AN EMPIRICAL TEST OF THE RANDOM WALK MODEL FOR THE NAIROBI STOCK EXCHANGE (NSE)

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DECLARATION

I the undersigned declare that this research project is my original work and has not been submitted to any college, institution or University other than the University of Nairobi for academic purposes.

Signed: _____ Date: _____

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This research project has been submitted with my approval as University supervisor.

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DEDICATION

This study has been dedicated to my dear husband Robert, my son Albert, my daughter Mical and my sister Rebecca for their love, understanding and patience when I could not be with them because of my studies. May they receive God's blessings in abundance.

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ABSTRACT

It is usually believed that the markets in developing and less developed countries are not efficient in semi-strong form or strong form. Efficient capital market is one which prices fully reflect the available information. An important implication of efficient market theorists is that stock market should approximately follow a random walk. The Random walk Model states that present market price is the best indicator of the future market price with an error term that is stochastic in nature. Hence the next period's price is anybody's guess.

The purpose of the study is to empirically test whether NSE indices follow random walk or not, that is to determine whether NSE conforms to the efficient market hypothesis or not. If NSE follows random walk, the share prices cannot be predicted or forecasted using predictive model developed using the historical data. Hence NSE will be classical example of efficient capital market in developing economy in the weak form.

The research study assessed the variance ratio of NSE 20 share index and NASI at lag q and corresponding Z-statistic for different specification of the error Et term behavior between operational periods; 1st March 2004 to 30th April 2009 and 1st January 2008 to 30th April 2009 respectively. It adopted a model in random walk first designed by Bachelier in 1990 but modified by substituting stock prices by NSE share indices. The study population will comprise of the NSE 20 share indices points and NASI. The study used secondary data collected from NSE daily index return files, daily newspapers and internet.

NSE was found to follow random walk, hence according to this project; it has been classified as efficient market in a developing economy under weak form of Market Efficiency. The information is significant to different stake holders in making informed

decisions in relation to the share prices, better policies to regulate the players in CMA, proper planning and also form a basis of further research on the subject.

LIST OF ABBREVIATIONS

AIG (EA) - American Insurance Group (East Africa)

AIMS - Alternative Investment market Segment

ANN - Artificial neutral network

ANOVA - Analysis of Variance

ARIMA - Auto-regression Integrated Moving Average

ASE - American Stock Exchange

ASMs - Asian stock markets

BSE - Bombay stock exchange

CRSP - Centre for research in security prices

CSE - Chittagong Stock Exchange

D/N - Daily Nation

DSE - Dhaka Stock Exchange

DW -Durbin Watson Test

ESMs - Emerging Stock Markets

FMA - Fixed length moving average

GSE DSI - Ghana Stock Exchange Databank stock Index

ISE - Indian stock exchange

ISM - Indian stock market

NASI - Nairobi Stock Exchange All Share Index

NYSE - New York Stock Exchange

NBK - National Bank of Kenya

NSE - Nairobi stock Exchange

P/E - Price per Earning Ratio

SKM - South Korean market

USSM - United States Stock market

VMA - Variable length moving average

ZSE - Zimbabwe Stock Exchange

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CHAPTER ONE
INTRODUCTION

1.1Background to the study

It is usually believed that the markets in developing and less developed countries are not efficient in semi-strong form or strong form. Random walk has become prominent in the macroeconomics literature since the development of rational expectation, they are implications, for example, of the efficient market hypothesis for real stock prices, of hysteresis models of unemployment, and of the permanent income hypothesis of consumption (Kennedy, 1996).

From a statistical dictionary, a random walk is defined as a walk in which the walker's movements are a consequence of a sequence of observations on one or more random variables. For instance, suppose that, at each time point an individual walks one step to the left (with probability p) or one step to the right (with probability $1-p$). This simple Markov process is a one-dimensional random walk.

The Random Walk Model states that present market price is the best indicator of the future market price with an error term that is stochastic in nature. Hence the next period's price is anybody's guess. In an Efficient market it is not possible to make profits based on past information hence the prediction of future price conditional on the past prices on an average should be zero. In the most efficient market the future prices will be totally random and the price formation can be assumed to be a stochastic process with means in prices change equal to zero. Alexander, *et al* (1989) points out that in most efficient market the future price will be totally random and the price formation can be assumed to

be a stochastic process. The random walk assumes that a fixed drift in the price change from one period to another with a component of increment that are independently and identically distributed. The increment term has a zero mean and a fixed variance (homoskedasticity).

Kangila(2007) basing his argument on the significance of the relationship between dividends declared and effect on share price, he concluded that only twenty percent (20%) of the share price of the companies responded positively to the amount of dividends declared. He found out that some shares prices increased significantly even when the companies made loses and no dividends declare d e.g. National Bank of Kenya and Uchumi supermarkets. In general he concluded that share prices are not influenced by any information about the company's previous day's events or trading.

Brealey *et al* (1995) points out that if stock's price follow a random walk, the odds of an increase or decrease during any day, month, or year do not depend at all on the stock's prices. Stock prices traded in the bourse seems to wander randomly, virtually equally likely to go up or go down on any particular day, regardless of what had occurred on the previous day.

Kennedy (1996) defines random walk in terms of macroeconomic data that are nonstationary in nature as this period's value is equal to last period's value plus a random error, even after a deterministic trend has been removed.

Mishkin (2004), points out that while the theory of rational expectation was being developed by monetary economists, financial economists were developing a parallel theory of expectation formation in financial markets called the efficient market hypothesis which led to the same conclusion as that of rational expectation theorists that expectation of financial markets are equal to optimal forecast using all available information. An important implication of efficient market theorists is that stock market should approximately follow a random walk. In fact, when people mention the random walk theory of stock prices, they are in reality referring to the efficient market hypothesis.

For many years' economists, statisticians, and teachers of finance have been interested in developing and testing models of stock price behavior. One important model that has evolved is the theory of random walks. This theory casts serious doubt on many other methods for describing and predicting stock price behavior-methods that have considerable popularity outside the academic world.

An efficient market is defined as a market where there are large numbers of rational profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflect the effects of information based both on events that have already occurred and on events which as of now the market expects to take place in the future.

Under Weak Form of Market Efficiency, the price of a security reflects all the available information about the economy, the market and the specific security and that price adjust immediately to new information. Pandey (2006), points out that the security prices reflect all the past information about the price movement in a Weak Form of Efficiency. It is therefore, not possible for an investor to predict future security by analyzing historical prices and achieve a performance (return) better than the stock market index, that is, investors cannot make more than a fair (required) return using information based on historic price movement. Stock market share index

The Stock Market is one of the most closely observed economic phenomenons in the world. Market indicators meet the demand for measures of stock market performance. Such indicators quantify movements in stock market prices, and act as a standard in evaluating the returns on money invested in the stock market. Stock market indices as aggregate measures are an instrument to meet the information requirement of investors by characterizing the development of global markets and specified market segments (descriptive function). Presently, In Kenyan stock market, that is, the Nairobi Stock Exchange, two major indices are used, that is, Nairobi Stock Exchange, NSE 20 share index reconciled from previously used NSE Share Index (1966=100) and its compliment, the NSE All Share Index, NASI introduced on 25th February 2008, backdated to 1st January 2008 to replace AIG (EA) 27 Share Index. Index numbers are applied in the measurement of movements at the stock market. An Index number effectively summarizes hundreds of price movements. There are both price and volume index. The volume of shares traded might be as important as the change in a market index since

substantial price increases and decreases are often accompanied by heavy trading activity. (Obtained from NSE website)

1.2 Statement of the problem

Market efficiency has been and is likely to continue to be a matter of intense debate in investment community. Economists agree that it is desirable to see that capital is channeled to places where it will do most good, in which case, a reasonable goal is to encourage the establishment of allocatively efficient markets in which the firms with the most promising investment opportunities have access to needed funds at affordable costs. This is ensured by informationally efficient markets.

In efficient market, actual price of a security will be a good estimate of its intrinsic value (an equilibrium price) which depends on the earning potential of the security. The earning potential of the security depends on such fundamental factors as the quality of management, the outlook of the industry, reported profits and general economic conditions prevailing at that time.

Empirical studies on random walk theory based on developed markets (Lo and Mackinlay, 1988; Pan *et al*, 1991; Kim *et al*, 1991; Koh and Goh, 1994; Campbell, 1997; Mobarek and Keasey, 2000 and Abraham et al, 2002) have yielded mixed findings. For example, Lo and Mackinlay (1988) found a positive autocorrelation for weekly holding period returns not only for the entire sample but also for all sub-periods. Pan *et al* (1991) applied variance ratio test on daily and weekly returns for a five year sample period in Taiwan, Hongkong, Japan, South Korea and Singapore. They rejected the null hypothesis of randomness for both daily and weekly returns for Singapore, South Korea and Japan.

Koh and Goh (1994) tested the random walk hypothesis on Malaysian stock indices. The results revealed that Malaysian stock market followed random walk in the long run.Grieb and Geyes (1999) employed variance ratio on weekly stock returns to re-examine the Brazilian market which indicated evidence in favour of the random walk.

The study of rejection of random walk in the share price due to mean reverting tendency which is a consequence of persistence of one sided volley in share price was first presented by De Bondt and Thaler (1985). The presence of mean reverting tendency and absence of random walk in United States stocks was confirmed by studies of Poterba and Summers (1988) and De Bondt and Thaler (1989). The rejection of the random walk model by Lo and Mackinlay (1988) was mainly due to behavior of small stocks. But this could not be attributed entirely to the effect of the infrequent trading on time varying volatilities. They used simple specification test based on variance estimators to prove that stock market did not follow a random walk. Fama and French (1988) who discovered that for the USSM, 40% of the variations of longer holding period returns were predictable from the information on past returns.

A study conducted by Sunde and Ziwanomoyo (2008) in Zimbabwe stock Exchange, ZSE found that using monthly data from January 1998-November 2006, ZSE did not follow a random walk and therefore was not efficient in the weak form. This meant that past prices had an influence in the determination of future prices and this provided an opportunity for out-performance by skillful financial managers and investment specialists. During the period studied investment analysts and managers of companies were able to take advantage of these investment opportunities to make abnormal returns from the ZSE.

Presently, in Kenya, some Investment advisors basically employ technical analyst approach in advising their clients. This is in contrast to the random walk theory as advocated by efficient market hypothesis where successive price changes in individual securities are independent, implying that a series of stock prices changes has no memory, that is, past history of the series cannot be used to predict the future in any meaningful way.

From the foregoing, empirical analysis of random walk has been conducted in various stock markets globally to establish whether they conform to efficient market hypothesis. Despite Dickinson and Muragu (1994) findings that Nairobi stock Exchange amongst other emerging stock market is efficient stock markets, yet it is generally assumed that the emerging markets are less efficient than the developed markets.

Kangila (2007) used correlation coefficient that is by definition a measure of degree of linear relationship between any two variables. Correlation analysis is non directional and only considers relationship as the critical aspect. It does not give a clear indication as to whether dividend declared is the best independent variable (Economic Plausibility). The presence of correlation between two variables does not necessarily mean that there is a cause and effect on the relationship between the two variables. Correlation only implies that the variables move together in the same direction (positive correlation) or opposite direction (negative correlation). There is need to employ a better method of analyzing whether share prices depends on the previous day's trading at NSE. The variance ratio derived from regression analysis will be used in this study.

There has been no consensus on whether random walk applies in the stock exchange. There existed a gap hence continuous research on this area to reach an ultimate

conclusion about the level of efficiency of less developed market is necessary. It was therefore necessary to conduct such analysis at the Nairobi stock Exchange, NSE.

It was on the strength of this background that the study sought to empirically test whether NSE indices follow random walk or not. The study sought to establish whether NSE conforms to the efficient market hypothesis or not.

1.3 Research objective

To empirically test Random Walk model for NSE indices.

1.4 Importance of the study

This study will empirically test whether NSE share indices follow a random walk to establish whether NSE conforms to efficient market hypothesis or not. If the NSE will be found to follow a random walk, then it will be classified as efficient market in the weak form a developing economy. This study will be significant to the following stakeholders:

Corporate Managers of Multi-national companies

The corporate Managers of Multi-National Companies interested in trading their shares at NSE, will make informed decisions in relation to their share prices, which cannot be predicted using a forecasting model or any historical data because random walk has no memory.

Capital Market Authority (CMA)

Capital Market Authority (CMA) being a regulatory body will be able to make better policies in order to regulate the players in the Capital Market Sector e.g. Stock brokers, bond traders and other interested parties in the NSE.

The Government of Kenya

The Ministry of Finance will be in a position to plan well especially in the area of privatization. When the Government is planning to off load its shares from public parastatal, will have detailed information about the financial market and the expected selling price of her shares.

The Academics

There is very little literature in relation to random walk especially in the developing countries. This research thus aims at shading more light in this field and forms the basis for further research on this subject. It will also help the academics to use this study as an example when teaching random walk theory.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter reviews prior studies, highlights issues that are related to this study. In addition it also reviews theories related to the study and discusses the conceptual framework, which help to appreciate the idea behind the study. This section will thus be discussed under the following subheadings as follows:

2.1Theoretical Literature

2.1.1The Genesis of random walk in stock prices

Brealey *et al* (1995) points out that the idea of stock market following random walk was first suggested by a British statistician Maurice Kendall in 1953 in a conference held by the Royal Statistical society in London to discuss his paper titled; the analysis of economic time series part one with the subject of discussion being the behavior of stock and common prices. This, he came up with, after having looked for regular price cycles in stock, but to his surprise he could not find them. Fama(1960)persuasively made the argument that in an active market that includes many well informed and intelligent investors securities will be appropriately priced and reflect all available information. If a market is efficient no information or analysis can be expected to result in outperformance of an appropriate benchmark.

2.1.2Theory of efficient market hypothesis

Levich (1998) asserts that the classical definition of efficient market was formally developed by Eugene Fama in 1970. He defined an efficient capital market as one in

which prices in the market fully reflects available information. If this condition is satisfied, market participants can not earn more above-average returns without accepting above average risks (Malkiel, 2003,) that is, unusual, or risk-adjusted profits on the basis of available information. According to this, a stock market is seen as more efficient the faster market relevant information is incorporated into assets prices. Under fully efficient markets, past information should not affect returns in present period (Fratzscher, 2002). Market efficiency does not mean that the market price of a stock should equal the true value of the stock. What it means is that errors in the market price, that is, over or under valued of the true value, should be unbiased and randomly deviated. Based on this argument, the existence of random deviation prevents investors from finding those over or undervalued stocks.

2.1.3 The Dumb Agent Theory

States that many people making individual buying and selling decisions will better reflect true value than any one individual can. In finance this theory is predicated on the efficient-market hypothesis (EMH). One of the first instances of the Dumb Agent Theory in action was with the Policy Analysis Market (PAM); a futures exchange developed by DARPA. While this project was quickly abandoned by the Pentagon, its idea is now implemented in futures exchanges and prediction markets such as Intrade, Newsfutures and Predictify.

While first mentioned strictly by name in relation to PAM in 2003, the Dumb Agent Theory was originally conceived (as the Dumb Smart Market) by James Surowiecki (1999). Here, Surowiecki differentiated from the EMH stating that it "doesn't mean that

markets are always right." Instead, he argues that markets are subject to manias and panics because "people are always shouting out" their stock picks. This, in turn, results in other investors worrying about these picks and become influenced by them, which ultimately drives the markets (irrationally) up or down. His argument states that if market decisions were made independently of each other, and with the sole goal of being correct (as opposed to being in line with what others are choosing), then the markets would produce the best choice possible and eliminate biases such as Groupthink, the Bandwagon effect and the Abilene Paradox.

2.2 Empirical studies

2.2.1 Empirical evidence of independence

Over the years a number of empirical tests of the random-walk theory have been performed. The main concern of empirical research on the random-walk model has been to test the hypothesis that successive price changes are independent, that is, successive price changes are generally random and that the correlation between stock prices from one day to the next day is virtually zero. Brealey *et al* (1995), Points out that historical path of prices gives no useful information about the future – just as a long series of recorded heads and tails gives no information about the next coin toss. Pandey, (2006) asserts that most empirical tests have shown that there exists serial independence between the security prices over time, implying that share prices behave randomly.

Brealey *et al* (1995) asserts that researchers have looked at many different stocks in many different countries and for many different periods; they have calculated the correlation

coefficient between these prices change, they have looked for runs of consistently positive or negative price changes, and they have simulated mechanical trading rules that try to exploit trends or cycles in stock prices. With remarkable unanimity researches have concluded that there is little information in sequence of past stock price changes.

Two different approaches have been followed. First, there is the approach that relies primarily on common statistical tools such as serial correlation coefficients and analyses of runs of consecutive price changes of the same sign. If the statistical tests tend to support the assumption of independence, one then infers that there are probably no mechanical trading rules or chartist techniques, based solely on patterns in the past history of price changes, which would make the expected profits of the investor greater than they would be with a simple buy-and-hold policy. The second approach to testing independence proceeds by testing directly different mechanical trading rules to see whether or not they provide profits greater than buy-and-hold (Mishkin, 2004). Research to date has tended to concentrate on the statistical approach to testing independence since its results has been consistent and impressive.

The random walk model was first developed by Bachelier in 1900 in which he asserted that the successive price change between two periods is independent with zero mean and its variance is proportional to the interval between two time periods. Accordingly, the variance of weekly changes should be five times the variance of daily changes (assuming the market remains closed on the weekends-like in NSE).This concept is exploited in the

variance ratio test which has been widely used to test the random walk hypothesis various markets.

Lo and Mackinlay (1988) found a positive autocorrelation for weekly holding period returns not only for the entire sample but also for all sub-periods. Pan *et al* (1991) applied variance ratio test on daily and weekly returns for a five year sample period in the five ASMs namely; Hong Kong, Japan, Singapore, South Korea, and Taiwan. They rejected the null hypothesis of randomness for both daily and weekly returns for Korea, Singapore and Japan. The null hypothesis for Hong Kong daily return index and the Taiwan weekly return index was also rejected. Their result indicated that all the returns based on the five market indices were positively auto correlated except for Japan. Kim *et al* (1991) examined the random walk process of stock prices by using weekly and monthly results in five Pacific-basin stock markets. The findings provided evidence that the mean reversion was only a phenomenon of the pre World War II period and not a feature of the post-war period. They found that the variance ratio tests produced positive serial correlation.

Dickinson and Muragu (1994) found efficient stock markets in several emerging markets (Kuwait, Greece and Nairobi). Koh and Goh (1994) tested the random walk hypothesis by extending the framework of Cochrane (1988) on Malaysian stock indices. The results revealed that Malaysian stock market followed random walk in the long run. Campell (1997) used variance decomposition method for stock return and concluded that the expected stock returns changes through time in a fairly persistent fashion. Grieb and Geyes (1999) employed variance ratio on weekly stock returns to re-examine the Brazilian market which indicated evidence in favor of the random walk

For retail investor, tests of the Alexander filter technique used by chartists tend to support the random-walk model.

2.2.2Empirical evidence against independence

Various studies have rejected the random walk despite its exhibition in many markets.

One of the earliest studies that focused on the Middle East was done by Butler and Malaikah (1992). They examined the behavior of individual stock returns in two stock markets, Saudi Arabia and Kuwait, over the period 1985-1989. They used serial correlation and run several tests to evaluate the weak form of efficiency in these two stock markets. The study tried to investigate the similarities and dissimilarities of these stocks, regarding exchange mechanisms and efficiency. They concluded that institutional factors contribute to operational inefficiency in Saudi Arabia stock market and less pronounced but significant autocorrelations for many Kuwait stocks similar to other thinly traded markets. Another study, by Al-Loughani (1995), used different statistical techniques on the Kuwait market index; it concluded that this index does not follow random walk as it shows signs of stationarity.

Maborek and Keasey (2000), in their study to study seeks evidence supporting the existence of at least weak-form efficiency of the Dhaka Stock Exchange (DSE), used sample which included the daily price indices of all the listed securities on the DSE for the period of 1988 to 1997. The hypothesis of their study was whether the Dhaka Stock Market is weak form efficient. The results of both non-parametric (Kolmogrov–Smirnov normality test and run test) test and parametric test (Auto-correlation test, Auto-regression, ARIMA model) provide evidence that the share return series do not follow random walk model and the significant autocorrelation co-efficient at different lags reject

the null hypothesis of weak-form efficiency. The results were consistent in different sub-sample observations, without outlier and for individual securities.

A recent study by Abraham et al, (2002) tested the random walk hypothesis (RWH) and market efficiency hypothesis for three Gulf countries, namely Saudi Arabia, Kuwait and Bahrain. Their results could not reject the RWH for Saudi and Bahraini markets, while the Kuwaiti market fails to follow a random walk, which means it is inefficient.

The study of rejection of random walk in the share price due to mean reverting tendency which is a consequence of persistence of one sided volley in share price was first presented by De Bondt and Thaler (1985). The presence of mean reverting tendency and absence of random walk in United States stocks was confirmed by studies of Poterba and summers (1988) and De Bondt and Thaler (1989). The rejection of the random walk model by Lo and Mackinlay (1988) was mainly due to behavior of small stocks. But this could not be attributed entirely to the effect of the infrequent trading on time varying volatilities. They used simple specification test based on variance estimators to prove that stock market did not follow a random walk. Farma and French (1988) who discovered that for the USSM, 40% of the variations of longer holding period returns were predictable from the information on past returns.

The variance ratio test was proposed by Lo and Mackinlay in 1988 to test random walk hypothesis. The study compared various estimators derived from data at various levels of frequency for weekly stock market return in the NYSE and ASE for a period of over thirty-two years. They improved the variance ratio statistics by taking overlapping periods and corrected the variance used in estimating the statistics for bias. They also

proposed a test statistics Z*, which is robust under the heteroscedastic random walk hypothesis, hence can be used for a longer time series analysis. They conducted an extensive Monte–Carlo simulation to find out the size and power of variance ratio test in infinite samples. They identified that the variance of random walk increments was linear in all sampling intervals. Their finding provided evidence to reject the random walk model for the entire sample period of 1962 to 1985 and for all sub periods for a variety of aggregate return indices and size sorted portfolios. Studies based on the Lo and Mackinlay's simple volatilities based on specification test have indicated a rejection of random walk in the stock market of developing countries and newly developed countries as well. The rejection of the random walk model by Lo and Mackinlay was mainly due to the behavior of small stocks. But this could not be attributed entirely to the effect of infrequent trading or time-varying volatilities. They used sample specification tests based on variance estimator to prove that stock prices did not follow a random walk.

Ayadi and Pyun (1994) showed that SKM does not follow random walk when tested under homoskedastic error term assumption and follow random walk when the test statistics is corrected for heteroskedasticity. Madhusoodanan (1998) used variance ratio test to find out the temporary and permanent component in the ISM. The study based on industry wise indices concluded that in general ISM is mean reverting. In his further study, he concluded that if random walk hypothesis cannot be accepted by BSE sensitivity index and BSE national index then heteroskedasticity does not seem to play an important role in ISE. Grieb and Geyes (1999) employed variance ratio on weekly stock returns to re-examine the Mexican stock markets. The findings indicated that non-random behavior in the Mexican market. Ramasastri (1999) tested Indian Stock Market for

random walk during the post liberalization period using three Dickey-Fuller hypotheses. Contrary to the other studies he could not reject the null hypothesis that the stock prices are random walk.

Parameswaran (2000) performed variance ratio test corrected for bid –ask spread and non-synchronous trading on the weekly returns derived from CRSP daily returns file for the period of twenty-three years. His results show that eight out of ten size sorted portfolios do not follow random walk. He observed that non-trading is not a source of serial correlation in the large sized firms. Ming *et al* (2000) showed that variance ratio and the multiple variance ratio tests rejects the random walk for Kuala-Lampa stock exchange. They further showed that trading rules like VMA and FMA have predictive ability of earning profit over and above the transaction cost. Darrat and Zhong (2000) examined random walk hypothesis for two newly created stock exchanges in China. They rejected the random walk in newly created Chinese stock exchange. They further suggested ANN based models as strong tools for predicting prices in the stock exchanges of developing countries.

Chaudhuri and Wu (2003) implemented the Zivot and Andrews (1992) endogenous one break test to examine the random walk hypothesis in seventeen emerging markets. They found that for ten markets, the null hypothesis of a random walk can be rejected at 1% and 5% significance level.

In a study to investigate the efficiency of the Karachi stock exchange (KSE) with corrections for thin trading and non-linearity as suggested by Miller, Muthuswamy and Whaley (1994), daily, weekly, and monthly data on stock prices from December 1991 to

May 2003 were used, with three non-overlapping periods (December 1991 to May 1998; May 1998 to September 2001; and September 2001 to May 2003) and one combined period (May 1998 to May 2003). The results indicated that the Karachi stock Market is efficient for the overall period, the three sub-periods, and the combined period in linear and non-linear behavior after making adjustments for thin trading. The same result was observed when the efficiency test is conducted on weekly and monthly data after adjusting for thin trading during the overall study period.

Gupta (2007) tested the weak form efficiency in the framework of random walk hypothesis for the two major equity markets in India, that is, Mumbai (formerly known as Bombay) stock exchange and National stock exchange for the period 1991 to 2006. The evidence suggested that the series do not follow random walk model and there is an evidence of autocorrelation in both market.

Raihan and Ullah (2008), in their study, in Bangladesh searched for evidence supporting the existence of at least weak-form efficiency of the Chittagong Stock exchange, CSE. The sample they used included the daily price indices of all the listed securities on the CSE for the period of 10/10/1995 to 19/01/2004. The hypothesis of the study was whether the Chittagong Stock Market is weak form efficient. The results of parametric test – auto-correlation test, auto-regression & ARIMA model – provide evidence that the share return series do not follow random walk model and the significant autocorrelation co-efficient at different lags reject the null hypothesis of weak-form efficiency.

A study conducted by Sunde and Ziwanomoyo (2008) in Zimbabwe stock Exchange, ZSE found that using monthly data from January 1998-November 2006, ZSE did not follow a random walk and therefore was not efficient in the weak form. This meant that

past prices had an influence in the determination of future prices and this provided an opportunity for out-performance by skillful financial managers and investment specialists. During the period studied investment analysts and managers of companies were able to take advantage of these investment opportunities to make abnormal returns from the ZSE.

In the 9th International academy of African Business and Development conference held at the University of Florida, USA between 20th to 24th may 2008, Frimpong and Oteng-Abayie presented a paper they researched on Ghana Stock exchange titled; Market Returns and Weak-Form Efficiency: The Case of the Ghana Stock Exchange. Their paper examined the weak-form efficient market hypothesis (EMH) in the case of the Ghana Stock Exchange (GSE) as an emerging market. Daily returns from the Databank Stock Index (DSI) over a 5-year period 1999-2004 were used for the exercise. Random walk (RW) and GARCH (1, 1) models are used as the basis for the analysis. The GSE DSI returns series exhibit volatility clustering, an indication of inefficiency on the GSE. The weak-form efficient market (random walk) hypothesis was rejected for the GSE, meaning that the market is inefficient. The inefficient market has important implications for investors, both domestic and international. Knowledge of profitable arbitrage opportunities due to market predictability serves to attract investors to diversify from more efficient markets to invest on the GSE bourse to increase their returns.

For a long time the empirical testing of the efficient market hypothesis was based on the rejection of forecastability of asset returns. Ability of any model to predict future stock price fairly accurately itself proves that the market does not follow random walk. The

studies based on technical analysis and neural network disapprove random walk hypothesis by providing that future prices can be accurately forecasted. Mitra (2000) developed ANN model based on past stock prices as parameters and showed that network performs very well in forecasting the criteria of unforecastability of stock prices in BSE.

In general, the results of previous research evidence that the market of developed economies are generally weak form efficient. That means the successive returns are independent and follow random walk. On the other hand, the research findings on the market of developing and less developed countries are controversial. Some of the researcher find evidence of weak form efficiency and cannot reject the random walk hypothesis in emerging markets.

2.3 Common Predictive Techniques

The two approaches usually used to predicting stock prices that are espoused by market professionals are chartist or technical theories and the theory of fundamental or intrinsic value analysis. These theories are really the province of the market professional and, to a large extent, of teachers of finance. Historically, however, there has been a large body of academic people, primarily economists and statisticians, who subscribe to a radically different approach to market analysis-the theory of random walks in stock market prices. Random-walk theorists usually start from the premise that the major security exchanges are good examples of efficient market.

2.3.1Chartist or technical theories

The basic assumption of all the chartist or technical theories is that history tends to repeat itself, that is, past patterns of price behavior in individual securities will tend to recur in the future. Thus the way to predict stock prices (and, of course, increase one's potential gains) is to develop a familiarity with past patterns of price behavior in order to recognize situations of likely recurrence. Chartists can approach this in two ways that is, determining the existence of predictability using past return series or price information or use technical trading rules if they can be exploited as profit making strategy.

Brealey, *et al.* (1995) asserts that Technical analysts try to get rich by looking for patterns in stock prices. The success of some of them is credited to luck and good judgment, not to technical trading rules because technical trading rules are useless when stock prices follow a random walk. Technical analysts can however help keep the market efficient since they identify misplaced stock hence their trading would extinguish any predictable patterns in stock prices. However, whether any trading rule is profitable depends largely on the operating cost (such as brokerage cost, interest cost, trading settlement procedure) and on whether transactions can be made at the exact prices quoted in the market. Essentially, then, chartist techniques attempt to use knowledge of the past behavior of a price series to predict the probable future behavior of the series by using charts of previous stock prices and trading volumes (most commonly bar charts indicating a security's high price, low price and closing price for the day) to pick stock investments. A statistician would characterize such techniques as assuming that successive price changes in individual securities are dependent. That is, the various chartist theories

assume that the sequence of price changes prior to any given day is important in predicting the price change for that day.

2.3.2 Fundamental or intrinsic value analysis.

The assumption of the fundamental analysis approach is that at any point in time an individual security has an intrinsic value (an equilibrium price) which depends on the earning potential of the security. The earning potential of the security depends on such fundamental factors as quality of management, outlook for the industry and the economy, and many others. The fundamental price of stock may fluctuate because of the expectation about the dividend may change and the required rate of return may change. A combination of these two factors enables the calculation of the warranted price. Through a careful study of these fundamental factors the analyst should, in principle, be able to determine whether the actual price of a security is above or below its intrinsic value. If actual prices tend to move toward intrinsic values, then attempting to determine the intrinsic value of a security is equivalent to making a prediction of its future price; and this is the essence of the predictive procedure implicit in fundamental analysis. In an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value. Now in an uncertain world the intrinsic value of a security can never be determined exactly. Thus there is always room for disagreement among market participants concerning just what the intrinsic value of an individual security is, and such disagreement will give rise to discrepancies between actual prices and intrinsic values. In an efficient market, however, the actions of the many competing participants should cause the actual price of a security to wander randomly about its intrinsic value. If the discrepancies between actual prices and intrinsic values are systematic rather than

random in nature, then knowledge of this should help intelligent market participants to better predict the path by which actual prices will move toward intrinsic values. When the many intelligent traders attempt to take advantage of this knowledge, however, they will tend to neutralize such systematic behavior in price series. Although uncertainty concerning intrinsic values will remain, actual prices of securities will wander randomly about their intrinsic values.

2.4 Historic Information

Brealey *et al* (1995) asserts that the fact that stock prices follow a random walk is consistent with the notion that they reflect all available historic public information about a firm and hence you can't make superior profits just by studying past stock prices since old news and trends are already impounded in the historic prices and are of no use in predicting today's or future stock prices.

2.4.1 New Information

Brealey *et al* (1995) points out that if prices already reflect all available information about a firm, then only new information will cause price to change. But new information, by its nature, is unpredictable and equal likely to make the prospects of the firm seem rather worse than your current assessment.

Intrinsic values can themselves change across time as a result of new information. The new information may involve such things as the success of a current research and development project, a change in management, a tariff imposed on the industry's product by a foreign country, an increase in industrial production, or any other actual or anticipated change in a factor which is likely to affect the company's prospects. When

new information is released about a firm, expectation about the firm and the prices changes (Mishkin, 2004). New information can cause changes in expectation about the level of future dividends or the risk of those dividends. In an efficient market, on the average, competition will cause the full effects of new information on intrinsic value to be reflected instantaneously in actual prices.

However, because there is vagueness or uncertainty surrounding new information, instantaneous adjustment really have two implications. First, actual prices will initially over adjust to changes in intrinsic values as often as they will under adjust. Second, the lag in the complete adjustment of actual prices to successive new intrinsic values will itself be an independent, random variable, with the adjustment of actual prices sometimes preceding the occurrence of the event which is the basis of the change in intrinsic values (that is, when the event is anticipated by the market before it actually occurs) and sometimes following. This implies that the instantaneous adjustment property of an efficient market means that successive price changes in individual securities will be independent. A market where successive price changes in individual securities are independent is, by definition, a random-walk market. Most simply the theory of random walks implies that a series of stock price changes has no memory-the past history of the series cannot be used to predict the future in any meaningful way. The future path of the price level of a security is no more predictable than the path of a series of cumulated random numbers. It is unlikely that the random-walk hypothesis provides an exact description of the behavior of stock-market prices.

The independence assumption of the random-walk model is valid as long as knowledge of the past behavior of the series of price changes cannot be used to increase expected gains. More specifically, if successive price changes for a given security are independent, there is no problem in timing purchases and sales of that security. A simple policy of buying and holding the security will be as good as any more complicated mechanical procedure for timing purchases and sales. This implies that, for investment purposes, the independence assumption of the random-walk model is an adequate description of reality as long as the actual degree of dependence in series of price changes is not sufficient to make the expected profits of any more sophisticated mechanical trading rule or chartist technique greater than the expected profits under naive buy-and-hold policy.

2.5 The interaction between weak form market efficiency and the emerging markets

A few studies conducted on the test of efficient market hypothesis (EMH) in emerging markets compared to the volume of studies published on the developed market. It is generally assume that the emerging markets are less efficient than the developed market. The definition of emerging market is highlighted on the growth potentiality as well as rapid growth of size of the market. However, it is not unlikely that the market participants are not well informed and behaving irrational compare to well organize markets. The causes of lack of financial development especially in capital markets are due to certain market imperfection such as transaction costs, lack of timely information, cost of acquiring new information, and possibly greater uncertainty about the future [Taylor (1969); Goldsmith (1971); Marson (1972); Wai and Patrick (1973)]. The different researchers define the emerging market in different ways.

Samuel's (1981), who asserts the nature of the emerging market in terms of information availability such as follows: Prices cannot be assumed to fully reflect all available information. It cannot be assumed that investors will correctly interpret the information that is released. The corporation has greater potential to influence its own stock market price and there is a greater possibility that its price will move about in a manner not justified by the information available.

Emerging markets are also defined in terms of policy-making decisions such as follows:

A realization of inefficiencies inherent in command and control policies and the tighter lending policies of international creditors have led the developing countries to re-define the role of domestic equity markets in their economies. Most countries have adopted policies that make the allocation of equity capital more responsive to market forces. These policy changes have resulted in remarkable growth in the size of the equity markets in the developing world, commonly known as Emerging Stock Markets (ESMs). And with this open market policy, in the emerging markets speculations are common; large investors can easily speculate the market. As a less organized market without market makers and timely available information, there is always a possibility to make profit by large investors and insiders. The ability to predict stock price changes based on a given set of information lies behind the notion of stock market efficiency. The lower the market efficiency, the greater the predictability of stock price changes.

2.6 Criticism of random walk

Although the statistical technique is a common tools used in testing independence, the chartist or technical theorist probably would not consider it adequate. Chartists would not consider either serial correlations or runs analyses as adequate tests of whether the past

history of series of price changes can be used to increase the investor's expected profits. The simple linear relationships that underlie the serial correlation model are much too unsophisticated to pick up the complicated patterns that the chartist sees in stock prices. Similarly, the runs tests are changes, regardless of the size of the price change that causes the change in sign. The chartist would like to have a more sophisticated method for identifying movements, a method which does not always predict the termination of the movement simply because the price level has temporarily changed direction much too rigid in their manner of determining the duration of upward and downward movements in prices. In particular, in runs testing, a run is considered as terminated whenever there is a change in sign in the sequence of successive price.

One such technique used by chartists is Alexander's filter technique, which is an attempt to apply more sophisticated criteria to the identification of moves. Although the filter technique does not correspond exactly to any well-known chartist theory, it is closely related to such things as the Dow Theory. Thus, the profitability of the filter technique can be used to make inferences concerning the potential profitability of other mechanical trading rules.

2.7 Conceptual framework

Alexander, *et al.* (1989) points out that in most efficient market the future price will be totally random and the price formation can be assumed to be a stochastic process. This study will adopt a random walk with a drift. Kennedy (1996) points out that Nelson and Plosser (1982) is a seminar study claiming that macroeconomic data are better characterized as a random walk with a drift than as a stationary with a time trend. This model assumes that present period stock price is equal to a fixed drift in the price change

from one period to another with a component of increment, ε_t that is independently and identically distributed. The increment term has a zero mean and a fixed variance (homoskedasticity). The relationship formulae of the current stock are given by the sum of the expected price drift to the previous trading period's stock price to an independent term that is independent and is identically distributed. The incremental term will be assumed homoskedastic, that is,

$$P_t = \mu + p_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim I\,ID\,(0, \sigma 2)$$

This study adopts this model but modify it as stated below to establish whether the NSE indices follow random walk.

$$\mathbf{I}_t = \mu + \mathbf{I}_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim I\,ID\,(0, \sigma^2)$$

Where μ = Expected NSE Share Index drift.

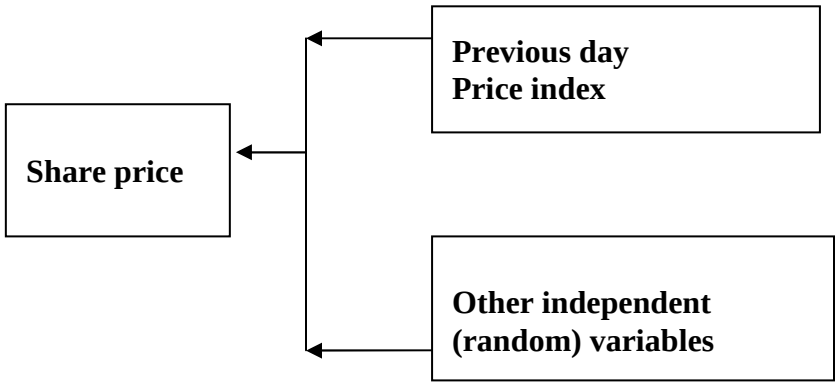
ε_t = Error term.

$\mathbf{I}_t$ = Current period NSE Share Index.

$\mathbf{I}_{t-1,}$ = Previous period NSE Share Index.

$\varepsilon_t \sim I\,ID\,(0,\sigma^2)$ = Error term, ε_t is independently and identically distributed. The incremental term has zero mean and Constant variance, (homoskedasticity).

CONCEPTUAL FRAMEWORK



(Dependent variable) **(Independent Variables)**

2.8 Conclusion from Literature Review

Several studies have been done in relation to the applicability of random walk theory in different stock exchange.Lo and Mackinlay (1988) found out that a positive autocorrelation for weekly holding period returns, indicating that random walk exists in a developed economy. Pan *et al* (1991) rejected the null hypothesis of randomness for Korea, Singapore and Taiwan. Dickson and Muragu (1994) found efficient stock market in Kuwait, Greece and Nairobi.

Butler and Malaikah(1992) concluded that institution factors contribute to operation inefficiency in Saudi Arabia stock, Al-Loughani(1995) in his study noted that price index does not follow random walk in Kuwait as he used different statistical techniques. Sunde and Ziwanomoyo(2008) concluded that ZSE did not follow a random walk and therefore was not efficient in the weak form.

In general, the results of previous research evidence that the market of developed economies are generally weak form efficient, the successive returns are independent and

follow random walk. On the other hand, the research findings on the market of developing and less developed countries are controversial. There seems to be no agreement as to whether random walk theory applies or not. Currently no study has been done in Kenyan market to give a conclusive result. This study differs from the rest in that it relates to Kenyan Scenario.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

This chapter covers the research design and methodology that was used in the study. It discusses the population from which the firms studied were obtained from and how the data used in this study was collected and analyzed.

3.1 Research Design

The research was descriptive and was based on a case study of Nairobi stock Exchange. The study was useful in studying in-depth the randomness of the variables already mentioned in the theoretical framework to test whether Nairobi stock exchange indices follows random walk model. The variables were known and well defined. The design was adopted as it allows collection of large amounts of data from the target population.

3.2 The target population

The study population comprised of the fifty five companies quoted at the Nairobi Stock Exchange for operational period 1st January 2008 to 30th April 2009 for NASI. Also for the fifty five listed companies at Nairobi Stock Exchange, another population of twenty companies forming the NSE 20 share index will be tested for operational period; 1st March 2004 to 30th April 2009, to give a better comparison for the two sets of population. The period was selected as it captures both times of improved growth and decline of growth in the Kenyan economy. The existence of available data for NSE 20 share index for a long period of time is an added advantage for this study. NASI replaced AIG (EA) 27 Share Index as a compliment of NSE 20 Share Index with effect from 1st January

2008. NASI is a comprehensive and complementary index designed to represent investors' expectations of the future performance of all listed companies.

3.3 Sample

There was no sample to be taken since the study was based on the entire qualifying population.

3.4 Data type and Collection Techniques

The study used secondary data. NSE 20 Share indices and NASI running from 1st March 2004 to 30th April 2009 and 1st January 2008 to 30th April 2009 respectively, collected from NSE daily index return files, daily newspapers and Internet.

3.5 Data Analysis

Variance ratio test of NSE 20 share index and NASI at q lag and corresponding Z – statistics for different specification of the error ε_t term behavior between the operational periods; 1st March 2004 to 30th April 2009 and 1st January 2008 to 30th April 2009 respectively was used .The variance ratio at lag q is the ratio of the variance of q-periods' return to the variance of the one period return divided by q, which is a unity under random walk hypothesis, that is, VR=Var $[r_t(q)]$ / (q. Var $[v_t]$) =1. This is the null hypothesis of random walk model. Acceptance of this null hypothesis means conformity to random walk hence a rejection of null hypothesis for this study.

Lo and Mackinlay, (1988) stated that in a finite sample the increments in the variance are linear in the observation interval for a random walk. The variance ratio is defined as

$$VR\ (q) = \sigma^2_c\ (q) / \sigma^2_\gamma$$

Where $\sigma^2_c\ (q)$ = unbiased estimator of 1/q of variance of q^{th}

difference of R_t

σ^2_γ = unbiased estimator of the variance of the first difference of R_t

After deriving an asymptotic distribution, the Z statistical tests for different specification of error term, $\mathcal{E}_t$, behavior will be conducted. Under the random walk hypothesis, the variance ratio (VR) at lag q for NSE 20 share weekly and monthly indices and NASI weekly and monthly indices, that is, VR (2), VR (4), VR (8) should have values closer to one since the variance of increment of a random walk is linear in the sampling interval. The statistics of interest was the autocorrelation at various orders.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents the results of the analysis and findings of the study with reference to the study objectives. The first section gives a summary of the data analysis method used. The second part gives the findings of the study, and it includes relevant graphs that help to explain the results of the data analysis. The last part gives a summary of findings and interpretations.

4.1 Data Analysis

The variance ratio VR at various lags q for NSE 20 share weekly and monthly indices and NASI weekly and monthly indices, that is, VR (2), VR (4), VR (8) were determined, and corresponding Z-statistics for different specification of the error ε_t term behavior between the sampling periods of 1st March 2004 to 30th April 2009 for NSE 20 share weekly and monthly indices and 1st January 2008 to 30th April 2009 for NASI were determined. Derived asymptotic standard normal distribution that takes the following form was used.

$$Z(q) = \frac{\sqrt{nq}\,[VR(q)-1]}{\sum_{j=1}^{q-1} [2(q-j)^{-q}]\,{}^{2}\delta(j)}$$

When q=2, that is, $q=2^1$ VR (q) - 1 estimates the first order of autocorrelation coefficient $[x_t-x_{t-1}]$ s, thus, if x_t s are weekly / monthly indices, then VR (q) =VR (2) approximates

the first order autocorrelation of weekly / monthly returns. First order of autocorrelation coefficient $[x_t-x_{t-1}]$ s was critical for decision making in this study, that is, whether to accept or reject the null hypothesis for random walk model and for the study since the sample size used to determine the variance ratio tests of the NSE indices at different lags q was small, that is, nq=270 for NSE 20 share weekly indices for sampling period between 1st March 2004 to 30th April 2009, nq=68 for NASI weekly indices for sampling period between 1st January 2008 to 30th April 2009, nq=62 for NSE 20 share monthly indices for sampling period between 1st March 2004 to 30th April 2009 and nq=16 for NASI monthly indices for sampling period between 1st January 2008 to 30th April 2009. Third or higher order of autocorrelation coefficient (that is, when q=8 => $q=2^3$ or more) wasn't critical in decision making in this study, that is, whether to accept or reject the null hypothesis for random walk model that the variance ratio has a value of one hence reject or accept the null hypothesis of this study since higher order of autocorrelation coefficient are prone to very high deviation more so for data with small sample size analyzed with variance ratio test. Therefore the variance ratio for NSE indices at lag q should be equal to unity for random walk model under homoskedastic error term, $\mathcal{E}_t$, assumption. Accepting the null hypothesis for random model means rejecting the null hypothesis for this study.

4.2 TABLES AND ANALYSIS OF RESULTS OF VARIANCE RATIO ESTIMATES OF NSE 20 SHARE INDEX AND NASI AT VARIOUS LAG q AND VALUES FOR Z-STATISTICAL TESTS UNDER HOMOSKEDASTIC ERROR TERM, $\mathcal{E}_t$, ASSUMPTION AT 5% LEVEL OF SIGNIFICANCE

Table 4.2.1: Tabulation of the weekly values of the NSE 20 share indices of Nairobi stock exchange for the null hypothesis of random walk model that the variance ratio

has a value of one under homoskedastic error term, ε_t, for the sampling period between 1st March 2004 to 30th April 2009

Lag q	Total sample size Nq	Variance Ratio Estimate VR(q)	Z-Statistical Z(q)	Inference
2	270	0.96	-0.52	NOT rejected at 5%
4	270	1.07	0.80	NOT rejected at 5%
8	270	1.15	1.51	NOT rejected at 5%
16	270	1.41	1.78	NOT rejected at 5%

Source: Survey data (2010)

The table shows that for NSE 20 share weekly indices for q=2, that is, $q=2^1$; q=4, that is, $q=2^2$; q=8, that is, $q=2^3$; and q=16, that is, $q=2^4$, VR (q) - 1 estimated the first, second, third, and forth order of autocorrelation coefficients respectively and their corresponding z-statistics to test for different specification of homoskedastic error term, ε_t, for NSE 20 share weekly indices of sample size nq=270 and the results are such that at lag q=2, The variance ratio estimate for the first order of autocorrelation coefficient, VR(q)=0.96 and the corresponding Z(q)= -0.52 at 5% level of significance, and since VR(q)=0.96 is greater than (>) the absolute value of Z(q)= -0.52 , that is, | Z(q) |= | -0.52 |= 0.52, the null hypothesis for random walk model that the variance ratio of NSE 20 share weekly indices of the Nairobi stock exchange for the sampling period between 1st March 2004 to 30th April 2009 has a value of one is not rejected at 5% level of significance. Therefore,

first order of autocorrelation coefficient estimate of variance ratio of the NSE 20 share weekly index for Nairobi stock exchange for the period between 1st March 2004 to 30th April 2009 follows random walk and hence rejects the null hypothesis for this study. The same applies to the second order of autocorrelation coefficient estimate of variance ratio for the NSE 20 share weekly indices for the same period where, at lag q=4, VR(q)=1.07 and the corresponding Z (q) = 0.80 at 5% level of significance, and since VR (q) =1.07 is greater than (>) the value of Z (q) =0.80, the null hypothesis for random walk model that the variance ratio of NSE 20 share weekly indices of the Nairobi stock exchange for the sampling period between 1st March 2004 to 30th April 2009 has a value of one is not rejected at 5% level of significance. At lag q=8, the variance ratio estimate for the third order autocorrelation, VR (q) =1.15 and the corresponding Z (q) = 1.51 at 5% level of significance isn't critical for accepting or rejecting the null hypothesis of random walk model that the variance ratio of NSE 20 share weekly indices for the sampling period 1st March 2004 to 30th April 2009 has a value of one since the sample size nq=270 is small and such a higher order of autocorrelation coefficient estimate for variance ratio are prone to very high deviation. This means that the first and the second order of autocorrelation coefficient estimates of VR (q) for NSE 20 share weekly indices under homoskedastic error term, $\dot{\varepsilon}_{t,}$ follows random walk hence the null hypothesis for this study that NSE 20 share index do not follow random walk is rejected.

Table 4.2.2: Tabulation of the weekly values of the NASI of Nairobi stock exchange for the null hypothesis of random walk model that the variance ratio has a value of one under homoskedastic error term, ε_t, the sampling period between 1st January 2008 to 30thApril 2009

Lag q	Total sample size Nq	Variance Ratio Estimate VR(q)	Z-Statistical Z(q)	Inference
2	68	0.97	-0.35	NOT rejected at 5%
4	68	1.12	0.84	NOT rejected at 5%
8	68	1.30	1.42	NOT rejected at 5%

Source: Survey data (2010)

The table shows that for NASI weekly indices for q=2, that is, $q=2^1$; q=4, that is, $q=2^2$; and q=8, that is, $q=2^3$, VR (q) - 1 estimated the first, second, and third order of autocorrelation coefficients respectively and their corresponding z-statistics to test for different specification of the error term, ε_t, for NASI weekly indices of sample size nq=68 and the results are such that at lag q=2, The variance ratio estimate for the first order of autocorrelation coefficient, VR(q)=0.97 and the corresponding Z(q)= -0.35 at 5% level of significance, and since VR(q)=0.97 is greater than (>) the absolute value of Z(q)= -0.35 , that is, | Z(q) |= | -0.35 |= 0.35, the null hypothesis for random walk model that the variance ratio of NASI weekly indices of the Nairobi stock exchange for the sampling period between 1st January 2008 to 30th April 2009 has a value of one is not rejected at 5% level of significance. Therefore, first order of autocorrelation coefficient

estimate of variance ratio of the NASI weekly index for Nairobi stock exchange for the period between 1st January 2008 to 30th April 2009 under homoskedastic error term, ε_t, follows random walk hence the null hypothesis for this study that NASI weekly indices do not follow random walk is rejected. The same applies to the second order of autocorrelation coefficient estimate of variance ratio for the NASI weekly indices for the same period where, at lag q=4, VR(q)=1.12 and the corresponding Z (q) = 0.84 at 5% level of significance, and since VR (q) =1.12 is greater than (>) the value of Z (q) =0.84, the null hypothesis for random walk model that the variance ratio of NASI weekly indices of the Nairobi stock exchange for the sampling period between 1st January 2008 to 30th April 2009 has a value of one is not rejected at 5% level of significance. At lag q=8, the variance ratio estimate for the third order autocorrelation, VR (q) =1.30 and the corresponding Z (q) = 1.42 at 5% level of significance isn't critical for accepting or rejecting the null hypothesis for random walk model that the variance ratio of NASI weekly indices for the sampling period 1st January 2008 to 30th April 2009 has a value of one since the sample size, nq = 68 is small and such a higher order of autocorrelation coefficient estimate for variance ratio are prone to very high deviation. This means that the first and second order of autocorrelation coefficient estimate of variance ratio at lag q, that is, VR (q) under homoskedastic error term, ε_t, for NASI weekly indices follows random walk hence the null hypothesis for this study that NASI weekly indices between the sampling period do not follow random walk is rejected.

Table 4.2.3: Tabulation of the monthly values of the NSE 20 share indices of Nairobi stock exchange for the null hypothesis of random walk model that the variance ratio has a value of one under homoskedastic error term, ε_t, for the sampling period between 1st March 2004 to 30th April 2009

Lag q	Total sample size Nq	Variance Ratio Estimate VR(q)	Z-Statistical Z(q)	Inference
2	62	1.01	0.23	NOT rejected at 5%
4	62	1.01	0.10	NOT rejected at 5%
8	62	1.09	0.43	NOT rejected at 5%

Source: Survey data (2010)

The table shows that for NSE 20 share monthly indices for q=2, that is, $q=2^1$; q=4, that is, $q=2^2$; and q=8, that is, $q=2^3$, VR (q) - 1 estimated the first, second, and third order of autocorrelation coefficients respectively and their corresponding z-statistics to test for different specification of the error term, ε_t, for NSE 20 share monthly indices of sample size nq=62 and the results are such that at lag q=2, The variance ratio estimate for the first order of autocorrelation coefficient, VR(q)=1.01 and the corresponding Z(q)= 0.23 at 5% level of significance, and since VR(q)=1.01 is greater than (>) the value of Z(q)= 0.23, the null hypothesis of random walk model that the variance ratio of NSE 20 share monthly indices of the Nairobi stock exchange for the sampling period between 1st March 2004 to 30th April 2009 has a value of one is not rejected at 5% level of significance. Therefore, first order of autocorrelation coefficient estimate of variance

ratio of the NSE 20 share monthly index for Nairobi stock exchange under homoskedastic error term, $\mathcal{E}_t$, for the period between 1st March 2004 to 30th April 2009 follows random walk and hence the null hypothesis for this study that NSE 20 share monthly index between the sampling period does not follow random walk is rejected. The same applies to the second order of autocorrelation coefficient estimate of variance ratio for the NSE 20 share monthly indices under homoskedastic error term, $\mathcal{E}_t$, for the same period where, at lag q=4, VR(q)=1.01 and the corresponding Z (q) = 0.10 at 5% level of significance, and since VR (q) =1.01 is greater than (>) the value of Z (q) =0.10, the null hypothesis for random walk hypothesis that the variance ratio of NSE 20 share monthly indices of the Nairobi stock exchange under homoskedastic error term, $\mathcal{E}_t$, for the sampling period between 1st March 2004 to 30th April 2009 has a value of one is not rejected at 5% level of significance. At lag q=8, the variance ratio estimate for the third order autocorrelation, VR (q) =1.09 and the corresponding Z (q) = 0.43 at 5% level of significance isn't critical for accepting or rejecting the null hypothesis that the variance ratio of NSE 20 share monthly indices for the sampling period 1st March 2004 to 30th April 2009 has a value of 1 since the sample size, nq=62 is small and such a higher order of autocorrelation coefficient estimate for variance ratio are prone to very high deviation. This means that the first and the second order of autocorrelation coefficient estimates of variance ratio at lag q, that is, VR (q) for NSE 20 share monthly indices under homoskedastic error term, $\mathcal{E}_t$, follows random walk hence rejecting the null hypothesis for the study that NSE 20 share monthly indices between the sampling period do not follow random walk.

Table 4.2.4: Tabulation of the monthly values of the NASI of Nairobi stock exchange for the null hypothesis of random walk model that the variance ratio has a value of one under homoskedastic error term, ε_t, for the sampling period between 1st January 2008 to 30st April 2009.

Lag q	Total sample size Nq	Variance Ratio Estimate VR(q)	Z-Statistical Z(q)	Inference
2	16	1.21	4.25	Rejected at 5%
4	16	1.49	5.35	Rejected at 5%
8	16	1.64	4.40	Rejected at 5%

Source: Survey data (2010)

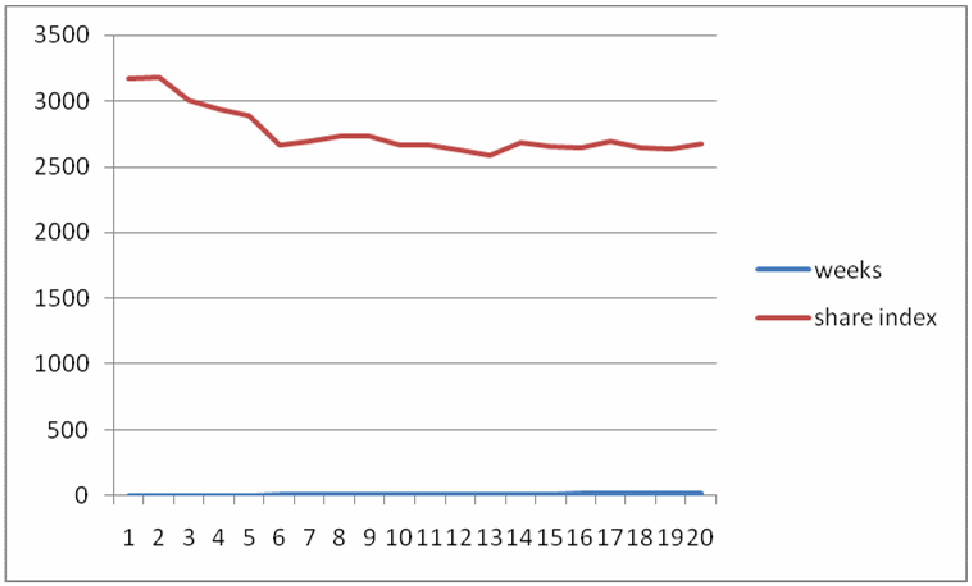
The table shows that for NASI monthly indices for q=2, that is, $q=2^1$; q=4, that is, $q=2^2$; and q=8, that is, $q=2^3$, VR (q) - 1 estimated the first, second, and third order of autocorrelation coefficients respectively and their corresponding z-statistics to test for different specification of the error term, ε_t, for NASI monthly indices of sample size nq=16 and the results are such that at lag q=2, The variance ratio estimate for the first order of autocorrelation coefficient, VR(q)=1.21 and the corresponding Z(q)= 4.25 at 5% level of significance, and since VR(q)=1.21 is less than (<) the value of Z(q)= 4.25 , that is, the null hypothesis for random walk model that the variance ratio of NASI monthly indices of the Nairobi stock exchange for the sampling period between 1st January 2008 to 30th April 2009 has a value of one is rejected at 5% level of significance. Therefore, first order of autocorrelation coefficient estimate of variance ratio of the NASI monthly indices for Nairobi stock exchange under homoskedastic error term, ε_t, for the period between 1st January 2008 to 30th April 2009 does not follow random walk hence the null

hypothesis for the study that NASI monthly indices between the sampling period is not rejected. The same applies to the second order of autocorrelation coefficient estimate of variance ratio for the NASI monthly indices under homoskedastic error term, $\mathcal{E}_t$, for the same period where, at lag q=4, VR(q)=1.49 and the corresponding Z (q) = 5.35 at 5% level of significance, and since VR (q) =1.49 is less than (<) the value of Z (q) =5.35, the null hypothesis for random walk model that the variance ratio of NASI monthly indices of the Nairobi stock exchange under homoskedastic error term, $\mathcal{E}_t$, for the sampling period between 1st January 2008 to 30th April 2009 has a value of one is rejected at 5% level of significance. At lag q=8, the variance ratio estimate for the third order autocorrelation, VR (q) =1.64 and the corresponding Z (q) = 4.40 at 5% level of significance isn't critical for accepting or rejecting the null hypothesis for random walk model that the variance ratio of NASI monthly indices for the sampling period 1st January 2008 to 30th April 2009 has a value of one since the sample size, nq=16 is small and such a higher order of autocorrelation coefficient estimate for variance ratio are prone to very high deviation. This means that the first and the second order of autocorrelation coefficient estimates of variance ratio at lag q, that is, VR (q) for NASI monthly indices under homoskedastic error term, $\mathcal{E}_t$, for the sampling period did not follow random walk.

4.3 LINE GRAPHS FOR NSE 20 SHARE INDEX AND NASI FOR PORTIONS OF THE STUDY PERIOD

Line graphs for the first and the last year for the study, that is, 1st March 2004 to 30th April 2005 and 1st March 2008 to 30th April 2009 for NSE 20 share weekly and monthly indices are presented. The line graph for NASI for the period between 1st January 2008 to 30th April 2009 for weekly and monthly indices are presented.

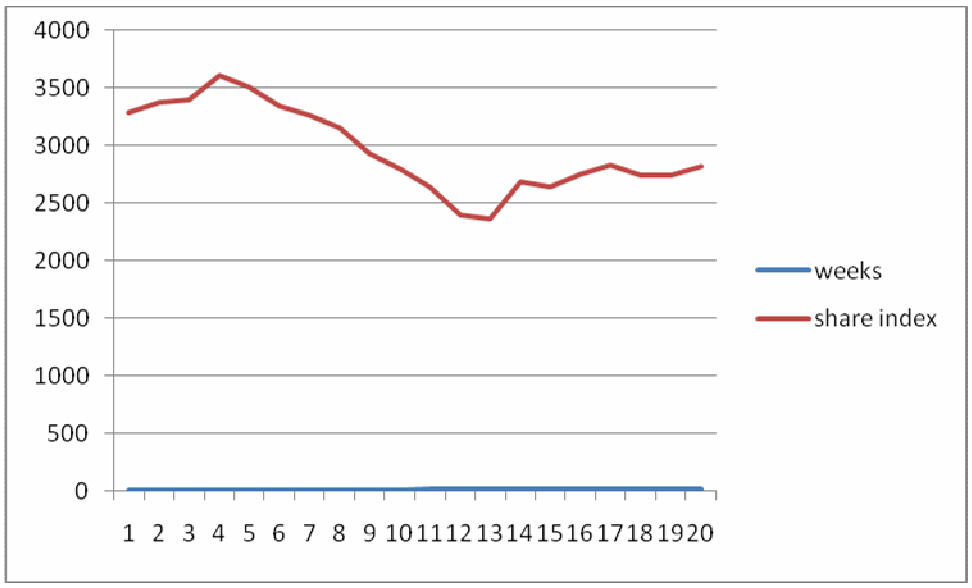
Figure 4.3.1 Line graph for NSE 20 share weekly indices based on Monday's reports of the first twenty weeks (1st March 2004 to 30th April 2005)



Source: Response data (2010)

The above line graph relating the share index with the first twenty weeks of the first year of the sampling period, show that the weekly index is very variable oscillating between 2500 and 3200. From the above graph, it is clear that the share prices were varying from week to week, bearing in mind that the Kenyan economy was showing a sign of recovery under a new government.

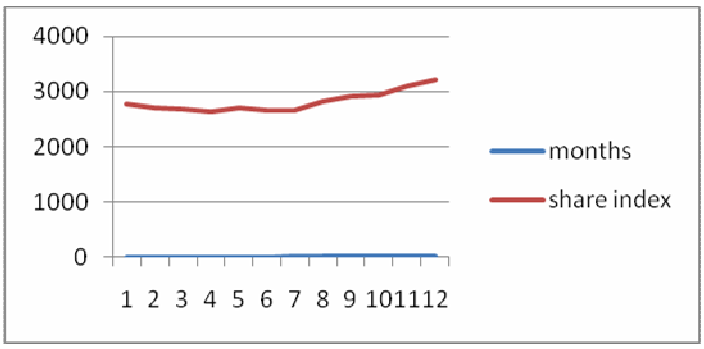
Figure 4.3.2 Line graph for NSE 20 share weekly indices based on Monday's reports of the last twenty weeks (1st March 2008 to 30th April 2009)



Source: Response data (2010)

The graph above present the behavior of weekly share index during last year of the sampling period. The last twenty weeks shows how un predictable were the share prices at the time the economy was down , following the political instability in the country. This is clear evidence that the market was efficient consistent with the random walk theory.

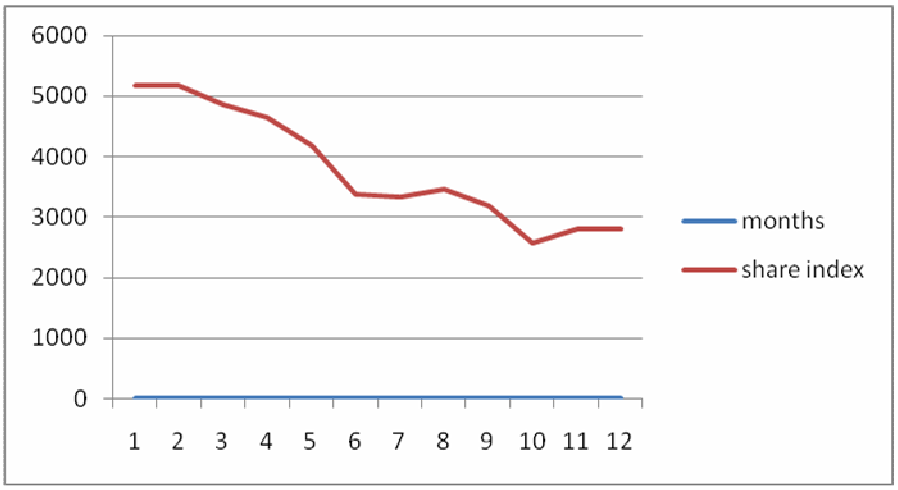
Figure 4.3.3 Line graph for NSE 20 share monthly indices based on the last working day of the month for the first one year period for the study (1st March 2004 to 30th April 2005)



Source: Response data (2010)

The graph of monthly indices during the first year of the of the sampling period, shows a steady increase with time. This is due to economic growth which was being experienced at that time. Though the volume traded was increasing, the share prices were fluctuating as usual, as shown in the weekly indices within the same period.

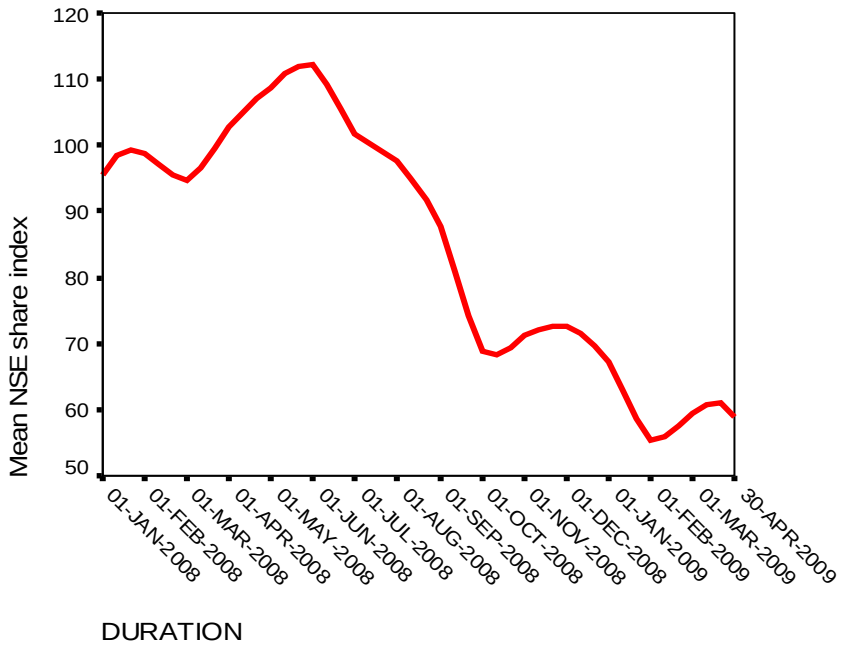
Figure 4.3.4 Line graph for NSE 20 share monthly indices based on the last working day of the month for the last one year period for the study (1st March 2008 to 30th April 2009)



Source: Response data (2010)

The monthly indices for last year of the sampling period appear very variable without any obvious trend. Though within this period the indices in general were on the downward trend, there is no pattern to predict the next period's value. This is very consistent with efficient market, though in the weak form. In this scenario it is not possible to develop a predictive model because the observations are independent of one another and therefore a predictive model like time series is not applicable.

Figure 4.3.5 Line graph for NASI monthly indices based on the last working day of the month (1st January 2008 to 30th April 2009)



Source: Response data (2010)

This graph was meant to test whether there is a relationship of share index at different time intervals. From the graph, there is no relation of the share index with the time interval picked. Since there is no pattern, a forecasting model cannot be used in this market.

4.4 Summary of Findings

The aim of the study was to empirically test random walk model for the Nairobi stock exchange indices for the period between 1st March 2004 to 30th April 2009 using parametric autocorrelation test, that is, variance ratios of the indices for the sampling periods at lag q under homoskedastic error term, ε_t, assumption and hence ascertains

whether during this period, historical price for stock traded in the bourse were used to predict future stock price as advocated by chartists or technical analysts / theorists.

The Z statistics was used to test autocorrelation because the error term is assumed to be normally distributed with zero mean and constant variance. The level of significance was 5% (95% confidence level). Null hypothesis was to be rejected if the Z value computed is greater than the critical of Z at 5% level of significance and fail to reject Null hypothesis if the value of Z computed is less than critical value of Z.

The study population comprised the NSE 20 share indices points and NASI. NSE 20 share index was a natural choice for including in this study as it is the most popular market index and widely used by market players for benchmarking. For the entire study period, the NSE 20 share weekly indices comprised a sample size nq=270, NSE 20 share monthly indices comprised of nq=62, NASI weekly indices comprised of nq=68 and NASI monthly indices comprised a sample size of nq=16.

The findings of the study show that for the entire study period, except for NASI monthly indices whose sample size was as small as nq=16, the NSE 20 share weekly indices, the NSE 20 share monthly indices and NASI weekly indices at the first and the second order of autocorrelation estimate of variance ratio test under homoskedastic error term, $\mathcal{E}_t$, follows random walk for the operational periods between 1st March 2004 to 30th April 2009 for NSE 20 share indices and 1st January 2008 to 30th April 2009 for NASI.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the conclusion to the study and the implications of the main findings. Limitations encountered in the course of the study are also given. Suggestions for further research are also given.

5.1 Conclusion

Except for NASI monthly indices, the random walk model for NSE 20 share weekly and monthly indices and NASI weekly indices are accepted for the Kenyan, Nairobi Stock Market using homoscedasticity corrected variance ratio test. This is evident for the acceptance of the of the null hypothesis of random walk model at 5% level of significance that the variance ratio for the NSE 20 share weekly and monthly indices for the sampling period between 1st March 2004 to 30th April 2009 and NASI weekly indices for the sampling period between 1st January 2008 to 30th April 2009 under homoskedastic error term, ε_t, assumption.

The null hypothesis of random walk that VR (q) have a value of one is not rejected since none of the test statistics Z (q) is large or small enough to reject the hypothesis. That is to say that except for NASI monthly indices for the sampling period between 1st January 2008 to 30th April 2009, there is a strong support that during the period between 1st March 2004 to 30th April 2009, Nairobi stock indices followed random walk, hence NSE as an emerging market conformed to the weak form of the efficient market hypothesis. This means that during this period, prices for stock traded in the bourse were governed by

market fundamentals and that stock prices already reflected all available information about a firm, and that past stock prices could not be used to forecast future stock prices with certainty as advocated by chartists / technical theorists since stock market has no memory. Though the sampling period was only five years, a conclusion is drawn for this study that NSE follows random walk under the weak form of market efficiency.

5.2 Recommendations

Recommendations to Policy Makers

There is need to establish sufficient machinery for prudential policy measures and supervision hence proper regulatory framework be set in place.

Recommendations to retail and corporate investors

There is need to invest on security stocks traded in the bourse whose prices are driven by market fundamentals, hence seek investment advisor's advice first before investing in any stock. Also a simple policy of buy and hold be adopted in trading on stock which will be as good as any more complicated mechanical procedures of timing purchases and sales.

Recommendations for investment advisors

There is need to conduct sufficient research on stock for companies trading in the bourse and avail all the necessary information to any client who comes for advice. Full disclosure of factors determining prices for stocks traded in the bourse will protect individual and corporate investors interested in trading in stocks

5.3 Limitations of this study

The data for NASI was inadequate to make a concrete conclusion; the data available was only for sixteen months that is operational period 1st January 2008 to 30th April 2009. If

the model is applied for a longer period, chances are that NASI will conform to efficient market in a weak form, consistent to random walk model.

The model used, variance ratio to test autocorrelation on the assumption that the error term is normally distributed, which might to be the case. Use of Durbin Waston statistics could have been better to test autocorrelation especially for a second order autocorrelation.

5.4 Suggestions for further research

There is need to constantly conduct research to ascertain whether emerging stock market are efficient in the weak form since it is generally assume that the emerging markets are less efficient than the developed market continuous research on this area to reach an ultimate conclusion about the level of efficiency of less developed market is necessary.

Researchers could specifically conduct a parametric autocorrelation test of NSE indices to ascertain whether it follows random walk using a test statistics that is corrected for heteroskedasticity for the sampling period of this study to establish whether under this condition the NSE conformed to weak form of market efficiency

Researchers could also use Durbin Waston statistics to test second order autocorrelation of which is a more robust approach than the variance ratio.

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APPENDIX

COMPANIES LISTED IN NAIROBI STOCK EXCHANGE.

AGRICULTURAL

Kakuzi Ord.5.00
Rea Vipingo Plantations Ltd Ord 5.00
Sasini Ltd Ord 1.00

COMMERCIAL AND SERVICES

AccessKenya Group Ltd Ord. 1.00
Car & General (K) Ltd Ord 5.00
CMC Holdings Ltd Ord 0.50
Hutchings Biemer Ltd Ord 5.00
Kenya Airways Ltd Ord 5.00
Marshalls (E.A.) Ltd Ord 5.00
Nation Media Group Ord. 2.50
Safaricom limited Ord 0.05
Scangroup Ltd Ord 1.00
Standard Group Ltd Ord 5.00
TPS Eastern Africa (Serena) Ltd Ord 1.00
Uchumi Supermarket Ltd Ord 5.00

FINANCE AND INVESTMENT

Barclays Bank Ltd Ord 2.00
Centum Investment Company Ltd Ord 0.50
CFC Stanbic Holdings Ltd ord.5.00
Diamond Trust Bank Kenya Ltd Ord 4.00
Equity Bank Ltd Ord 5.00
Housing Finance Co Ltd Ord 5.00
Jubilee Holdings Ltd Ord 5.00
Kenya Commercial Bank Ltd Ord 1.00
Kenya Re-Insurance Corporation Ltd Ord 2.50
National Bank of Kenya Ltd Ord 5.00
NIC Bank Ltd 0rd 5.00
Olympia Capital Holdings ltd Ord 5.00
Pan Africa Insurance Holdings Ltd 0rd 5.00
Standard Chartered Bank Ltd Ord 5.00
The Co-operative Bank of Kenya Ltd Ord 1.00

INDUSTRIAL AND ALLIED

Athi River Mining Ord 5.00
B.O.C Kenya Ltd Ord 5.00
Bamburi Cement Ltd Ord 5.00

British American Tobacco Kenya Ltd Ord 10.00
Carbacid Investments Ltd Ord 5.00
Crown Berger Ltd 0rd 5.00
E.A.Cables Ltd Ord 0.50
E.A.Portland Cement Ltd Ord 5.00
East African Breweries Ltd Ord 2.00
Eveready East Africa Ltd Ord.1.00
Kenya Oil Co Ltd Ord 0.50
Kenya Power & Lighting Ltd Ord 20.00
KenGen Ltd. Ord. 2.50
Mumias Sugar Co. Ltd Ord 2.00
Sameer Africa Ltd Ord 5.00
Total Kenya Ltd Ord 5.00
Unga Group Ltd Ord 5.00

ALTERNATIVE INVESTMENT MARKET

A.Baumann & Co.Ltd Ord 5.00
City Trust Ltd Ord 5.00
Eaagads Ltd Ord 1.25
Express Ltd Ord 5.00
Williamson Tea Kenya Ltd Ord 5.00
Kapchorua Tea Co. Ltd Ord 5.00
Kenya Orchards Ltd Ord 5.00
Limuru Tea Co. Ltd Ord 20.00

Source: The Nairobi Stock Exchange.