analysis of returns is a key requirement for intelligent investment in stocks.

Conducting this study on the NSE will provide an opportunity to check whether the alternative model of D-CAPM is more helpful to investors in analyzing returns for better investment decisions.

The finding of this study will provide evidence concerning D-CAPM and the evidence will be used as a basis for further study either in the search for better capital asset pricing models or in any other study that will find it useful citing the findings of this study. Scholars will therefore use the findings of this study to further their study in related areas.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter discusses various theories and the literature related to the relationship between risk and return. Section 2.2 discusses the theories explaining risk-return behavior. Section 2.3 presents the determinants of returns. Section 2.4 delves into the past empirical literature regarding the D-CAPM. In section 2.3 the discussion centers on the evidence in Kenya concerning risk and return relationship. Section 2.6 summarizes the literature review and identifies the research gap.

2.2 Theories Explaining the Risk-Return Relationship

This section presents three theories that explain the relationship between risk and return. These theories are the Capital Asset Pricing Model (CAPM), the Arbitrage Pricing Theory (APT) and the Downside Risk Capital Asset Pricing Model (D-CAPM).

2.2.1 The Capital Asset Pricing Model (CAPM)

The capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) marked the beginning of asset pricing theory. The model is up to now the most widely used in financial applications concerning cost of capital estimation and portfolios performance evaluation. This is mainly due to its simplicity and the powerful and intuitively pleasant suggestions on how to measure risk and the predictions of the relation between expected return and risk (Fama and French, 2004).

The CAPM is based on the portfolio choice model developed by Markowitz (1959). Investors are assumed to be risk-averse and, choose portfolios considering only the mean and the variance of their one-period investment return. Due to this, investors choose portfolios that minimize the variance of portfolio return with respect to a given expected return, and maximize the expected return at a given level of variance.

In addition to the Markowitz assumptions, Sharpe (1964) and Lintner (1965) added the assumption that given market clearing asset prices at time$t-1$, investors agree on the joint distribution of asset returns from time $t-1$ to t. The second assumption added was that there is borrowing and lending at a risk-free rate. The risk-free rate is the same for all investors and does not depend on the amount borrowed or lent.

The Sharpe-Lintner model postulates that the return of an asset *i* is partly constant and partly varies as the risk. The constant part is captured by the risk-free rate in the financial market while the risk is measured by the asset beta. The coefficient of beta in this model is the market risk premium, i.e. the difference between the market return and the risk-free rate. Beta measures the factor through which the market rewards investment in a given asset and it is the quotient of dividing the covariance between the returns of the asset *i* and the market return by the variance of the market returns (Sharpe, 1964).

2.2.2 The Arbitrage Pricing Theory (APT)

The Arbitrage Pricing Theory (APT) is a model developed by Ross (1976) that extended the single factor CAPM to a multiplicity of factors, like inflation, interest rates, rate of GDP growth etc., in linear form. The model allowed the application of CAPM in the calculation of expected returns since it was possible to calculate the betas of each asset

with respect to any benchmark portfolio. This therefore made the APT a sort of multifactor CAPM. All the variables affecting the returns on an asset were to be determined and their betas discovered before making a linear function whose intercept term was not necessarily the risk-free rate of the market.

Since the APT was silent on the number of factors that could be used in the model the three factor model by Fama and French was presented. The Fama French Three Factor model reduced the indefinite APT to three factors: the market premium, size risk and value risk (Fama and French, 1992, 1993).

2.2.3 The Downside Risk Capital Assets Pricing Model (D-CAPM)

The downside risk model, the D-CAPM took a different angle that had earlier been suggested by Markowitz (1959). Markowitz (1959) offered the possibility of measuring portfolio risk using the semi-variance of returns instead of the variance of returns. The weakness of the earlier portfolio theory was that variance treats deviations below the mean and deviations above the mean in the same way when investors actually assign a higher weight to negative deviations than to positive deviations. This new semivariance approach of security returns measures the dispersion of the distribution of returns that fall below a pre-specified target rate of return. The pre-specified target return was taken to be the risk-free rate (Estrada, 2002).

According to Estrada (2002) the D-CAPM can suitably estimate expected return when the market condition is asymmetric. In an asymmetric market, there are factors that affect either risk or expected return rate. However, negative risk is the most important factor in D-CAPM. Estrada factored negative risk concept in capital assets suggesting that

negative risk can offer a more suitable estimation in an asymmetric market. Unlike in the traditional CAPM the downside standard deviation is the square root of the sum of the minimum of the portfolio return minus a given benchmark return or zero squared. Additionally, variance is the squared standard deviation. Other than the differences in the measurement of risk, the process takes the CAPM approach.

2.3 Determinants of Returns

The return of an asset is made up of two fundamental factors, namely capital gains and dividend (Millerand Modigliani, 1961). A capital gain or loss is achieved when a capital asset holder sells the asset. The difference between the amount realized from the sale and the buying price basis is either a capital gain or a loss. If the selling price is higher than the buying price, the investor gets a capital gain. If the buying price is higher, the investor suffers a capital loss.

A dividend refers to a payment made to shareholders proportionally to the number of shares owned. Declared and authorized by the board of directors, dividends are usually issued when companies do not expect to reap significant growth by reinvesting the profits. Dividends are given in form of cash dividend, stock dividend, property dividend, scrip (promissory) dividend or liquidating dividend. The sum of the dividend and the capital gains make up the return of the asset when expressed as a percentage of the investor's base (Manos, 2001).

2.4 Empirical Literature Review

O'Malley (2013) conducted a study to determine whether the use of a Downside risk variable, namely the D-Beta was a more appropriate measure of risk in the emerging

market of South Africa as compared to the regular Beta used in the classical CAPM. The study was done on Johannesburg Stock Exchange Top 40 listed firm with data for the period 2001-2011. The results indicate that using the D-CAPM to forecast returns was more accurate as compared to using the CAPM. However, when comparing goodness of fit, the CAPM and the DCAPM are not significantly different. Even with these conflicting results, there was indeed value in using the D-Beta in South Africa.

Artavanis, Diacogiannis, and Mylonakis (2010) conducted another study that empirically investigated the relationship between risk and return in a downside risk framework and in a regular risk framework by utilizing returns of securities traded on the London Stock Exchange and Paris Stock Exchange. The study employed two time-series samples of weekly security returns. The study confined its attention to continuously listed firms on the London Stock Exchange (LSE) and the Paris Stock Exchange (PASE) during two periods: between January 1997 to December 2002 and between January 1999 to December 2004. The researchers selected 260 securities from the LSE and 161 from PASE for each sample period. The study used the FTSE-100 to calculate UK betas while the CAC-40 was used for the calculation of the betas of the firms listed in the PASE.

This study by Artavanis, Diacogiannis, and Mylonakis (2010) considered four risk measures, two related to the expected return variance framework (i.e. standard-deviation and beta) while the other two related to the expected return standard semivariance analysis(i.e. semi-deviation and downside beta). It examined the explanatory power of each of the frameworks both on individual asset and portfolio basis. Summarizing the results from Great Britain it was found that for individual securities the downside risk offered a better explanation of mean returns than the standard deviation and beta framework. For portfolios it was not easy to conclude whether downside beta was

superior to ordinary beta. In France it was observed that for individual securities only the semi-deviation had significant influence on mean return. For portfolios both the standard deviation and the semi-deviation provided insignificant coefficients. Furthermore, for portfolios the downside beta was either equivalent or better than the traditional beta in terms of explanatory power when beta and the downside beta were jointly considered.

In a study by Nikoomaram (2010) the main purpose was to compare the capital asset pricing model (CAPM) and downside capital asset pricing model (D-CAPM) with focus on the automobile manufacturing industry. The aim was to suggest more suitable model that can be used to estimate the expected return rate in the automobile industry. The comparison was made through defining four hypotheses each focusing on the risk premium correlation rate as an independent variable with the expected return in the two models, CAPM traditional beta and D-CAPM downside beta, the expected return rate of the two models, and finally the deviation rate of the expected return from the realized return in both models. The statistical results indicated that the results of the D-CAPM were more superior to those of CAPM.

In another study, Post and van Vliet (2004) conducted an empirical study to find out whether the downside risk CAPM was better than the unconditional CAPM in explaining the returns of assets. In the empirical analysis the study utilized individual stock returns, index returns, hedge portfolio returns and conditional variables. The monthly stock returns (dividends and capital gains) were got from the Center for Study in Security Prices (CRSP) of the University of Chicago. The one -month US Treasury bills were obtained from Ibbotson. The monthly hedge portfolio returns were taken from the data library of Kenneth French. The dividend and earnings yield were obtained from Robert Schiller's homepage.

Post and van Vliet (2004) selected ordinary common US stocks listed on the New York Stock Exchange(NYSE), American Stock Exchange (AMEX), and NASDAQ markets. They only included stocks that had a CRSP share type code of 10 or 11. A stock was excluded from the analysis if there was no more price information available. Stocks were sorted into portfolios based on historical 60-month regular beta and downside beta. For each portfolio they calculated the value-weighted returns for the following next 12 months, these provided the benchmarks. The sample period of the study covered the period 1926 to 2002. The study found that the MS CAPM strongly outperformed the traditional MV CAPM due to its ability to explain the cross-section of US stock returns. The study concluded that Downside beta is both theoretically and empirically a better risk measure than regular beta.

Olmo (2006) conducted a study to assess the explanatory power of the mean-variance-downside-risk model in the returns of the returns of risk averse investors. The study introduced a family of utility functions that described the preferences of mean-variance-downside-risk investors. The study was done on the London Stock Exchange (LSE), focusing on Aerospace and Defence, Banks, Chemicals, Mining, Oil and Gas, Telecommunications Services and Transport sectors. The market portfolio was proxied by FTSE-100. The data collected covered the period November 2003-April 2006 and the time series published by Bank of England corresponding to three-month treasury bills used to compute the return on a risk-free asset. The study used three different pricing models: standard CAPM, a simple downside risk CAPM, and *mvdr* CAPM. The study found the downside risk CAPM to be a better model in explaining risk-return behaviour.

Kordlouie, Haftlang and Dehghani (2012) conducted a study that compared the D-CPAM and the Revised Downside CAPM (RD-CAPM) on the Tehran Stock Exchange through examining the explanation power of each of the models in returns. The study was done on listed stocks on the TSE for the period of eight years between 2001 and 2009. In the first analysis method, the Pearson correlation coefficient was used. In the second method, Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and Theil Inequity Coefficient (TIC) were the models of analysis. It was found that RD-CAPM showed better results than D-CAPM.

Akbar, Rahman, and Mahmood (2012) investigated the empirical validity of the D-CAPM in the Pakistani equity market using a sample of 313 stocks listed on the Karachi stock exchange (KSE) over sample period July 2000 to June 2011. TheKSE100 index was used as the market portfolio. The KSE100 index is a market value weighted index made up of the top 100 companies in the KSE based on market capitalization. The 100 companies represented more than 80 percent of the total market capitalization. The six months' T-Bill rate was used as a proxy for the risk free rate. The findings on the empirical validity of the downside risk based CAPM were inconclusive and not more accurate as found by some study findings.

Ang, Chen and Xing (2005) did a study to show that the cross-section of stock returns reflects a premium for downside risk. The study focused on only on NYSE stocks to minimize the illiquidity effects of small firms. The study found that for the vast majority of stocks, past downside beta cross-sectionally predicted future returns. However, for stocks with very high volatility, past downside beta provided a poor predictor of future downside risk. While high volatility stocks constitute only a small fraction of the total

market, meaning a predictive downside beta relationship holds for the majority of stocks, there was need to explore why the cross-sectional predictive relation for downside risk did not hold for very high volatility stocks.

2.5 Empirical Evidence on Risk-Return Relationship in Kenya

A study conducted by Ondieki (2012) sought to find out whether the risk-return behavior on the NSE could be explained by the Fama-French Three Factor Model (FFTFM). The specific aim of the study was to determine whether the three variables the market premium, Small Minus Big (SMB), and High Minus Low (HML) could predict the risk return behavior on the NSE. The study was conducted using data from the NSE for the period between between January 2007 and December 2011. Regression analysis with market premium, SMB, and HML as the independent variables while return was the dependent variable. Though the regression analysis was significant, only 35.5% variability in return was explained by the three variables. The study, therefore, found that the Fama-French Three Factor Model did not explain the risk return relationship on the NSE.

In another study Wagura (2011) tested the effect of the introduction of the Central Depository System (CDS) on the price efficiency on the NSE. Though the study did not establish the risk-return relationship, the CAPM was used to analyze the behavior of returns before and after the establishment of the CDS. The study covered the time between January 2005 and December 2007. This analysis indicated no change in market efficiency.

Gitari (1990) conducted a study to establish the relationship between risk and return on the Nairobi Stock Exchange using a simple regression model with risk as the independent variable and return as the dependent variable as suggested by the CAPM. The study found a positive relationship between risk and return. However, this relationship was not statistically significant indicating that the model used could not accurately explain the risk-return relationship on the NSE.

2.6 Conclusion

As demonstrated by the review of the theories, there is a rivalry concerning which model best explains risk return relationship. The classical CAPM and the APT have not been able to consistently explain the risk return behavior on stock markets. This led to the emergence of the Downside Risk CAPM (D-CAPM) as a way of providing an alternative model to explain the relationship. Empirical review has shown that the D-CAPM has been able to more accurately relate risk and return in securities market such as the London Stock Exchange, Paris Stock Exchange, New York Stock Exchange (NYSE), American Stock Exchange (AMEX), NASDAQ and Tehran Stock Exchange. However, despite the CAPM, the APT and the FFTFM not being able to explain the risk return relationship on the NSE, the D-CAPM has not been tested. This study filled this gap by testing the risk-return relationship using the D-CAPM.

CHAPTER THREE
STUDY METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that was used to achieve the objectives of this study. Section 3.2 presents the study design; section 3.3 focuses on the target population and the sample. In section 3.4 the data and data collection are discussed while section 3.5 discusses the data analysis techniques.

3.2 Study Design

This study was a time series cross-sectional study on the returns of listed companies consistently on the NSE for the last five years starting 2010 to 2014. Time series analysis, consists of the techniques which when applied to time series lead to improved knowledge concerning phenomena. The purposes of time series analysis include summary, decision making, description and prediction through the applications often involving techniques of ordinary statistics like, but not limited to, regression, analysis of variance and multivariate analysis (Brillinger, 2000).

The time series analysis is the most appropriate for this study because there is need to study whether as time passes the returns of the various companies adhere to the prediction of the D-CAPM. Artavanis, Diacogiannis, and Mylonakis (2010) when studying the applicability of D-CAPM in Great Britain and France used this study design.

3.3 Population and Sample

All the 62 firms listed on the NSE as at 31st December 2014(See Appendix) make up the population of this study. However, for plausibility of inference, only listed companies that consistently traded on the NSE between January 2010 and December 2014 will make up the list of companies whose data will be used for the study.

The sample is made up of the secondary data made up of the numbers of shares sold; the daily NSE 20 share index and the risk free rates will be proxied by the 91-day Treasury bills rates. The sample period is from January 2010 to December 2014.

3.4 Data Collection

The raw secondary data for this study were collected from the electronic database of the NSE. All the average day's stock prices of shares of the companies listed on the NSE during the period January 1, 2010 and ending December 31, 2014 were considered. The numbers of shares sold, and the daily NSE 20 share index data were also collected from the NSE.

The risk free rates were proxied by the 91-day Treasury bills rates for the study period and were obtained from the Central Bank of Kenya website. The capture and analysis of data was done using MS EXCEL 07 software.

3.5 Data Analysis

This section presents the conceptual and the analytical models that were used to analyze data. The method of generating each of the variables to be used in the analytical model is presented. The analytical model shows the relationships between the variables. Assessment of D-CAPM was done by comparing returns predicted by the D-CAPM model against the actual returns.

3.5.1 Conceptual Model

The variables required for this study were the risk-free return rate (R_f), the weekly market return rates (R_M), the weekly company return rates (R_i), and company betas ($\beta_{i,j}$). The variables were related by the model below which shows that the predicted weekly returns for asset i is a function of the risk-free rate, the downside beta of asset i in year j and the downside market returns.

$$R_{p,i} = f\left(R_f, \beta_{i,j}, R_{M,d}\right) \quad (1)$$

Below is a detailed explanation of how each of the variables was generated. The weekly risk free rates were found by first annualizing the 91Day T-Bill rate before reducing it to a weekly rate. This was done using the formula below:

$$R_f = (T_b)^{\frac{4}{52}} \quad (2)$$

Where,

$R_f =$ The weekly risk-free return rate

$T_b =$ The 91 Day Treasury bill rate

The calculation of the weekly prices was done using the Wednesday prices of the listed assets. According to Fama (1965) and French (1980) Wednesday prices are the most representative of stock prices for they are least affected by investor emotion especially in a Monday-to-Friday trading market like the NSE. The weekly return for an asset was found using the continuous compounding formula below:

$$R_i = Ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \quad (3)$$

Where,

$R_i =$ Return of asset i in a given week

$P_{i,t} =$ Price of asset i in week t

$P_{i,t} =$ Price of asset i in week $t-1$

The calculation of the weekly market returns was done using the weighted average of Wednesday returns. The weights were the number of shares sold of each company.

$$R_{M,\ t} = \sum_{i=1}^{i=47} w_{it} r_{it} \quad (4)$$

Where,

$R_{M,\ t}$ = Market return in week t

w_{it} = Weight of shares of firm i in week t

r_{it} = Return of firm i in week t

The downside risk for both the market and the individual assets was determined by getting the difference between the risk-free rate and the market rates and that between the risk-free rate and the asset returns. This was done using the formula below:

$$R_{M,d,t} = R_f - R_{M,t} \quad (5)$$

and,

$$R_{i,d,t} = R_f - R_{i,t} \quad (6)$$

where,

$R_{M,d,t}$ = Downside market return for week *t*. Negative values were reduced to zero

R_f = Risk free rate

$R_{M,t}$ = Market return for week *t*

$R_{i,d,t}$ = Downside return for asset *i* in week *t*

$R_{i,t}$ = Return for asset *i* in week *t*.

The annual downside beta of each of the assets was found by using the downside returns of the market and the downside returns of the particular asset using the formula below in which $\beta_{i,j}$ is the downside beta for asset *i* in year *j*. the other variables are as defined before but grouped with respect to the years.

$$\beta_{i,j} = \frac{Cov\left(R_{M,d,t}, R_{i,d,t}\right)}{Var\left(R_{M,d,t}\right)} \tag{7}$$

3.5.2 Analytical Model

The predicted returns using the downside risk linear model were found using the model:

$$R_{p,i} = R_f + \beta_i\left(R_{M,d} - R_f\right) \tag{8}$$

Where,

$R_{p,i}$ = Predicted weekly returns for asset *i*

R_f = Risk-free rate

β_i = Downside Beta of asset *i*

$R_{M,d}$ = Downside market returns

The statistical significance in the difference between the predicted and the actual return on annual basis was tested using Z-scores at 0.95 confidence level. The model below was used to calculate the Z-scores:

$$Z_{cal} = \left| \frac{\bar{R}_i - \bar{R}_{p,i}}{\sigma_{R_i}} \right| \tag{9}$$

The Z_{cal} for each of the years will be compared with the critical values, Z_c, at 0.95 confidence level to provide an indication of whether there is a statistically significant difference between the D-CAPM predicted returns and the actual returns for each asset on annual basis and to assess the general performance of the model. All the working i.e. sorting and processing of data, to achieve the objectives of this study was done using MS EXCEL 07 and the finding presented in a report.

CHAPTER FOUR
DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

This chapter discusses the findings of the study. In section 4.2 the focus is on the summary statistics of the data used in the analysis. Section 4.3 discusses how the predicted returns were calculated using the D-CAPM model. Section 4.4 presents the comparison of the returns as predicted by the D-CAPM against the actual returns from the NSE. Section 4.5 is an interpretation of the findings vis-à-vis what other researchers have established regarding the D-CAPM.

4.2 Summary Statistics

This section focuses on data presentation. In the data presentation, the section describes the sample, the Wednesday returns, market returns, the downside market and company returns, the predicted returns and their summary statistics, the test results and interpretation of results.

4.2.1 The Sample Companies

The data to be used for this study targeted all the 62 listed companies on the NSE. However, data for 15 companies could not be used because 11 of them were new comers on the NSE while the remaining four had been trading inconsistently in the NSE. The study, therefore, focused on the remaining 47 companies making up 75.81 percent of the listed companies. The period covered in this study covers the data for Wednesdays for the period starting January 01 2010 and ending 31 December 2014. The data for the T-bill rates are for the same period but reduced to weekly rates.

4.2.2 Wednesday Returns

Wednesday returns were the proxy of the weekly returns of the listed companies. The Wednesday returns for each listed company were generated by taking the natural logarithm of the ratio of two successive weeks' share prices with the later week as the numerator. The key summary statistics of the distribution of the returns per company for the entire five years of study are presented in Appendix II.

4.2.3 Market Returns

Market returns for each week were calculated as the arithmetic weighted average of all the returns of traded stock each Wednesday for the study period. The averages were weighted on the volumes of each company traded on Wednesday. The market returns are tabulated in Appendix III.

4.2.4 Summary Statistics of Returns

Appendix II presents the summary statistics of each of the 47 companies studied. The summary statistics include the maximum return, the minimum return, the mean and standard deviation of each listed firm. From the summary statistics it can be observed that the company with the highest maximum return rate was Express Kenya (Ltd) with a return of 3.978 while the company with the lowest minimum was Limuru Tea with a return of 0.143132. The company with the highest minimum return was Sameer with a rate of -0.139072 while the company with the lowest minimum was CMC with a rate of-0.9006.

Average returns for the five years per listed firm were calculated and it was observed that the highest average was realized by Diamond Trust Ltd at 0.017179 while the lowest average was recorded by Eveready at -0.004297. The widest variation in return was realized by Express which had a standard deviation of 0.259284. The least variation in return was 0.015060 realized by Limuru Tea Ltd.

4.2.5 Downside Returns and Downside Company Betas

Downside returns are realized when asset returns less the risk-free rate yields a negative value. To find the downside returns, the weekly T-bill rates were subtracted from each company's return and market return for each week. Weeks in which both the resulting difference regarding market return and company's returns were negative were sampled out. These pairs of negative results were used to generate the downside beta for each company.

Wednesdays where both the market return and company return were less than the corresponding T-bill rate were used to calculate each company's downside beta. The beta was found by dividing the covariance of the downside market returns with the company's downside return by the variance of the downside return of the market. The resulting betas are presented in Appendix IV.

As shown in the table in Appendix IV the ten firms that had the highest average reward for investors were BAT, Jubilee, Mumias SUGAR, Stanchart, Express, Athi River, Eveready. Eaagards, Kenya Re and Olympia in that order from the highest to the lowest. The firms with the lowest average reward for investors were A Bauman, HFC, Crown, NBK, Total, Diamond Trust, CMC and Equity Bank. The deductions arise from their betas which measure the factor by which the firm multiplies the return of the market to reward those who invest in the given firm.

4.3 Predicted Returns

Returns for each company according to D-CAPM were generated by use of the week's T-bill rate, the market rate and the calculated downside beta. For each company, the predicted return was found by adding the T-bill rate to the product of a company's downside beta and the market premium. This was done for each of the 47 companies studied.

4.4 Comparing Predicted and Actual Returns

To achieve the objective of this study, a comparison of predicted returns and the realized returns was necessary. The returns predicted by the D-CAPM were found by fitting the risk free (T-bill) rates, market return and the calculated downside company betas in the CAPM. This was done for each of the 47 companies studied. The comparison was done using $Z - scores$ at 95 percent confidence level at which $Z_{0.95} = 1.96$. This was done by taking the absolute value of the difference between the mean actual return and the mean predicted return of a firm and dividing it by the standard deviation of the actual returns. The difference was significant where the Z value was more than 1.96. Otherwise the difference was not significant. As shown in Appendix V all results showed no significant difference between the actual and predicted returns for all the 47 firms studied.

4.5 Summary and Interpretation of Findings

The prediction of the returns of assets in a financial market is a contentious issue. This means there is no express method to accurately project the returns from investing in listed companies' stocks. With this background this study was designed to test the suggested model called the D-CAPM by Estrada (2002). The D-CAPM is the latest genre of CAPM which is different from the others due to its focus on the losses experienced by investors

in stocks. Without comparing its performance to other models of predicting returns, this study assessed whether the returns of stocks on the NSE were consistently similar to what the D-CAPM would suggest. The findings showed no significant difference between what the D-CAPM suggests and the actual returns. This indicates that the D-CAPM is a plausible method that can be applied to predict the behavior of returns on the Nairobi Securities Exchange. The findings agree with the assertions of Estrada (2002) that the semi-variance approach is the most accurate measure of the behavior of returns since it focuses on what matters most to investors, namely, the low side deviation from the expected return.

The findings of this study to some extent support the use of the classical CAPM by Sharpe (1964). For instance, the assumptions such as there being many investors that are price takers looking ahead over the same (one period) planning horizon were considered holding for this study. Further, all investors have equal access to all securities. Taxes on capital gains were assumed absent and were not factored in the calculation of return. The study assumed no commissions to facilitators of buying and selling transactions and that each investor cares only about risk and return.

However, the main point of deviation is the definition of risk. While CAPM considers risk to be the standard deviation of the whole set of returns in a given period, the D-CAPM considers the standard deviation of the returns that did not reach the expected return measured by the T-bill rate. This is the point asserted by the model of Kahnemann and Tversky (1979) in their Prospect Theory who formalized the behavioral finance approach in the analysis of the risk-return relationship. According to the Prospect Theory the effect of returns that are below expectation influence investment decision more than

returns that surpass expectation. Consequently, investors focus more on the pain of loss than the glory of gaining above expectation. This study agrees with the use of returns that are below the T-bills in generating a CAPM model that can be used to explain variations in market return at the NSE or any other financial market.

The findings of this study agree with those of O'Malley (2013) who applied the D-CAPM on top 40 companies listed on the Johannesburg Stock Exchange in South Africa. In the study, the D-beta, Market return and the risk free rate were the main points of focus in explaining the variation in stock returns. The study established that the D-CAPM was useful in this aspect when it confirmed that the D-Beta was a more appropriate measure of risk in an emerging market such as South Africa. The results of D-beta were more accurate as compared to those of the classical beta. The classical beta was not entirely rejected in the study because the two models had similar results when it came to fitting results on the two models.

The other study with which the findings of this study agree with is that of Nikoomaram (2010). Just like in this study, the aim of Nikoomaram was to compare the CAPM and the D-CAPM but focusing on firms in the automobile manufacturing industry in Iran. With the study, he had to reach a decision of which of the two models was better than the other. Statistical analysis indicated that the statistical results indicated that the results of the D-CAPM were more superior to those of CAPM.

The findings of this study also echoes the findings of Post and van Vliet (2004) done on common stock trading on the New York Stock Exchange(NYSE), American Stock Exchange (AMEX), and NASDAQ in the USA. The motive of the study was to

determine whether classical beta was superior to downside beta in the explanation of the behavior of returns. For the 77 years spanning 1926 to 2002 the study established that the D-CAPM strongly outperformed the traditional CAPM due to its ability to explain the cross-section of US stock returns. This led to the conclusion that the Downside beta is both theoretically and empirically a better measure of risk than regular beta.

A similar study conducted by Olmo (2006) on the London Stock Exchange (LSE), focusing on Aerospace and Defence, Banks, Chemicals, Mining, Oil and Gas, Telecommunications Services and Transport segments confirmed the superiority of D-CAPM over the classical CAPM. The study compared three genres of CAPM, namely, the classical CAPM, the D-CAPM, and *mvdr* CAPM. Indeed, the study confirmed D-CAPM as the most accurate of the three.

However, the findings of this study are at variance with the findings of Akbar, Rahman, and Mahmood (2012) and those of Ang, Chen and Xing (2005). The study by Akbar, Rahman, and Mahmood (2012) was meant to determine whether the D-CAPM provided an accurate explanation of returns on the Karachi stock exchange (KSE) over sample period July 2000 to June 2011. The analysis provided inconclusive results. It was not possible to tell whether the D-CAPM was good at explaining the variation in results. It was also not possible to tell whether it was better than the classical CAPM. The study by Ang, Chen and Xing (2005) was more categorical. When returns elicited higher volatility, the D-CAPM performed poorly despite being accurate for assets with low volatility.

CHAPTER FIVE
SUMMARY AND CONCLUSIONS

5.1 Introduction

Section 5.2 of this section is the summary of this study. Section 5.3 presents the conclusions of this study. Section 5.4 presents the recommendations based on the findings of this study while Section 5.5 suggests areas of further research.

5.2 Summary

One of the most contentious issues in finance is accurately modelling the behaviour of returns in a financial market. Scholars have made suggestions and models to explain this phenomenon. Such suggestions include the classical CAPM, the APT and many other genes of CAPM such as the I-CAPM, the consumption-CAPM and the D-CAPM. The models have been rivals in terms of applicability.

This study was done to determine whether the latest of the rival models namely, the D-CAPM would effectively explain the relationship between risk and return on the NSE. Focusing on 47 listed firm's data were collected for the five years beginning January 2010 and assessed using the D-CAPM. The study was a times series study whose objective was to compare actual returns with what D-CAPM predicts.

The results indicated that the actual returns of the 47 listed firms were not significantly different from those predicted by D-CAPM. This shows that the D-CAPM is a reliable model that can be used to determine the behaviour of returns on the NSE and a method that investors can use to decide regarding their investment strategies.

5.3 Conclusions

From the finding of this study, the following conclusions are made. First, the relationship between returns and risk on the NSE is well explained by the D-CAPM. This means that the returns of the market and the returns of each company that are below the T-bill rate are the key considerations in the behaviour of investors.

Secondly, investors are more sensitive to the losses experienced by those who invest in listed stocks on the NSE. From the analysis, only weeks where both market return and company returns were lower than the T-bill rate were considered. The result was the model was able to capture the behaviour of the returns when applied even to those weeks where the returns were higher than the T-bill rate. Focusing on returns below expectation can explain the behaviour of returns on the NSE.

The key conclusion of this study is that the D-CAPM holds on the NSE for stocks that consistently traded on the NSE between 2010 and 2014. This indicates that the relationship between risk and return is linear with risk measured in terms of D-beta. However, the D-beta should be arrived at by considering only those returns that are below the expected return measured by the T-bill rate.

5.4 Recommendations

Based on the findings of this study, the following recommendations arise. First, the management of the NSE should focus on the return below the T-bill rates. The rates that are below the T-bill rates influence the pattern of returns to a greater extent. The returns of the market and the returns of each company that are below the T-bill rate are the key considerations in the behaviour of investors.

The D-CAPM should be the model to be used in estimating and projecting returns on the NSE. This is based on the finding that the relationship between risk and return is linear with risk measured in terms of D-beta. The relationship should be arrived at by considering market returns and company returns that are below the T-bill rate.

5.5 Limitations of the Study

The data covers a few years, precisely only 5 years. The findings may not be applicable across all times in Kenya. The results given by this study are therefore limited to the five years that were studied. This indicates that the findings may not expressly apply to time before 2010 and time after 2014 due to the unpredictable behavior of investors. The findings may also vary across time due to variations in national investment policies and the policies at the bourse.

The study has not shown if the results are applicable universally. It has not, for instance, provided any indication of whether or not the D-CAPM would have the same results if applied in Uganda, Tanzania Rwanda or any other of the member countries in the EAC. The results can only hold for the NSE. Kenya being a member of the EAC coupled with Kenyan companies listing in the other East African countries requires that investment information maintains relevance across East Africa. This study has fallen short of that.

Volatility is a key consideration when making investment decision. While some assets show a higher level of volatility, others elicit low volatility. Investment patterns in the two environments may not necessarily be the same. Studies like that of Ang, Chen and Xing (2005) have hinted that the D-CAPM performs differently regarding the level of volatility in returns. This study has not given a clear indication whether this is indeed true.

5.6 Suggestions for Further Research

The findings of this study can be improved if the study is expanded to cover a longer period of time. A future study can be carried out on the same topic, but using data across a longer period of time. This is with the assumption that the data for a longer time will provide results that are better than those provided by the data used in this study. The possible higher objectivity that arises based on the sample period may be settled covering a longer period.

Also given that Kenya is a key player in the East African Community the study can be expanded to cover other stock markets within the East African community in order to provide results that will be useful in that context. A study can be done to cover all the bourses in East Africa. Such a study would be used as a referential manuscript when coming up with plans regarding investment in any of the East African Community member countries.

A future study can conduct the study with the aim of determining whether there is a difference in the performance of the D-CAPM regarding the level of volatility. Some study papers such as the one by Ang, Chen and Xing (2005) suggested that the D-CAPM seemed volatility dependent. It requires to be established whether this was a unique result for the NYSE or whether it also holds for the Nairobi Securities Exchange. This will help in making more accurate investment decision depending on the level of volatility of the returns of an asset.

Though the results of this study indicate the success of the D-CAPM, there is need to conduct a study to establish whether the findings are period-specific or whether this is true for any time periods including the future. The study that is to be done should compare the D-CAPM with other models in order to enable informed decision regarding which model can be used to explain risk return relationship on the NSE.

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APPENDICES

Appendix I: List of Listed Companies (As at 31st December 2014)

I. AGRICULTURAL

1. Eaagads Ltd
2. Kakuzi Ltd
3. Kapchorua Tea Co. Ltd
4. The Limuru Tea Co. Ltd
5. Rea Vipingo Plantations Ltd
6. Sasini Ltd
7. Williamson Tea Kenya Ltd

II. AUTOMOBILES & ACCESSORIES

8. Car & General (K) Ltd
9. Marshalls (E.A.) Ltd
10. Sameer Africa Ltd

III. BANKING

11. Barclays Bank of Kenya Ltd
12. CFC Stanbic of Kenya Holdings Ltd
13. Diamond Trust Bank Kenya Ltd
14. Equity Bank Ltd
15. Housing Finance Co. Kenya Ltd
16. I&M Holdings Ltd
17. Kenya Commercial Bank Ltd
18. National Bank of Kenya Ltd
19. NIC Bank Ltd
20. Standard Chartered Bank Kenya Ltd
21. The Co-operative Bank of Kenya Ltd

IV. COMMERCIAL AND SERVICES

22. Express Kenya Ltd
23. Hutchings Biemer Ltd
24. Kenya Airways Ltd
25. Longhorn Kenya Ltd
26. Nation Media Group Ltd
27. Scangroup Ltd
28. Standard Group Ltd
29. TPS Eastern Africa Ltd
30. Uchumi Supermarket Ltd

I. CONSTRUCTION & ALLIED

31. ARM Cement Ltd
32. Bamburi Cement Ltd
33. Crown Paints Kenya Ltd
34. E.A.Cables Ltd
35. E.A.Portland Cement Co. Ltd

II. ENERGY & PETROLEUM

36. KenGen Co. Ltd
37. KenolKobil Ltd
38. Kenya Power &Lighting Co Ltd
39. Total Kenya Ltd
40. Umeme Ltd

III. INSURANCE

41. British-American Investments Co.(Kenya) Ltd
42. CIC Insurance Group Ltd
43. Jubilee Holdings Ltd
44. Kenya Re Insurance Corporation Ltd
45. Liberty Kenya Holdings Ltd
46. Pan Africa Insurance Holdings Ltd

IV. INVESTMENT

47. Centum Investment Co Ltd
48. Olympia Capital Holdings Ltd
49. Trans-Century Ltd

V. INVESTMENT SERVICES

50. Nairobi Securities Exchange Ltd Ord 4.00

VI. MANUFACTURING & ALLIED

51. A.Baumann & Co Ltd
52. B.O.C Kenya Ltd
53. British American Tobacco Kenya Ltd
54. Carbacid Investments Ltd
55. East African Breweries Ltd
56. Eveready East Africa Ltd
57. Kenya Orchards Ltd
58. Mumias Sugar Co. Ltd
59. Unga Group Ltd

VII. TELECOMMUNICATION & TECHNOLOGY

60. Safaricom Ltd

VIII. GROWTH ENTERPRISE MARKET SEGMENT (GEMS)

61. Flame Tree Group Holdings Ltd Ord 0.825
62. Home Afrika Ltd

Appendix II: Summary Statistics of Assets Returns

ASSET	MAX	MIN	MEAN	SD DEVIATION
A BAUMAN	0.750000	-0.523810	0.001641	0.071429
ATHI RIVER	0.317440	-0.204037	0.007575	0.055541
BOC	0.666667	-0.437500	0.000979	0.051117
BAMBURI	0.175000	-0.152441	0.001120	0.037487
BARCLAYS	0.329412	-0.862380	0.000117	0.072971
BAT	0.377439	-0.278492	0.002330	0.043187
C&G	0.388856	-0.321543	0.005182	0.064986
CARBACID	0.762629	-0.338413	0.002870	0.064722
STANBIC	0.360577	-0.288732	0.002018	0.064642
CITYTRUST	2.611831	-0.711599	0.012664	0.173656
CMC	0.488979	-0.900653	0.003412	0.093554
CROWN	0.627907	-0.515625	0.001204	0.089179
DIAMOND T	2.789059	-0.778625	0.017179	0.197540
EA CABLES	0.468792	-0.857182	-0.001030	0.093879
EA PORTLAND	0.481481	-0.284173	0.000556	0.059084
EAAGARDS	1.150000	-0.388235	0.009310	0.114241
EA BREW	0.506120	-0.188221	0.003200	0.049427
EQUITY	0.767739	-0.857938	0.004106	0.126332
EVEREADY	0.353550	-0.189799	-0.004297	0.060107
EXPRESS	3.978205	-0.785628	0.012465	0.259284
HFC	0.778243	-0.397059	0.007205	0.102577
JUBILEE	0.310627	-0.265574	0.005386	0.061368
KAKUZI	0.415842	-0.288136	0.004215	0.068044
KAPCHORUA	0.372115	-0.444382	0.001222	0.060697
KENGEN	0.486227	-0.341413	0.000158	0.077295
KENOL	0.324112	-0.899497	-0.003052	0.079887
K. AIRWAYS	0.345921	-0.209845	0.000584	0.068221
KCB	0.543826	-0.871860	0.001267	0.082958
KENYA RE	0.459224	-0.139072	0.000487	0.053314
LIMURU TEA	0.143132	-0.154519	-0.000098	0.015060
MARSHALLS	0.317308	-0.259259	-0.000305	0.049024
MMS SUGAR	0.821206	-0.679102	0.000938	0.098142
NATION	0.392019	-0.366266	0.001758	0.057460
NBK	2.705263	-0.720170	0.012623	0.197899

Appendix II: Summary Statistics Continued…contd.

ASSET	MAX	MIN	MEAN	SD DEVIATION
OLYMPIA	0.486227	-0.341413	0.000158	0.077295
PANAFRIC	0.324112	-0.899497	-0.003052	0.079887
REA VIPINGO	0.345921	-0.209845	0.000584	0.068221
SAFCOM	0.543826	-0.871860	0.001267	0.082958
SAMEER	0.459224	-0.139072	0.000487	0.053314
SASINI	0.143132	-0.154519	-0.000098	0.015060
SCAN GRP	0.317308	-0.259259	-0.000305	0.049024
STANCHART	0.821206	-0.679102	0.000938	0.098142
COOP BANK	0.392019	-0.366266	0.001758	0.057460
TOTAL	2.705263	-0.720170	0.012623	0.197899
TPS SERENA	0.486227	-0.341413	0.000158	0.077295
UNGA GRP	0.324112	-0.899497	-0.003052	0.079887
KENYA POWER	0.345921	-0.209845	0.000584	0.068221

Appendix III: Weekly Market Returns

WK	R_M	WK	R_M	WK	R_M	WK	R_M	WK	R_M	WK	R_M	WK	R_M
1	**0.04352**	39	**-0.01747**	77	**0.04544**	115	**-0.06859**	153	**0.00129**	191	**-0.02919**	229	**-0.04308**
2	**0.00176**	40	**0.02666**	78	**0.00706**	116	**0.01234**	154	**0.00000**	192	**-0.02481**	230	**0.03204**
3	**0.00000**	41	**0.02255**	79	**-0.01873**	117	**0.13253**	155	**0.00189**	193	**-0.08304**	231	**0.01979**
4	**0.00356**	42	**-0.00794**	80	**-0.02642**	118	**-0.02459**	156	**0.00000**	194	**0.04080**	232	**0.06314**
5	**0.00981**	43	**-0.00440**	81	**-0.01466**	119	**-0.06701**	157	**0.04366**	195	**0.00074**	233	**0.02202**
6	**0.00015**	44	**0.07700**	82	**0.03258**	120	**0.12821**	158	**-0.03183**	196	**0.00000**	234	**0.03147**
7	**0.00087**	45	**-0.01968**	83	**0.01282**	121	**-0.01033**	159	**-0.05259**	197	**-0.01571**	235	**0.07745**
8	**-0.00602**	46	**0.04267**	84	**-0.04556**	122	**-0.04238**	160	**-0.04086**	198	**-0.10665**	236	**-0.00824**
9	**0.01422**	47	**-0.00079**	85	**0.00268**	123	**0.04649**	161	**-0.04998**	199	**-0.13795**	237	**0.02789**
10	**-0.00654**	48	**0.02412**	86	**0.12595**	124	**0.00644**	162	**0.09073**	200	**0.37953**	238	**-0.01354**
11	**-0.01194**	49	**0.00000**	87	**-0.04163**	125	**0.00069**	163	**-0.01388**	201	**-0.07921**	239	**0.00143**
12	**-0.01385**	50	**0.02209**	88	**0.10156**	126	**0.05961**	164	**-0.01451**	202	**-0.05163**	240	**0.03637**
13	**-0.00786**	51	**0.00690**	89	**0.00477**	127	**-0.00564**	165	**0.08979**	203	**0.00708**	241	**-0.03675**
14	**0.00756**	52	**0.05216**	90	**0.05612**	128	**-0.00935**	166	**-0.04700**	204	**-0.09700**	242	**-0.03561**
15	**0.01846**	53	**0.04734**	91	**-0.01798**	129	**-0.01603**	167	**-0.06768**	205	**0.01180**	243	**0.02796**
16	**0.01933**	54	**0.01791**	92	**0.03795**	130	**0.06003**	168	**0.00907**	206	**0.04104**	244	**-0.01958**
17	**0.01354**	55	**-0.00745**	93	**-0.01825**	131	**-0.00434**	169	**-0.00171**	207	**0.03991**	245	**0.01222**
18	**0.01128**	56	**-0.01746**	94	**0.02362**	132	**0.03069**	170	**0.03905**	208	**0.02249**	246	**-0.01127**
19	**0.03812**	57	**0.00721**	95	**0.02526**	133	**0.02014**	171	**0.03199**	209	**-0.02015**	247	**-0.02101**
20	**0.10064**	58	**-0.00183**	96	**0.20656**	134	**0.03969**	172	**0.02868**	210	**-0.03471**	248	**-0.01473**
21	**0.00072**	59	**0.00967**	97	**-0.11550**	135	**-0.06240**	173	**0.07445**	211	**-0.06273**	249	**0.02165**
22	**0.00000**	60	**-0.00361**	98	**0.01700**	136	**-0.00142**	174	**0.00866**	212	**0.01910**	250	**0.02744**
23	**0.07805**	61	**-0.06551**	99	**0.01630**	137	**0.01195**	175	**-0.09005**	213	**-0.06329**	251	**0.02126**
24	**0.07968**	62	**0.04864**	100	**-0.07497**	138	**0.03720**	176	**-0.00990**	214	**0.01365**	252	**0.00690**
25	**0.02084**	63	**0.02214**	101	**-0.01584**	139	**0.14524**	177	**0.01448**	215	**-0.05606**	253	**0.00995**
26	**0.22752**	64	**0.04064**	102	**0.00919**	140	**0.01587**	178	**0.07255**	216	**-0.08335**	254	**0.02690**
27	**0.11736**	65	**-0.03059**	103	**0.01307**	141	**-0.03416**	179	**-0.00517**	217	**-0.04118**	255	**0.12427**
28	**-0.11197**	66	**-0.00958**	104	**0.03006**	142	**-0.04083**	180	**0.10965**	218	**0.04195**	256	**0.00078**
29	**-0.03449**	67	**0.02142**	105	**0.00913**	143	**-0.01070**	181	**-0.03131**	219	**0.13670**	257	**0.00000**
30	**-0.00427**	68	**0.05153**	106	**-0.02239**	144	**0.00125**	182	**-0.03684**	220	**-0.01571**	258	**0.00878**
31	**0.01995**	69	**0.10896**	107	**-0.02424**	145	**0.00000**	183	**-0.05914**	221	**-0.02167**	259	**0.00076**
32	**0.07895**	70	**0.13260**	108	**-0.06246**	146	**-0.03949**	184	**-0.01133**	222	**-0.02086**	260	**0.00000**
33	**-0.02822**	71	**0.04474**	109	**-0.01937**	147	**0.00227**	185	**-0.03623**	223	**-0.02735**		
34	**-0.01706**	72	**-0.00460**	110	**0.01058**	148	**-0.14807**	186	**-0.07016**	224	**0.00602**		
35	**-0.00904**	73	**0.01448**	111	**-0.00888**	149	**0.00641**	187	**-0.03217**	225	**0.01872**		
36	**0.02677**	74	**-0.04705**	112	**-0.11227**	150	**0.03096**	188	**-0.08083**	226	**-0.01104**		
37	**-0.00239**	75	**0.10060**	113	**-0.02869**	151	**-0.01752**	189	**0.10849**	227	**0.00947**		
38	**0.02885**	76	**0.01352**	114	**-0.07617**	152	**0.03191**	190	**-0.04111**	228	**0.03795**		

Appendix IV: Asset Downside Betas

ASSET	COV	VAR MKT	ASSET BETA
A BAUMAN	-0.000059	0.001078	-0.054256
ATHI RIVER	0.000150	0.000943	0.158807
BOC	0.000003	0.000889	0.003710
BAMBURI	-0.000032	0.000892	-0.035510
BARCLAYS	0.000021	0.000925	0.022451
BAT	0.000237	0.000771	0.307586
C&G	-0.000009	0.000691	-0.012653
CARBACID	0.000004	0.000897	0.004709
STANBIC	-0.000033	0.001012	-0.032175
CITYTRUST	-0.000032	0.000904	-0.035173
CMC	-0.000207	0.000870	-0.237698
CROWN	-0.000073	0.000816	-0.089275
DIAMOND T	-0.000195	0.000876	-0.222351
EA CABLES	0.000052	0.000920	0.056401
EA PORTLAND	0.000052	0.000855	0.060736
EAAGARDS	0.000128	0.000926	0.138089
EA BREW	0.000031	0.000975	0.032032
EQUITY	-0.000215	0.000886	-0.242215
EVEREADY	0.000132	0.000842	0.156254
EXPRESS	0.000172	0.000922	0.186589
HFC	-0.000062	0.000845	-0.073906
JUBILEE	0.000198	0.000875	0.226047
KAKUZI	-0.000041	0.000866	-0.046859
KAPCHORUA	-0.000043	0.000914	-0.047102
KENGEN	0.000077	0.000943	0.081794
KENOL	-0.000004	0.000907	-0.003919
K. AIRWAYS	0.000079	0.000872	0.090654
KCB	-0.000002	0.000905	-0.001993
KENYA RE	0.000107	0.000844	0.127330
LIMURU TEA	-0.000016	0.000872	-0.017964
MARSHALLS	0.000022	0.000987	0.021794
MMS SUGAR	0.000194	0.000988	0.195786
NATION	0.000014	0.001071	0.013500
NBK	-0.000187	0.001036	-0.180221

Appendix IV: Asset Downside Betas…cont.

ASSET	COV	VAR MKT	ASSET BETA
OLYMPIA	0.000115	0.000998	0.115361
PANAFRIC	-0.000009	0.001039	-0.008884
REA VIPINGO	0.000079	0.000872	0.090654
SAFCOM	0.000037	0.001050	0.034766
SAMEER	0.000064	0.001003	0.063613
SASINI	-0.000005	0.001069	-0.005077
SCAN GRP	0.000022	0.000987	0.021794
STANCHART	0.000194	0.000988	0.195786
COOP BANK	0.000014	0.001071	0.013500
TOTAL	-0.000187	0.001036	-0.180221
TPS SERENA	0.000115	0.000998	0.115361
UNGA GRP	-0.000009	0.001039	-0.008884
KENYA POWER	0.000079	0.000872	0.090654

Appendix V: Test Results

ASSET	Mean Actual	SD Actual	Mean Predicted	Z Score	REMARK
A BAUMAN	0.001641	0.071429	0.014983	0.186788	Not Significant
ATHI RIVER	0.007575	0.055541	0.014983	0.133384	Not Significant
BOC	0.000979	0.051117	0.014983	0.273965	Not Significant
BAMBURI	0.001120	0.037487	0.014983	0.369799	Not Significant
BARCLAYS	0.000117	0.072971	0.014983	0.203718	Not Significant
BAT	0.002330	0.043187	0.014983	0.292984	Not Significant
C&G	0.005182	0.064986	0.014983	0.150818	Not Significant
CARBACID	0.002870	0.064722	0.014983	0.187161	Not Significant
STANBIC	0.002018	0.064642	0.014983	0.200568	Not Significant
CITYTRUST	0.012664	0.173656	0.014983	0.013354	Not Significant
CMC	0.003412	0.093554	0.014983	0.123683	Not Significant
CROWN	0.001204	0.089179	0.014983	0.154505	Not Significant
DIAMOND T	0.017179	0.197540	0.014983	0.011114	Not Significant
EA CABLES	-0.001030	0.093879	0.014983	0.170571	Not Significant
EA PORTLAND	0.000556	0.059084	0.014983	0.244180	Not Significant
EAAGARDS	0.009310	0.114241	0.014983	0.049658	Not Significant
EA BREW	0.003200	0.049427	0.014983	0.238387	Not Significant
EQUITY	0.004106	0.126332	0.013092	0.071132	Not Significant
EVEREADY	-0.004297	0.060107	0.014983	0.320769	Not Significant
EXPRESS	0.012465	0.259284	0.014983	0.009712	Not Significant
HFC	0.007205	0.102577	0.014983	0.075825	Not Significant
JUBILEE	0.005386	0.061368	0.014983	0.156382	Not Significant
KAKUZI	0.004215	0.068044	0.014983	0.158256	Not Significant
KAPCHORUA	0.001222	0.060697	0.014983	0.226723	Not Significant
KENGEN	0.000158	0.077295	0.014983	0.191792	Not Significant
KENOL	-0.003052	0.079887	0.014983	0.225756	Not Significant
K. AIRWAYS	0.000584	0.068221	0.014983	0.211059	Not Significant
KCB	0.001267	0.082958	0.014983	0.165338	Not Significant
KENYA RE	0.000487	0.053314	0.014983	0.271905	Not Significant
LIMURU TEA	-0.000098	0.015060	0.014983	1.001406	Not Significant
MARSHALLS	-0.000305	0.049024	0.014983	0.311859	Not Significant
MMS SUGAR	0.000938	0.098142	0.014983	0.143108	Not Significant
NATION	0.001758	0.057460	0.014983	0.230152	Not Significant

(Test were at 95% confidence level with $Z_{0.95} = 1.96$)

Appendix V: Test Results…. cont.

ASSET	Mean Actual	SD Actual	Mean Predicted	Z Score	REMARK
NBK	0.012623	0.197899	0.014983	0.011927	Not Significant
OLYMPIA	0.000158	0.077295	0.014983	0.191792	Not Significant
PANAFRIC	-0.003052	0.079887	0.014495	0.219643	Not Significant
REA VIPINGO	0.000584	0.068221	0.014983	0.211059	Not Significant
SAFCOM	0.001267	0.082958	0.014983	0.165338	Not Significant
SAMEER	0.000487	0.053314	0.014983	0.271905	Not Significant
SASINI	-0.000098	0.015060	0.014983	1.001406	Not Significant
SCAN GRP	-0.000305	0.049024	0.014983	0.311859	Not Significant
STANCHART	0.000938	0.098142	0.014983	0.143108	Not Significant
COOP BANK	0.001758	0.057460	0.014983	0.230152	Not Significant
TOTAL	0.012623	0.197899	0.014983	0.011927	Not Significant
TPS SERENA	0.000158	0.077295	0.014983	0.191792	Not Significant
UNGA GRP	-0.003052	0.079887	0.014983	0.225756	Not Significant
KENYA POWER	0.000584	0.068221	0.014983	0.211059	Not Significant

(Test were at 95% confidence level with $Z_{0.95} = 1.96$)