AN EMPIRICAL ANALYSIS OF THE WEAK FORM EFFICIENT MARKET HYPOTHESIS OF THE NAIROBI SECURITIES EXCHANGE

BY

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A RESEARCH DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE DEGREE OF MASTER IN COMMERCE (FINANCE AND INVESTMENTS) IN THE SCHOOL OF BUSINESS AND PUBLIC MANAGEMENT AT KCA UNIVERSITY

OCTOBER, 2013

DECLARATION

I declare that this is my original work and has not been previously published or submitted elsewhere for award of a degree. I also declare that this contains no material written or published by other people except where due reference is made and the author duly acknowledged.

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APPROVAL

I do hereby confirm that I have examined the master's dissertation of

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ABSTRACT

With the increased interest in the African economy, it is vital that we measure the performance of our capital markets to know where they stand. The Efficient Market Hypothesis (EMH) seeks to test whether a stock market is efficient in either the weak, semi-strong or strong form. With Kenya being an emerging market, the weak form efficient market hypothesis was put to test by the researcher, by determining whether successive daily stock market returns on the Nairobi Securities Exchange follow a random Walk or otherwise. The EMH briefly argues that for an efficient market, future share prices and returns should be random and unpredictable, such that any information regarding a stock is quickly assimilated into the market to reflect on the new share price

Data in the form of historical daily closing NSE 20-share Index from 1st January 2008 to 31st December 2012 was obtained from the Nairobi Securities Exchange. The use of a longer time period was to eliminate the thin trading bias that is characteristic of emerging stock markets, while the use of indices is to maintain consistency of data used in the research. Both parametric and non-parametric tests were used, to confirm results obtained in either of the tests. The data was analysed using STATA statistical package to test for stationarity of the model, normal distribution of stock prices, randomness of successive price changes and independence of stock price changes. Unit root test, runs test and Autocorrelation tests were carried out to test for the afore mentioned characteristics of the stock price and returns. Mixed results were obtained from the research, with the runs test concluding that the NSE daily market return series was random and therefore the NSE followed the random walk model. The autocorrelation tests and unit root tests, however, concluded the NSE was not weak form efficient. The autocorrelation tests detected serial correlation in the successive daily market returns and there was absence of a unit root in the time NSE time series.

The research concluded that the NSE was not weak form efficient, since all the tests conducted did not conform to the characteristics of weak form efficient market hypothesis. Information flow from the listed companies to the public is not efficient, giving some investors an advantage over others. It was recommended after the study that the NSE should put policies in place to ensure informational efficiency and also educate the public on the advantages of investing in the stock market to improve trading on the bourse.

ACKNOWLEDGEMENT

I am greatly indebted to my supervisor, Professor Silas Onyango, for his outstanding role in shaping the final outlook of this research proposal. His guidance and positive criticism have been vital in this research proposal.

I would also like to thank the Nairobi Securities Exchange for providing the vital data that was mandatory to conduct this study.

A special tribute is also accorded to my parents, John and Joyce Kamau for their sacrifice in dedicating their financial and moral support in the completion of my education. I also wish to thank my siblings Maureen and Michael for their unprecedented moral encouragement.

My classmates have also been part of this amazing academic journey and I greatly appreciate them.

DEDICATION

To my parents, for their continued support in my education.

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ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey-Fuller Test
ATS	Automated Trading System
BBO	Broker Back Office
CDSC	Central Depository and Settlement Corporation
CHU	Complaints Handling Unit
EMH	Efficient Market Hypothesis
FTSE	Financial Times Stock Exchange
K-S	Kolmogrov-Smirnov Goodness of Fit (K-S) Test
MV/BV	Market Value to Book Value
MOU	Memorandum of Understanding
NASI	Nairobi All Share Index
NSE	Nairobi Securities Exchange
P/E Ratio	Price/Earnings Ratio
P-P	Phillips-Peron Test
P/S Ratio	Price/Sales Ratio
FDIs	Foreign Direct Investments

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Rapid growth of equity markets has characterized emerging markets in the past decade, leading to increased investment options for investors. Capital markets efficiency is very vital for portfolio diversification and asset allocation across global markets (Guidi, Gupta and Maheshwari, 2010). Market efficiency is important, in that investors use this as a basis for identifying appropriate assets to invest in. In efficient capital markets, asset prices reflect all the information regarding a stock, thereby reducing chances that an investor may detect a mis-pricing and make an abnormal profit out of it. This means that no asset will be overvalued or undervalued, to eventually equate optimal reward to risk. An inefficient market, on the other hand, gives investors an opportunity in identifying mis-priced assets and making abnormal returns thereafter.

Globalization has necessitated and emphasized the importance of understanding developing countries and that means understanding capital markets in these countries. Will (2006) argues that the Efficient Market Hypothesis, hereafter regarded as EMH, can provide two main functions; the EMH can be used both as a predictive model as well as a theoretical model of financial markets by professionals in the financial market and investors and it is also an important instrument for encouraging people to invest in equity markets.

1.2 The Efficient Market Hypothesis

Bachelier (1900) in his study of securities concluded that stock price movements followed a Brownian motion, that is, future stock prices are unpredictable. In 1953, Maurice G. Kendall followed up on Bachelier's idea and came to the conclusion that stock prices seemed to follow a random motion, an idea that was later on supported by other statisticians. In a study conducted in 1959, Robert discovered that stock prices followed a random walk over time. The Random Walk Hypothesis simply states that at a given point in time, the size and direction of the next price change is random with respect to knowledge available at that point in time (Dyckman and More, 1986). Samuelson (1965) and Mandelbrot (1966) later on supported Kendall's studies and his position on the Random Walk Theory.

Fama (1965) reviewed empirical studies that had been earlier conducted and proceeded to support the Random Walk Model, which as described above argues that successive price changes are independent of each other.

Market efficiency can be distinguished under three levels, based on a stock market's ability to process information (Fama, 1970); Weak-Form market Efficiency (Past information regarding the company is fully reflected in current stock prices), Semi-Strong Market Efficiency Relevant public information is reflected in present prices of stocks) and Strong form Market Efficiency (All relevant information, both public and private, with regards to a given company, is reflected in the current stock price of the listed firm).

1.3 The Nairobi Securities Exchange

1.3.1 History of the NSE

The trading of stocks in Kenya started informally in the 1920s, devoid of any rules and regulations to govern the trading. The stock broking was characterised by agreements between parties and the need to meet contractual obligations on time. A common physical location was also not present at the time and deals were made over a cup of coffee. The first professional stock brokerage firm was established by Francis Drummond in1951 and. He, together with the then finance minister approached London Stock Exchange officials in 1953, seeking approval and recognition of the NSE as an overseas stock exchange.

The NSE was finally set up and registered under the Societies Act in the same year. Only Europeans could participate, however, since Africans and Asians were not allowed in trading. The market would face its first major challenge after independence in 1963, due to investor uncertainty with regards to the country's future.

The first major activity was the privatisation of the Kenya commercial Bank in 1988, which saw the government cede twenty (20) percent of its stake to the public. The NSE would later move its premises to the Nation Centre building in 1994, subsequently setting up the delivery and settlement system (DASS) that was computerised. The same year would also see eight (8) new brokers licensed and the International Finance Corporation name Kenya as the best performing market in the world with an all high 5030 points recorded by the NSE 20-share Index (http://www.nse.co.ke).

1.3.2 Development of the NSE

The Automated Trading System (ATS) was introduced in September 2006 in a bid to improve trading and general market efficiency. This saw the number of trading hours in a day increase from two hours to three hours. The trading of rights issues also started trading in the same manner as equities, with the ATS also enabling the trading of corporate and treasury bonds. Later that year, a Memorandum of Understanding (MOU) between the Nairobi and Ugandan Securities exchanges would allow the cross listing of securities across the two exchanges.

An upgrade of the NSE website in 2007 allowed faster access to trading information regarding to share trading and also boosted the data vending business for the exchange. The NSE 20-share Index was also reviewed to ensure the strongest of the listed companies comprised the index.

In 2008, the NSE All Share Index (NASI) was introduced as a measure of overall market capitalisation as opposed to a measure of selected companies. With regards to handling client concerns, the NSE formed the Complaints Handling Unit (CHU) in 2009. The body is mandated to handle any issues raised by clients conveniently, either through e-mail, short message services (sms), fax or over the telephone. This has certainly improved service delivery by the exchange. The year 2009 also government bonds included in the ATS, getting rid of the tedious paper work that was then characteristic in trading bonds and making the process automated.

The NSE was renamed to the Nairobi Securities Exchange in 2011 to reflect its strategic plan, which includes support in trading, clearing and settlement of equities, bonds, derivatives and other financial instruments. The equity settlement period also improved from T+4 settlement cycle to the T+3 settlement cycle. This means that investors who sold their shares would be compensated three days after the sale of their shares and the buyer's share account would be updated to reflect the buy in the same time period.

The Broker Back Office (BBO) also started operations by facilitating online trading and improved accessibility to the stock market. November 2011 saw the FTSE NSE Kenya 15 and FTSE NSE Kenya 20 indices being introduced as alternative indexes in a bid to expand the market's appeal globally.

In July 2012, the NSE and the Central Depository and Settlement Corporation (CDSC) jointly announced November 2012 as the date for dematerialisation of all listed securities. A dematerialised security is defined as one which has been prescribed by the CDSC under section 24 of the Central Depositories Act, whereby the underlying physical certificate is no longer *prima facie* evidence of ownership under the Companies Act Cap 486 on or after the dematerialisation date (Central Depositories Act, 2000). Arnold (2010) defines dematerialisation as the elimination of share certificates as evidence of financial security ownership to the use of electronic records.

1.3.3 Demutualisation of the Nairobi Securities Exchange

Demutualisation is the gradual process of converting securities exchanges from non-profit and member-owned organisations to profit oriented and investor owned organisations (Islam and Islam, 2011). Basically, it is summarised as separation of ownership of the exchange from the right to trade on such an exchange (Capital Markets Act, 2010). In the current mutual model of the NSE, ownership of the exchange requires one to be a stock broker. This means that ceasing to being a stock broker automatically leads to loss of shareholding of the NSE.

Demutualisation of the NSE will end this mutual relationship between ownership and brokerage rights. Traditionally, exchanges have been owned nationally, but this is quickly changing to the global model that has no loyalties to any particular markets. This will provide investors, both national and international, access to trading and get rid of stock exchange members that derail trading system expansion attempts.

Africa, sensationally referred to as an emerging market, is host to a number of stock markets across various countries on the continent (Africa Progress Report, 2012). Empirical studies on the African markets have found evidence of markets in favour of the weak form EMH, an example being the Johannesburg Stock Exchange (Smith et al, 2002). Magnusson and Wydick (2002) also concluded that the Johannesburg Stock Exchange was weak form efficient while a study conducted in 2003 by Appiah-Kusi and Menyah, also found stock markets in Kenya, Egypt, Mauritius, Morocco and Zimbabwe to be weak-form efficient. Earlier studies on the Nairobi Stock Exchange (now the Nairobi Securities Exchange) concluded that the evidence supported weak-form Efficient Market Hypothesis (Dickinson and Muragu, 1994).

1.4 Statement of the Problem

The NSE has been a good avenue for channeling capital and resource allocation on the individual, corporate national level but its full potential is yet to be achieved. To attract more investors, it is vital that potential investors know whether the NSE is a market in which every investor has a fair chance of making a fair return. Reviewed literature has shown that there is a very strong correlation between equity market development and a country's economic growth. In fact, stock markets enable an economy to ensure long term commitments in real capital and also act as an indicator of economic health (Ologunde, Elumilade and Asaolu, 2006). In the interest of both investors and the economy, it is important that the capital (and especially the equity markets), pass at least the minimal hurdle of informational efficiency (Magnusson and Wydick, 2002). Limited research has been conducted on the efficient market hypothesis of the NSE (Parkinson, 1984; Dickinson and Muragu, 1994; Olweny, 2012), with the last weak form test on efficiency dating back to almost 20 years. The stock market has developed admirably in the last few years, but more studies need to focus on the assimilation of new information on stock prices and whether some investors have an unfair advantage over others. To attract more investors, it is vital that potential investors know whether current stock prices are updated to reflect all relevant information and if a common investor using a buy-and–hold strategy and a seasoned trader using technical analysis can make the same return. This is done by testing whether successive stock prices and returns have any correlation and whether they form a predictable pattern over time to give some market players an advantage over others. This study therefore seeks to test the efficiency of the NSE with regard to quick assimilation of all relevant information to reflect on current stock prices.

1.5 Research Objectives

The general objective of this study was to test the weak-form efficient market hypothesis of the Nairobi Securities Exchange.

1.5.1 Specific Objectives

The specific objectives were to:

1.5.1.1 Test whether successive daily market returns are random.

1.5.1.2. Test independence of successive stock market returns on the NSE.

1.5.1.3. Test presence of a unit root in the NSE daily market return time series model.

1.6 Research Questions

1.6.1 Are successive daily market returns on the NSE randomly generated?

1.6.2 Are successive stock market returns on the NSE independent of each other?

1.6.3 Is there presence of a unit root in the NSE daily market return time series model?

1.7 Scope of the Study

In this study, the researcher used the Kenyan Capital Markets, in specific the Nairobi Securities Exchange as the data under study. The study used the daily closing NSE 20 share index from the period January 2008 to December 2012; with the securities under study being equities. Autocorrelation test, Runs test and Unit Root test were performed to test for independence of stock market returns, randomness of successive price changes and stationarity of the time series model.

1.8 Justification of the Study

Market efficiency is not only important to investors but also to companies listed on the Nairobi Securities exchange. Investors would benefit from the results of the study by knowing whether the market reflects the 'fair' price of a given stock *per se*, since the current price of the stock would be independent of the previous day's price for an efficient market. This would empower investors when making the all-important investment decision. On the part of the managers of the listed companies, knowing the efficiency of the NSE would help gauge how well their companies are placed in the market and the kind of environment their companies are operating in. New listings on the NSE cannot be written off after the study was conducted. This is especially after recommendations to further enlighten the public on the advantages of listing on the bourse were given. This is supported by the fact that many companies need capital injection into their organizations but lack the means to do it.

Given that Kenya is among the frontier markets in Africa and the entire world, a study on the Efficient Market Hypothesis on the Nairobi Securities Exchange was rather essential for the country's economic benefit. Foreign investors are willing to invest their finances in these markets, especially given the stale nature of economies in Europe and the USA. This, however, depends on the kind of markets they encounter, in terms of risk and return promised on their investments. This can be measured through efficiency of the markets and in specific the stock markets, which gauge an economy's economic health in one way or another. This study helped market Kenya as not only a frontier market, but also as THE frontier market.

In line with Vision 2030 of making Kenya a middle income earning country, the study was seeking to determine the efficiency and performance of equity companies. This is in tandem with financial and economic reforms that were proposed and implemented from the 1990s to promote financial liberalization. Are we at par with the world with regards to this?

1.9 Limitations of the Study

A number of difficulties were encountered in the course of conducting the research. They include the following;

1.9.1 The data was expensive to obtain from the NSE and this is expected to slow down the research process since the funds will have to be obtained from a sponsor.

1.9.2 The change in the number of listed companies has been shifting over the years under study, ranging from new listings to delisting of others. This fluctuating data is problematic, since the data cannot be adjusted to include these factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Efficient Market Hypothesis

The efficiency of capital markets can be regarded to as the capability of the financial markets in processing information in due time, to reflect on given asset prices (Yeng and Lee, 2008). Therefore, information efficiency becomes a critical proponent in this study. Both supporters and critics of Efficient Market Hypothesis primarily use stock markets in their research for three (3) main reasons; Stock markets were developed a long time ago and are still predominant in the capital markets there, the pioneering researchers in this area of study promote patterns of stock behavior in their studies on informational efficiency and stock price movements possess similar characteristics to other financial instruments; hence the patterns are assumed to be the same and are equally applicable.

Fama *et al* (1969) described an efficient market as one which adjusts rapidly to information. Later on, however, it was evident that rapid adjustments, although a critical aspect of market efficiency, was not the only element. Fama (1991) re-defined an efficient market as one which fully reflects all the available information, past, present and future in the asset prices. Informational efficiency not only means that a market is able to process new information into stock market prices in a market, but also that the information is systematically and quickly processed to reflect in present prices of stocks. In such a market, it is not possible for any investor to make abnormal profits, since current prices are reflective of current information or announcements (Azad and Bashar, 2010).

Another angle to explain the Efficient Market Hypothesis (EMH) is that the argument holds if all the available information was obtained at no cost at all. If, however, the information was obtained at a cost, a financial incentive motivated the investor to obtain it. No financial incentive would exist if all the information regarding the asset would be reflected fully in the current asset prices.

2.1.1 Forms of market efficiency

Market efficiency can be categorized under three forms, namely weak, semi-strong and strong efficient market hypothesis.

Weak form efficient market hypothesis

Also known as the Random Walk Model, the weak form EMH assumes that all the previous prices and information are reflected in today's stock prices. It further implies that a stock's price cannot be predicted on the basis of previous rates of return or any other historical market data, including trading volume or short interest. Technical analysis cannot predict future security prices and all past stock price data is available to the public at no cost. In case any data would be used to predict any future prices, investors would use this to make above average profits.

Dyckman and Morse (1986) explained that the random walk basically implies that the direction and price of a given stock is unpredictable, given the body of knowledge regarding that stock. The weak form EMH downplays chartists' (traders who employ technical analysis) advantages in the market by arguing that in an efficient market, no form of analysis on past information regarding a stock can predict a future return. The trader is no different from the ordinary investor who uses a simple buy-and-hold strategy for their portfolio, since all there is to know about the stock is public and available to all investors.

Information in an efficient market is also available to the public at no extra cost, eliminating any sort of informational advantage insiders would have to make abnormal profits from the stock market. If any data would be used to predict future returns for stocks, the market would cease to be efficient, since the pattern eliminates the random walk in the stock prices. Market anomalies have however been observed in markets regarded as efficient, where investors are able to predict the movement of share prices. They include time-of-the-year effects (where the prices tend to fall in December and rise in January) and day-of-the-week effects (share prices falling on Friday and rising on Monday. These patterns have been observed in markets all around the world and little evidence that would suggest investors can use this to make above normal returns exists (Sharma and Mahendru, 2009).

Tests on weak-form EMH include tests for independence of successive price changes or returns (conducted using serial correlation or autocorrelation tests) and tests on existence or absence of a pattern in successive stock price changes or returns (using a runs test). The absence of correlation among past stock prices indicates independence while lack of a pattern in successive price changes indicates randomness, hence efficiency of the market in weak form. Others include testing for the presence of stationarity by performing a unit root test. Presence of a unit root (stationarity) indicates that the prices follow a sequence, thereby making the market inefficient in the weak form.

Semi-strong form efficient market hypothesis

The semi-strong form EMH implies that all public information is calculated into the current price of a stock. Such information includes fundamental information on a company's product line, balance sheet structure, performance of managerial staff, patents held by the company, accounting principles adopted by the company and the company's forecasted earnings. An investor would expect all this information to be reflected on the share price. It further suggests that neither technical nor fundamental analysis can be used to achieve to the advantage of making superior gains.

This form of EMH implies that all public information regarding a stock is available and immediately incorporated into the current share price. This information includes company reports on profits and losses, dividend payouts, stock splits and even forecasted company revenues. The market reacts differently to announcements regarding accounting information such as a rise or fall in profits. Returns during the week of a major announcement with regard to listed companies' revenues were sixty seven percent (67%) higher than normal trading weeks, with the preceding and following weeks posting lower returns of just under ten percent (Beaver, 1986). Any attempt by investors to acquire such information with an intention of making bigger profits than the rest of the investors would be in vain in this form of market.

Other information such as the Price to Earning (P/E) ratio, Price to Sales (P/S) ratio and Market Value to Book Value (MV/BV) ratios also affects share prices and especially portfolio performance (Aga and Kocaman, 2008). In their research, Aga and Kocaman (2008) argue that over time, portfolios created based on lower end-year MV/BV ratios can outperform the market and obtain above average returns compared to the rest of the market. The study goes further to suggest that lower P/E and P/S ratios can also earn a company higher revenues.

Testing the semi-strong EMH can be performed by measuring market reaction to accounting information and stock splits. Accounting information is gauged by comparing current and aggregate accruals and cash flow to the stock market returns. The value of the stocks is expected to rise when accrual information is favourable as compared to the cash flow, proving the importance of earnings compared to cash flows. Stock splits are also a price mover. Prior to a stock split, the share prices shoot upwards with speculation of better profits but after the split, the prices drop due to the absence of an above-average return on the stocks. Another test for semi-strong EMH is testing for anomalies in the market, such as post-announcement price drifting, small-firm-in-January effect and book-to-market ratios. Neither fundamental nor technical analysis can be used to an investor's advantage to make abnormal returns in a semi-strong efficient market.

Strong form efficient market hypothesis

The strong-form EMH asserts that all information, both public and private (Insider information) is reflected in the current price of a share. Above-average profits cannot be consistently derived from this form of market by any investor. It conflicts laws on insider trading, in that analysts, after all, are within their job descriptions of unearthing information on a company that was previously not available to the general public.

Private information with this regard is known as insider information, which is only known to traders and company insiders, alongside their relatives and close associates. Any additional information known to either investors or traders is useless in such a market, since all the relevant information is known to all market participants. This form of EMH is considered rather extreme, since it is obvious that company insiders have access to such information long before it is made public. The market is considered rather extreme and flawed, since company insiders will always have first-hand information regarding the company before it is released to the public. It is in their job definition to unearth company information that was previously not known to them and make it public to all investors.

Efficiency tests on such a market are carried out on the inside information in a company that is listed and knowing how much a company holds on to this information before releasing it to the public for eventual market correction on the share prices of the company. Corporate governance issues also come into play in testing strong-form EMH.

2.2 Empirical Evidence Supporting the Efficient Market Hypothesis

Fama (1965) reviewed the EMH and stated that the major issue regarding the Random Walk Model was testing whether the hypothesis that successive price changes are independent. The Random Walk Model had been tested using two methods; the first approach was testing the various mechanical tools of trading to conclude whether they result to greater profits as opposed to the buy-and-hold strategy. This was for the sole purpose of an investor or an individual trader. The second approach relied primarily on statistical methods, namely correlation and runs tests. Fama then stated that up to then, research was primarily using statistical tools to determine the independence of successive stock price changes.

Kendall (1953) began testing whether a sequence of numbers displayed random characteristics by using four tests. First, he determined using a frequency test whether numbers in a given sequence of numbers were close enough to show any form of relationship, using chi square. He went on to compare the randomness of the numbers by comparing his idea of the number sequence to a roll of dice. A roll of the dice would give you six probable numbers and a constant number of results over a longer time period. This goes to show how independent the numbers are. Kendall advanced his idea by using a second test, a serial test, to compare a set of numbers and look for any correlation. This solved the problem of using huge numbers by just pairing two numbers. The gap test was the third test he employed, whereby he measured the number of expected gaps in a series. An example was counting the numbers that fell between two zeros in a number sequence and taking those numbers as the probability of occurrence. The last test was the poker test, which tested sequences with five or more digits. A series that passed all the four tests was considered random.

Samuelson (1965) and Mandelbrot (1966) cemented Kendall's ideas by explaining that a market with random stock returns is a perfectly normal market, since no investor had an unfair advantage over another. Both authors argued that competition was the main ingredient of a good market and that investing in the stock market was a fair game in which traders wouldn't expect to make extra ordinary gains by virtue of having informational advantage over other market investors. The main attraction of the fair game was that no one had any advantage over the other investor and future stock prices were unpredictable to keep the game open for any investor.

Fama (1970) then reviewed all the work done on efficient capital markets and distinguished the hypothesis into three forms, namely the weak-form, semi-strong and strong forms of market efficiencies. The weak form argues that technical analysis cannot be used to make above average stock market returns, the semi-strong form argues that neither technical nor fundamental analysis can be used to an investor's advantage and the strong-form EMH assumes no insider information is used to gain unfair advantage in a stock market.

2.3 Theory of Random Walks

The Random Walk Theory implies that a current stock price is completely independent of and unrelated to past market price patterns (Horne and Parker, 1967). The theory goes further to imply that it is impossible to predict future stock prices based on past price movements. The current price of a given security represents the market's best estimate of the stock's 'intrinsic' value based upon all information that is available. This intrinsic value is derived from fundamental analysis done on the company to predict future earnings. Any new information that comes up automatically triggers a revision on the company's stock price. Thus, the stock prices are said to be non-stationary (Gujarati and Porter, 2009).

The theory of random walks also posits that assimilation of new information into the market is such that any deviations from the intrinsic value are random. Any systematic deviations, however, would imply that a pattern in the stock prices exists, leading to market participants making abnormal profits from the opportunity. Arbitrage actions in such a situation would cancel out the efficiency of a stock market.

Availability of information regarding stock prices allows all market participants to compete fairly until all fluctuations that are not random from the intrinsic value become almost nuanced that no investor can exploit them for profit. The theory finally argues that a trader using technical analysis (also known as charting), will not get better profits than a trader who uses a simple buy-and-hold strategy. One of the reasons for testing the random walk theory is to find out if mechanical trading rules can be used by a chartist to obtain above-average profits compared to the buy-and-hold strategy.

The random walk theory has often been compared to a drunkard's walk back home after a night out. On leaving the bar, the drunkard takes a couple of steps forward and moves some steps back. By continually walking randomly, he eventually drifts further and further away from the bar, until he finally gets home. It would be impossible to obtain a pattern of this walk, since the movement is completely random. The same could be said of stock prices in an efficient market; today's stock price is the same as yesterday's stock price, including a random shock (Gujarati and Porter, 2009).

2.4 Mathematical Presentation of the EMH

In 1970, Fama proceeded to present the Efficient Market Hypothesis mathematically in the following equation;

$$E(P_{j,t+1} / \Phi_t) = [1 + E(r_{j,t+1} / \Phi_t)]\, P_{jt} \quad (2.1)$$

where, E is the expected value operator, P_{jt} is the price of security j at time t, $P_{j,\,t+1}$ is the price of security j at time t+1, $r_{j,\,t+1}$ is return in percentage over one period, equal to $(P_{j,\,t+1}-P_{jt})/P_{jt}$, Φ_t is the symbol of the given set of information assumed to be "fully reflected" on the price of security j at time t.

2.5 Efficient Market Hypothesis in Emerging Markets

Globalisation has led to an increasingly integrated world economy, including financial and capital markets. This means that foreign direct investments have been surging ever since, especially to emerging markets, with African economies being labeled as one of the leading frontier markets in the world.

Low correlations between African and global stock markets, excluding South Africa, offer international/Foreign investors portfolio diversification opportunities (Moin, 2007). Capital markets in Africa are beneficial to both the foreign investor and the developing economy. On their part, investors from developed economies are normally capable of undertaking the bigger risk associated with emerging economies (Snowden, 1997). The reward for this is certainly high returns. However, stock markets around Africa are regarded as thin markets and are subject to insider manipulation in favour of company insiders and to the expense of public investors. It is therefore vital that equity markets in emerging economies should at least pass the lowest hurdle of speculative efficiency (Magnusson and Wydick, 2002). Earlier studies on market efficiency concluded that no stock market is strong-form efficient, although research on mature markets in developed economies rejected hypothesis on weak and semi-strong market efficiencies.

Chan, Gup and Pan (1992) concluded that stock markets in Singapore, Hong Kong, South Korea and Taiwan were weak-form efficient after the unit root tests confirmed the stocks conformed to the Random Walk model. The Shanghai and Shenzhen stock markets were also found to be of weak form efficiency, after presence of the unit root showed that the stocks patterns were characterized by a random walk (Liu *et al*, 1997). Inefficiency between the stock markets, however, indicated inefficiency, since co-integration tests proved that investors could use past stock prices in one market to predict stock prices in the other. Testing efficiency in emerging markets should take into account the high volatility, non-linearity of share price variation and infrequent trading (Todea, Ulici and Silaghi, 2009).

Hadi (2006) in his study of the Efficient Market Hypothesis on the Jordanian Stock Exchange concluded that the equity market reacted differently to company announcements, that is, new information on profitability, solvency and liquidity.

On a study of the Bombay Stock Exchange, Sharma and Mahindru (2009) found out that the BSE was weak-form efficient. Autocorrelation and Runs tests were conducted to determine if the stock exchange was efficient in weak form. At first, the auto-correlation test gave conflicting results to the runs test gave conflicting results to the runs test but the series was then differenced and the autocorrelation test done to finally give a final conclusion.

Kubota and Takahara (2003) investigated stock market predictability in Asia by investigating whether financial firms' announcements create value within an asset pricing framework. They used a financial sector model, which explained the risk-return structure of Japanese companies, thereby indicating some degree of predictability of Japanese equities/stocks.

In his study of the Hong Kong Stock Exchange, Jarret (2008) argues that as long as closing prices, indices and returns on markets exist, it is possible for investors to forecast the stock price patterns and use this information to their advantage. He further argues that daily variation of the stock prices is neither random nor stochastic and prediction of daily stock patterns, with a certain degree of accuracy, is actually possible.

Finally, a study on four Asian markets (India, Hong Kong, China and Japan) found evidence in favour of weak-form efficient market hypothesis. Variance ratio, unit root and auto-correlation tests showed that the four markets did not adhere to weak-form market efficiency, declaring the whole sample inefficient (Patel, Radadia and Dhalian, 2012).

2.6 Empirical Evidence against the Efficient Market Hypothesis

Only in the case of mounting anomalies, will an alternative paradigm replace a prevailing paradigm (Kuhn, 1970). The above statement was said by an economist, one of a couple that was against the Efficient Market Hypothesis. Sweeney (1988) reviewed the empirical evidence on earlier studies and concluded that filter rules scrutinized by Fama and Blume (1966) could have earned investors in stock markets returns in excess.

Le Roy (1989) claims that a major bias in testing the EMH concluded that empirical evidence for

EMH was documented while evidence against it was simply ignored, without further scrutiny. Taylor (1982) highlights the use of biased methods in testing EMH. In his study, he replaced the traditional autocorrelation coefficient test with an advanced test statistic. The results rejected the RWH and supported price-trend hypothesis. He further went on to state that the normal test statistics used in testing the EMH never rejected the RWH, since they are naturally not powerful enough in studies involving trends.

Later on, in 1984, a major challenge came up on Famer, Fisher and Roll's (1969) work. Fama *et al* (1969) in their study investigated the effects of a stock split on the price movements of the stock. The researchers expect that no price movements should be observed, but interestingly, the stock prices react to the stock split announcement. The authors then argue that the investors are using the announcement in predicting future prices for the company and that such an announcement is rather 'seemingly' nominal and not 'truly' nominal. This then implies that empirical results in earlier studies may have flawed interpretations, further consolidating rejection of the EMH. Regarding this, Boldt and Arbit (1984), point out that the empirical evidence suggests a steady change in price regarding the stock split announcement. This meant that the investors gradually discovered the news on the stock split, explaining the gradual change in price. This greatly dented the study, which had concluded the market was semi-strong form efficient, since in such a market, investors would have quickly reacted to the information and made a quick buck in the stock.

Jensen (1978) welcomes the evidence against EMH and says that evidence inconsistent with EMH cannot be ignored. He goes further to discredit the Joint Hypothesis testing (market efficiency and a two parameter equilibrium model of determining the price of an asset) and points out that the fault could arise either because both hypotheses are false, or the joint hypothesis is not true.

In 1984, D`Ambrosio points out those idiosyncratic market phenomena should now prompt the challenging of the EMH, since the theory had gone unchallenged for too long a period. He pointed out these idiosyncrasies as inclusive of; the value line phenomenon, the weekend effects, junk stocks, low beta portfolio performances, low price-earnings ratio, small firm effect, information coefficients, low priced stocks, sector rotation and turn-of-the-year effect.

Fama (1991) later softens his stand after the challenges on empirical evidence supporting EMH are published in the 1970s and 1980s. Fama states that market efficiency is not testable and challenges the joint hypothesis testing. He also admits that insiders in listed companies have access to private information that is not available to the general public, hence the semi-strong EMH he earlier supported, he now questions.

Thaler (1993) welcomed the rejection of the EMH and went beyond recognising market anomalies and suggested that studies into behavioural finance be carried out to further explain capital market efficiency. In 1999, Haugen expresses that the EMH had been completely stretched and it was now up to the supporters (promoters) of EMH to provide further proof supporting the theory. He further stated that the investors' blunder in reacting without thought to announcements such as good profits or profit warnings and stated that good investors went ahead and first analysed the information to create a good portfolio. According to Haugen, the risky stocks are expected to produce the lowest returns, while the least risky stocks give the best returns later in the future.

Koonce (2001) exclaims that market efficiency is also studied under three basic assumptions of traditional market efficiency; Investors are rational, Irrational investors are random in their behaviour and therefore do not affect stock prices and assuming that the investors are systematically irrational, there automatically exist rational arbitragers who cancel out any influence they have on stock prices.

In reply to this, Schleifer (2000) expresses that investors are biased in their decision making and explains that behaviors portray that the investors are systematic and not random. He further argues that ultimate arbitrage is not applicable everywhere, hence the basic assumption of rationality of investors and in general the EMH is questioned.

Further exploration into empirical literature of the earlier decades brings to light arguments that openly rejected the EMH, or rather questioned the findings supporting the theory. It should not be out rightly assumed that capital markets are efficient and react expectedly to information or announcements released to reflect on current stock or asset prices. The major challenge economists are facing is to embrace this reality into their models (Shiller, 2003).

2.7 Efficient Market Hypothesis and its Studies on Africa

Stock markets in Africa have surged from 8 in the year 1989 to 26 in 2008 (Databank Group, 2008). Despite this, they are segmented and have inefficiency, making them small, illiquid and uncompetitive on the international stage of financial markets (Ntim *et al*, 2011). It has been suggested that only solution to this problem is integrating regional, or better yet, the whole continent's stock markets to beat some of these inefficiencies (Abumustafa, 2007). By operating as a single block, this would strengthen the capital markets to extremely strong, efficient markets. Abumustafa goes ahead to define stock market integration as a process that sees to it that an investor, regardless of their financial means can buy or sell shares in any stock market without restrictions or impediments and Stock prices across the whole continent would be the same in all the markets across Africa.

Smith *et al* (2002) group African stock markets into four categories:-

2.7.1 South Africa – This is the biggest and most established market in the continent, not to mention it is the most sophisticated. This is in terms of size (market capitalization) and liquidity.

2.7.2 Medium size markets - These markets have been around for a while and are stable and larger than the rest (excluding South Africa). They include Kenya, Egypt, Zimbabwe, Morocco, Nigeria and Tunisia.

2.7.3 Small but rapidly emerging markets – They have little capitalization and have fewer listed companies operating on their bourse. Such markets in Africa are found in Ghana, Botswana, Cote d'Ivoire, Namibia and Mauritius.

2.7.4Extremely small markets – Recently established and yet to completely take off. Tanzania, Zambia, Mozambique, Libya, Malawi, Uganda, Sudan, and Swaziland are in this category.

Non-parametric variance-ratio tests were conducted on 8 African stock exchange markets, with the evidence rejecting weak-form EMH and further implying that these markets were inefficient and predictable (Ntim *et al* 2011). This consequently means that even after incurring transaction costs, investors could exploit these inefficiencies and make profits out of these (Collins and Abrahamson, 2006).

African markets are quite small in the context of global markets, with the exception of South Africa. In 2003, the 15 stock markets (excluding South Africa) on the continent, accounted for a mere 0.2% of the entire world stock market capitalization (Standard and Poor's, 2004). Although small in size, turnover in these markets has increased, giving higher returns to investors. Despite being highly volatile, African markets also exhibit low correlations with international stock markets (Jefferis and Smith, 2005).

Growth in size of stock markets in Africa has been attributed mainly to economic reforms that have included among other things, a decline in the role of government in economies, coupled with the strengthened role of the private sector in these economies. Due to this move by governments, price determination has been left to market forces. Privatisation has also entailed making public some of the state owned companies, through listing on stock exchange markets. This entails offering new shares in the market, which in turn improves liquidity and offers investment opportunities to existing and new investors. Because of such programs (privatization), increased attention has been paid to African markets by foreign investors, who naturally seek to diversify their portfolio in risky emerging markets, which translates to higher returns.

Barriers to entry into the African market by foreign investors have also been eased, through liberalisation of exchange controls on capital and current controls, thereby easing entry and exit of the markets (Jefferis and Smith, 2005). Liquidity is also a major hurdle to development of markets in Africa, with turnover ratios (ratio of turnover to market capitalization), being too low.

South Africa is the biggest and ultimately the most liquid market, recording a turnover ratio of 44%, while the same ratio in developed markets is normally above 100%. This is attributed to both sides of the market, with the supply side being characterized by controlling interests holding most of the shares. This leaves very little amount of shares available for public trading.

Increasing the size of stock markets through regional integration are some of the policies that could be adopted to help improve efficiency. Innovations like free access by foreign investors, electronic trading systems, faster settlement, faster dissemination of information or announcements, and adjusting legal framework to adhere to international standards could also improve efficiency (Odera, 2012). Odera further suggests that market efficiency will remain elusive if professionalism and market regulations are not enforced.

Studies regarding the efficiency of stock markets in Africa have also been on the rise over the past decade, since Africa is considered an emerging market. Earlier studies were conducted by scholars such as Dickinson and Muragu (1994) portraying African markets (in this case the Nairobi Securities exchange) as an efficient. Since then, remarkable effort has gone into studying African stock markets, with varying results coming from these studies.

African stock exchanges are the smallest with regard to listed securities and market capitalization (Mlambo and Biekpe, 2007). Vitali and Mollah (2010) conducted the Random Walk Hypothesis test on stock markets in Kenya, South Africa, Mauritius, Egypt, Morocco, Nigeria and Tunisia. Their findings indicated that all markets in the study, except South Africa, were weak-form inefficient, since the Random Walk Hypothesis was rejected. This basically means that the security prices do not reflect all historical information.

Little is still known about efficiency of the continent's stock markets, since there is difficulty in accessing sufficient data for empirical research (Simons and Laryea, 2006). One of the pioneer researchers on stock market efficiency in Africa includes Samuel and Yacout (1981). In their study of 21 listed Nigerian firms over a period of 2 years, their research concluded that Weak-Form efficiency of the market could not be rejected. Parkinson (1984) while using autocorrelation tests on the Nairobi Securities exchange concluded the 30 listed stocks to be weak form inefficient. In 1994, Dickinson and Muragu, using 30 listed firms in the NSE, found the firm to be weak form efficient.

In a study of Botswana, Kenya, Mauritius, Zimbabwe, Ghana, Cote d'Ivoire, Nigeria and, South Africa, Magnusson and Wydick (2002) used partial autocorrelation in examining monthly stock returns. Excluding Zimbabwe and Ghana, the stock markets showed signs of weak-form efficiency. Smith *et al* (2002) used multiple variance-ratio tests on eight African stock market indices and concluded that the markets were weak-form inefficient. Similarly, Jefferis and Smith (2005) determined that African stock markets were weak form inefficient. In their study, a GARCH model was applied on weekly stock market indices to determine serial-dependence, after which weak form efficiency was rejected using the Africa All Share Index, Ntim *et al* (2011) found that the stock indices across the continent were not normally distributed. Using ranks and signs test, the study concluded that the majority of stock indices were weak form efficient. Eight individual stock markets were also picked and the same test performed, resulting in weak form inefficiency of the same market. The study further pointed out that there was significant improvement of informational efficiency of the Africa All Share Index, compared to individual stock markets. The implication of this is that price discovery and eventual efficiency of the African stock markets would significantly improve if markets were to integrate their operations.

Vitali and Mollah (2010) used multi approach methods (unit root, runs test, autocorrelation and variance ratio tests) to test the random walk hypothesis in 7 African stock markets. Only South Africa proved to be of weak-form efficiency, with the random walk hypothesis being rejected in the other countries. The conclusion was that share prices did not assimilate in the market fast enough to reflect on current stock prices. Ina a study of the Nigerian Stock Market, it was noted that although the market has developed significantly over the years, it remains informational inefficient (Nwosa and Olasunkanmi, 2011). The authors further point out those financial analysts in the market use historical pries in the data to make above normal profits from the market. Olowe (1999) found the same in his study of the Nigerian Stock Exchange.

2.8 Constraints to investing in African Equity Markets

Several unique features of African equity markets are considered constraints for foreign investors seeking to benefit from stock markets in Africa, which naturally gain this advantage through low market correlation (Moss *et al*, 2007).

2.8.1 Scale of the Market

African markets are explicitly small, with a market capitalization of $573 billion for the entire Sub Saharan Africa as of August 2011 (Bloomberg, 2011). The larger markets in Africa have capitalizations of $478 billion for South Africa and $40 billion for Nigeria (Bloomberg, 2011). In comparison, single listed companies in the USA have capitalization of approximately $4 billion, the size of an entire country’s stock exchange in Sub Saharan Africa. With reference to Gross Domestic Product, African equity markets range between 10% and 20% of a country’s GDP. This is excluding South Africa, whose GDP is at par with the listed firms’ capitalization rate of about 100% in the Johannesburg Stock Exchange (Standard and Poor’s, 2011).

2.8.2 Market Liquidity

Data from Standard and Poor’s (2001) indicates low turnover ratios, with Nigeria and Kenya recording 13% and 9% respectively. Other markets recorded turnover ratios of 4% and below.

Brazil and India, developing countries also, recorded similar ratios of 75% and 66% respectively. Equity markets in developed economies, on the other hand, constantly record turnover ratios of 100% and above. This is especially with reference to institutional investors, who have minimum trade requirements of $1-$5 million per trade (Moss, Ramachandran and Standley, 2007). Such markets are also considered risky as a result, since an investor willing to exit a given position may lack a willing buyer when need arises. Expressly, the market increasingly loses capability of following the Random Walk Hypothesis (Smith, 2008).

2.8.3 Market Volatility

Emerging equity markets are highly volatile, with Brazil, India and China having a higher standard deviation than all Sub Saharan Africa countries between 2006 and 2011. This is with the exception of Zimbabwe. In any case, investors in African equities are well compensated for the risk they undertake in investing in these markets (Alagidede, 2009). This ultimately becomes a concern about market efficiency in these countries. Ultimately, most of the emerging markets, as mentioned above, are as volatile as African equity markets and are even less vulnerable to economic and financial crisis.

Alagidede and Panagiotidis (2010) go further to suggest that African equity markets may actually hedge against inflation. This is definitely an advantage of investing in African equity markets. In fact, volatility is more of a problematic perception than a real constraint compared to other constraints such as liquidity and scale (Moss and Ross, 2013).

2.8.4 Foreign Exchange Risk

This is still a major hurdle in investing in African stock markets, with other factors affecting the exchange rate of an economy. They include bad weather adversaries, inflation risk, global prices of commodities and unstable fiscal policies. A solution to this would be to float local sovereign debt into the global bond market to stabilize local currencies in addition to supporting fiscal balances (Moss and Ross, 2013).

2.9 Conceptual Framework

The conceptual framework provides an analytical review on the literature discussed earlier and links it to the actual research to be carried out in the study. The variables relevant to the study were introduced in this section, as well as the research hypotheses and how the researcher tested the hypotheses.

2.9.1 Variables

The daily market return, computed from the daily closing NSE 20-Share Index will be used as an individual time series variable.

Description of the variable

The study used one variable for analysis, that is, the daily market returns. The daily market returns were preferred to daily stock prices since returns make more sense to investors as compared to the stock prices. Returns are the actual results of an investment, while price does not reflect much with relevance to investors.

Name of variable	Proxy	Description
Daily Market Return	R_t	Natural Logarithm of market returns

$$R_t = \ln (P_t / P_{t-1}) \quad (2.2)$$

where; R is the Market return in period t, P is the price index at day t, P_{t-1} is the price index at period t-1 and ln is the natural logarithm of the daily market returns.

Logarithm returns are preferred because they are analytically better when linking short period returns (Mobarek and Keasey, 2000). Mobarek and Keasey (2000) also argue that empirically, logarithmic returns tend to be normally distributed.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed the research design the researcher employed in the study. Data collection techniques, the study population and data analysis used in the study were also discussed in this chapter.

3.2 Research Design

A research design is a plan, structure and strategy of investigation so conceived as to obtain answers to research problems (Kerlinger, 1986). A research design basically has two major functions; identification and development of procedures required for the study and ensuring the quality of these procedures to retain validity, objectivity and accuracy of the same (Kumar, 2012).

Based on the nature of the investigation, the researcher used a time series model, in an attempt to systematically describe whether the prices of the stocks listed on the Nairobi Securities Exchange are predictable and whether they follow a random walk model.

3.3 Study Population

The study population constituted the daily closing price index of the NSE 20-share Index for a period of five years. This was in line with the objective of determining whether the market in general is efficient in weak form for the stated period of time.

3.4 Study Sample

The daily closing NSE 20-share Index, which is an average of the twenty best performing listed company share prices, will be used in the research. The sample included 1256 daily observations from the sample period of 1st January 2008 to 31st December 2012. The study period was long enough to ensure minimal effects of short term economic fluctuations on the study (Jarrel and Kyper, 2005). The high frequency data was used to avoid the problem of thin trading that poses a serious bias in empirical studies. Thin trading is common in emerging markets, where the volume of traded stocks in a day is not as high compared to that of developed markets.

3.5 Data Collection

Secondary data was used in the study, to include daily closing NSE 20-Share Index observations from 1st January 2008 to 31st December 2012. The data was purchased online from the Nairobi Securities Exchange database, through their official website. This form of data collection was appropriate, since the study compared past stock prices to test for any dependence or predictability in change patterns.

3.6 Data Analysis

With the study adopting a time series model, univariate time series analysis was employed in analyzing the data collected. The researcher used STATA statistical package, in collaboration with Microsoft Excel to carry out the analysis. Kumar (2012) argues that statistics help a researcher make sense of data, ascertain the extent of the variables' relationships and place confidence in your findings. Descriptive statistics (tests for normality) and inferential statistics (serial correlation, runs test and unit root tests) were carried out in the research process.

3.6.1 Descriptive Statistics

Descriptive statistics enabled the researcher get a quick glance of the characteristics of the time series model of the NSE daily market return. These characteristics included the mean, median, standard deviation, skewness and kurtosis.

3.6.2 Kolmogrov-Smirnov Goodness of Fit (K-S) Test

This is a non-parametric test that is used to determine how a set of data fits a given distribution (poisson, uniform, exponential or normal). The cumulative distribution function for the daily price indices of the NSE was compared to the K-S sample to test homogeneity of the distribution. The K-S test would should show a p-value of <0.05 at the 1%, 5% and 10% significance level for normal distribution.

3.6.3 Runs Test

Also referred to as the Geary test, this is a non-parametric test that is used to test randomness of successive stock prices. This approach detects randomness, which may not be caught by the autocorrelation test. According to Reilly and Brown (2000) a run occurs if two or more positive or negative changes occur. The price change may either be upwards (+) or downwards (-). An example which may constitute a run is + +- - - + - + + + - -. A price change in the opposite direction, such as positive to negative, automatically ends a run. A run is indexed by two major parameters, that is, the mode of the run (positive or negative) and the length of the run.

The run test converts the total number of runs into a Z-Statistic. It is carried out by comparing the number of runs in the price series, $a_{r,}$ to the expected number, μ. A large sample size is assumed to have a normal distribution, hence the use of the normal distribution, Z, for the runs test.

$$Z = \frac{R - E(R)}{SD} \tag{3.1}$$

where; $R = \frac{2N_1N_2}{N_1 + N_2} + 1$ and E(R) is the expected number of runs, and (3.2)

$$SD = \frac{\sqrt{2N_1N_2(2N_1N_2 - N_1 - N_2)}}{(N_1 + N_2)(N_1 + N_2 - 1)} \tag{3.3}$$

where; N_1 is the number of positive price changes, N_2 is the number of negative price changes and SD is the Standard deviation of the distribution of the number of price changes.

3.6.4 Autocorrelation

Also referred to as the serial correlation analysis, this is a parametric test adopted to examine the independence of successive price changes of stocks. Parametric tests are used to confirm the findings of the non-parametric tests as well as the extent to of dependency also measured under various statistical methods and parameters. The autocorrelation test is used to examine whether a given set of data, in this case the NSE, follows a random walk model. The random walk model can be expressed as:

$$P_t = P_{t-1} + \mu_t \tag{3.4}$$

where; P_t is the daily closing NSE 20 share index at time t, P_{t-1} is the daily closing NSE 20 share index in the immediate preceding period and μ_t is the random term.

The price index change, $\Delta P_t = P_t - P_{t-1}$ is basically μ, which is the noise or random variable and is assumed to be unpredictable. The error term should therefore be zero (0) since tomorrow's stock prices are expected to be the same as today's thereby implying unpredictability of the stock prices. The serial correlation coefficient measures the degree of dependence between itself (µt) and its value earlier (µt-n) can be expressed as;

$$r_n = \frac{Co\,\mathrm{var}\,iance(\mu_t, \mu_{t-n})}{Variance(\mu_t)} \tag{3.5}$$

If the serial coefficient is zero (0), future stock prices are unpredictable and the random walk model stands.

Positive autocorrelation is an indication of return predictability while negative correlation indicates a mean reversion in returns. Mean reversion basically implies that the stock, though below the average price at the current market price, eventually rises and gets to the average price. The Durbin-Watson d-statistic was the first test to detect absence or presence of serial correlation between successive daily market returns. The value of the d-statistic was expected to lie between 0 and 4, with a value of 2 indicating absence of any serial correlation. Any values approaching 4 signify negative serial correlation while any values towards 0 signify positive autocorrelation.

Durbin's alternative test for correlation was also used, to confirm results obtained from the DW d-statistic test and the tabulated results presented.

3.6.5 Unit Root Test

Unit root tests are used to measure stationarity of a time series model. A series that is initially stationary after the first differencing is considered to contain a unit root. The presence of a unit root means the time series is non-stationary and it thus follows a random walk. The Augmented Dickey-Fuller (ADF) test was used to test for the unit root.

In the ADF test, three forms of the random walk model were considered, namely; pure random walk model, random walk with a deterministic trend and random walk with a drift. The null hypothesis would be rejected if the computed absolute value is significantly less than the critical values at 1%, 5% and 10% significance levels.

Tables, line plots and figures were used in data presentation, where the research findings were displayed. These are easy to comprehend in the presentation of statistical findings.

CHAPTER FOUR

FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter provides statistical analysis of the secondary data collected for the purpose of fulfilling the research objectives, discussed in previous chapters. Using the methodology discussed in chapter three, the data was analysed using STATA statistical package. The chapter goes further to present and interprets the findings of the study.

4.2 Descriptive Statistics

A basic assumption in testing for a random walk model is that the time series should have normal distribution. Table 1 below summarises the descriptive analysis of the distribution of the natural logarithm of the market returns.

TABLE 1

Descriptive Statistics and Distribution of the Daily Market Returns

Variable	Obs	Mean	Std. Dev.	Min	Max	Variance	Skewness	Kurtosis
ln_Rmt	1256	-0.0001794	0.0101531	-0.0804511	0.0773313	0.000103	0.6714979	15.05822

A mean of -0.0001794 was observed from table 1 above in the return series, indicating a negative average daily market returns on the on the NSE. This represents the average return an investor gets back from their investment.

The standard deviation of 0.0101531 represents the risk an investor is exposed to when investing in the NSE. The NSE is therefore a low risk investment, considering the value of the standard deviation. Risk is measured by the standard deviation and the variance, with the former being the square root of variance. The standard deviation gives the original unit, the daily market return in this case, as opposed to the squared unit when variance is considered.

The minimum daily return of investing in the NSE is -0.0804511, with the maximum daily return an investor can make being 0.0773313.

Skewness was used in the data analysis to indicate asymmetry and general distribution of data from normal distribution. The observed skewness of 0.6714979 indicated that the data was right skewed. This means most of the data was concentrated to the left of the mean, with extreme observations distributed to the right of the mean.

Kurtosis is an indicator in data analysis used to show the sharpness or flatness of the peak of observations. The kurtosis value 15.05822 indicated a sharper than normal distribution of observations. The distribution of values was around the mean, with thicker tails and this implied that extreme values were many in the time series. This is referred to as a Leptokurtic distribution.

To confirm the findings of the distribution of data in the series, a non-parametric test in the form of the Kolmogorov-Smirnov (K-S) test was applied to the time series and the results presented in table 2 below.

TABLE 2

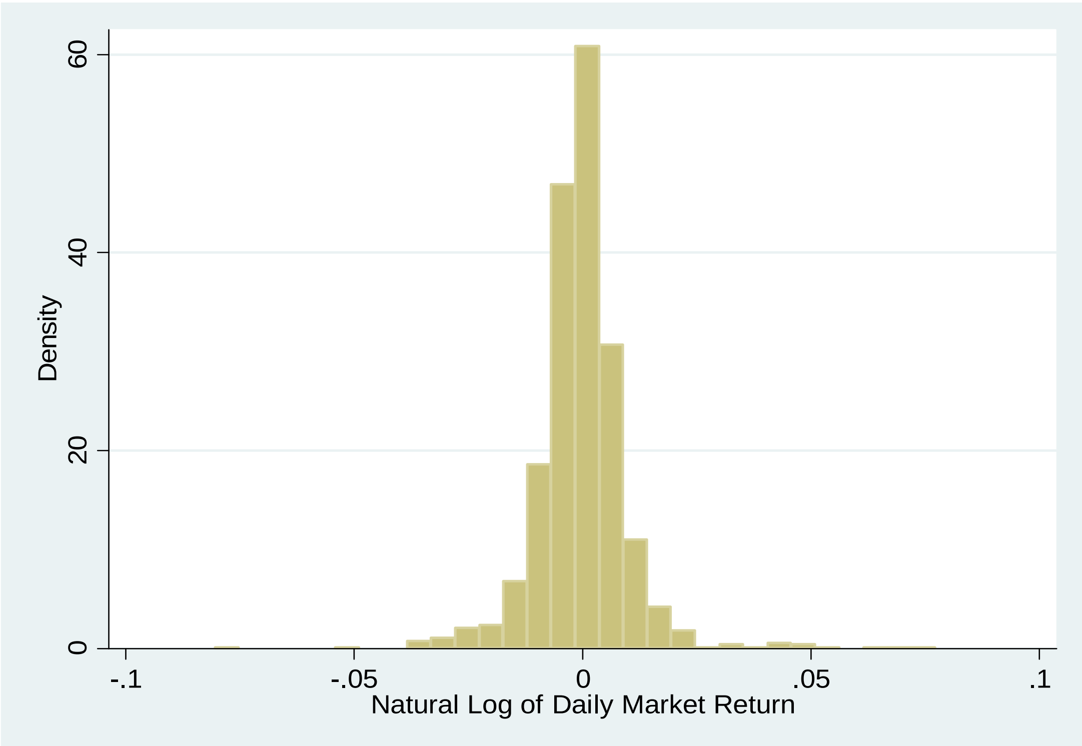
Kolmogorov-Smirnov Test on the NSE Daily Market Returns

Smaller group	D	P-value	Corrected
ln_Rmt:	0.9626	0.000	
Cumulative:	0.0377	0.028	
Combined K-S:	0.9626	0.000	0.000

The test compared the cumulative distribution to K-S sample to detect homogeneity between the respective values. The D value represented the test statistic or difference and the P and combined K-S values represented the chances of observing the D value or more extreme values. Since the P value is <0.05, the null hypothesis that the data was normally distributed was not accepted and the return series was therefore not normally distributed. To complement the K-S test for normality, a histogram was generated to show the distribution of the data, as shown below.

FIGURE 1

Distribution of the NSE Daily Market Return Series



The time series data appears to be skewed to the right, with extreme values on the right side of the histogram. This certainly means that the data is not normally distributed, since a mirror image would not be replicated if figure 1 above would be split right down the middle. The major implication of having asymmetrical data is that one assumption of the random walk is that the data should be normally distributed. Absence of normality in the time series model meant that the researcher had to include non-parametric tests, which are better used for non-normal data, although both tests were performed for consistency of results.

4.3 Runs Test

This is a non-parametric test that was employed to detect randomness of data in the daily market return series. The runs test ignores the distributional properties of data, regardless of normal or non-normal distribution of data.

TABLE 3

Runs Test on the NSE Daily Market Returns - 02 Jan 2008 to 31 Dec 2012

N(arma23 <= 6.60688215465e-06) = 628
N(arma23 > 6.60688215465e-06) = 628
obs = 1256
N(runs) = 596
z = -1.86
Prob>z = .06

The runs test results were presented in table 3 above with the probability value being greater than alpha (0.05). This means that the value of z (-1.86) fell between the required ± 1.96 for the time series to be random. The null hypothesis was therefore accepted and the return series was said to generate successive returns randomly.

4.4 Autocorrelation Tests

Autocorrelation tests compare the value of current market returns to previous market return values to detect any form of dependence between the values. A random walk model is supposed to have independent change of market returns, a condition which was tested in the study.

The Durbin-Watson test was used to test for autocorrelation. The findings were presented in table 4 below.

TABLE 4

The Durbin's Alternative Test for Autocorrelation

lags(p)	chi2	df	Prob > chi2
1	181.742	1	0

H0: no serial correlation

Table 4 above tested the time series for autocorrelation with results showing that Prob > chi2 is zero (0). This means that the daily market returns were serially correlated and therefore the daily market return time series was concluded not to be efficient in weak form.

Durbin's alternative test was also employed in the study, with the results presented in table 4 below.

TABLE 5

Durbin-Watson d-statistic

Durbin-Watson d-statistic(1, 1256) = 1.284811

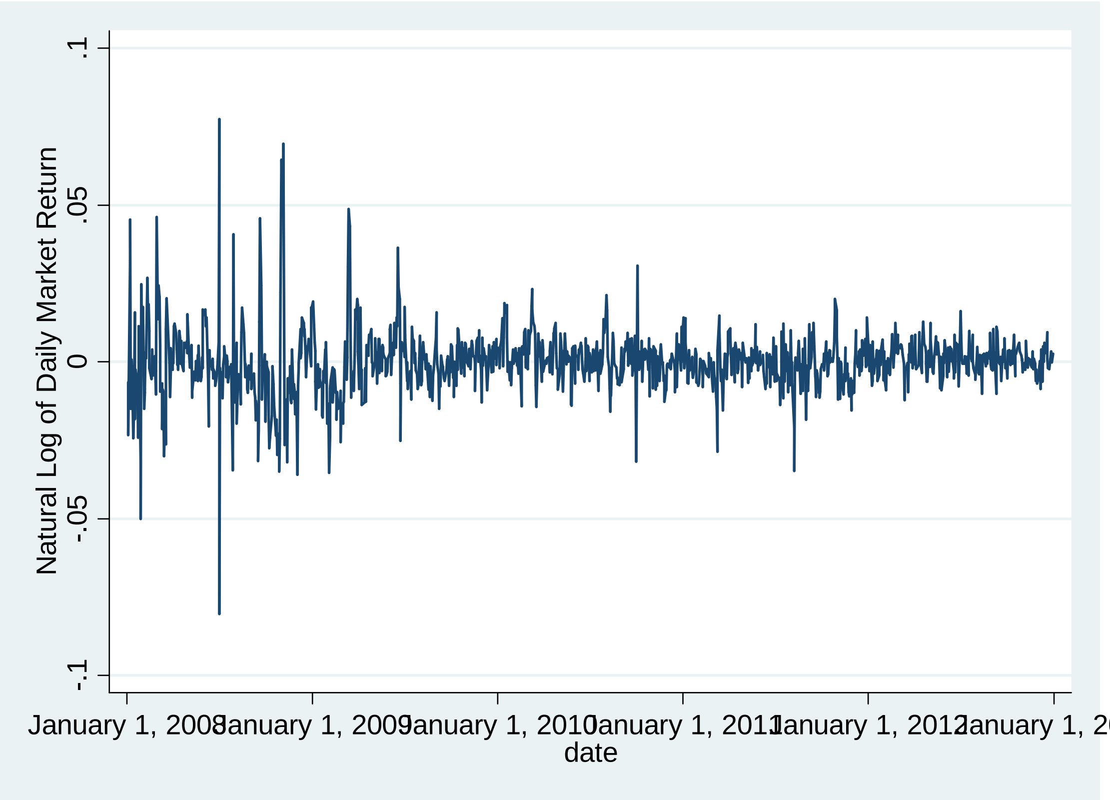
The value 1.284811 indicated a strong positive autocorrelation in the time series. The daily market returns on the NSE were therefore serially correlated and the null hypothesis of independence of successive daily returns was not accepted. The Durbin-Watson d-statistic values range between 0 and 4, with a value of two indicating absence of autocorrelation between successive observations in the time series. Any values approaching four indicate negative autocorrelation while values approaching two indicate positive autocorrelation.

4.5 Unit Root Test

The unit root test, through the Augmented Dickey-Fuller Test was used to test whether the time series was stationary or not. The presence of a unit root signifies non stationarity and therefore a random walk, which is the null hypothesis of the study. The first test for stationarity was conducted using a line plot, presented in figure 2 below.

FIGURE 2

Line Plot of the NSE Daily Market Return Series

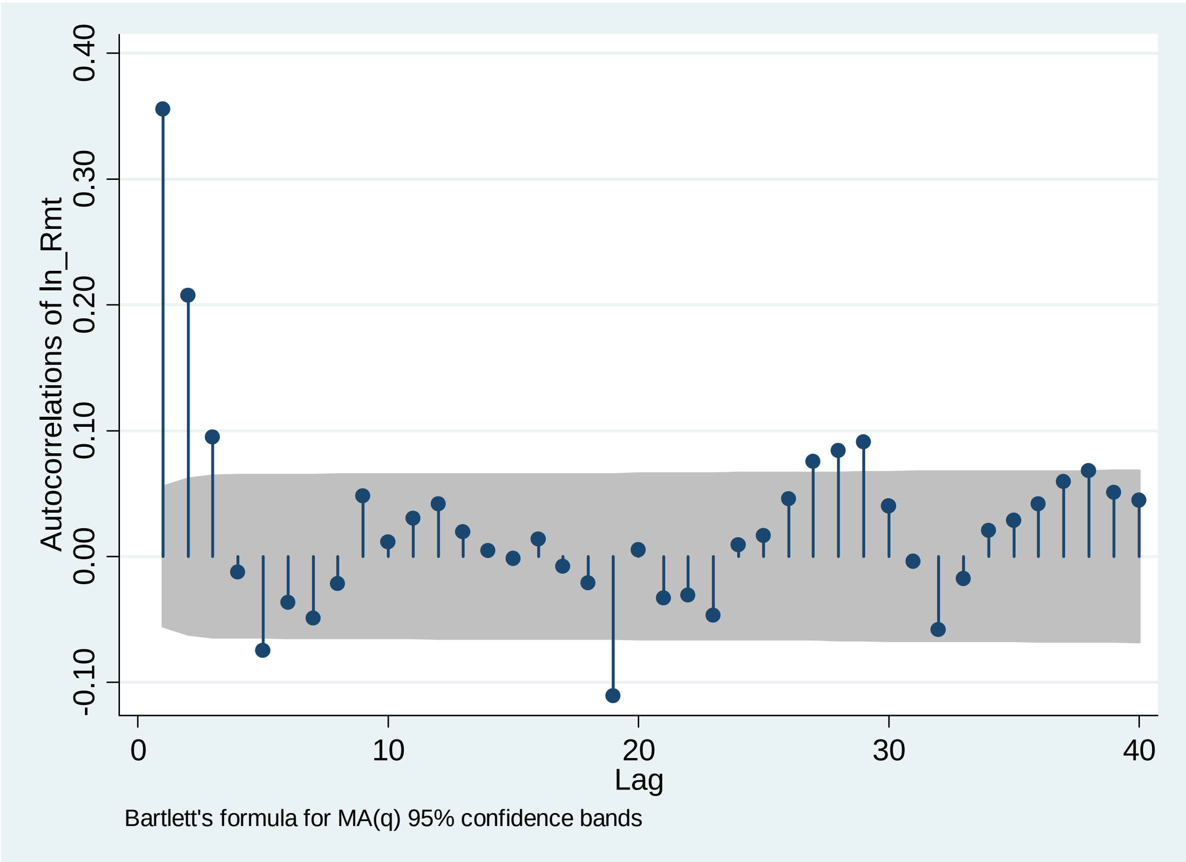


From figure 2 above, the time series appeared stationary, since the spikes oscillate around the same area. The time series appeared to contain a unit root, therefore the null hypothesis could be rejected and the return series concluded not to conform to the random walk. The period between January 2008 and January 2009 appears to have extreme activity compared to the other study periods. This was attributed to the uncertain political environment the country was in after the 2007 general elections, where the market experienced a lot of turbulence. Given that most investors in the NSE are foreigners, the political uncertainty exposed the market to a lot of speculation and therefore the market reflected instability at the time. The market eventually leveled out in subsequent years as observed in the years after 2009 after political differences were sorted out and this again reflected in the NSE.

To support the observations from the line plot, a correlogram was used to detect stationarity, with figure 3 below presenting the findings.

FIGURE 3

Correlogram of the NSE Daily Market Return Series



The lags start decaying to zero after lag 3. No slow decay of the lags is observed; hence the series is observed to be stationary, thereby rejecting the null hypothesis of presence of a random walk in the return series. The systematic decay of the first three lags was attributed to the turbulence of the markets in the period after the general elections in the year 2008, during which the political environment was not sustainable for business. Speculation was rife at the NSE during this time and this reflected in the stock prices then.

The Augmented Dickey-Fuller Test was then performed on the NSE time series, with tables 6, 7 and 8 presenting the results. Three forms of the random walk model were considered, namely the pure random walk model, random walk with a deterministic trend and random walk with a drift.

TABLE 6

Pure Random Walk

Test Statistic	1% Critical Value	5% Critical Value		10% Critical Value	
Z(t) -18.364	-2.580	-1.950		-1.620	
D.ln_Rmt ln_Rmt	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]
L1.	-.5855122	.0318832	-18.36	0.000	-.6480627 -.5229617
LD.	-.0936461	.0280761	-3.34	0.001	-.1487276 -.0385646

Comparing the computed test statistic value of -18.364 to the critical values at 1% (-2.580) , 5% (-1.950) and 10% (-1.620) significance levels, it was clear the computed absolute value is significantly less than the absolute values at the critical levels. This led to the rejection of the null hypothesis, of presence of a unit root in the daily market return series.

TABLE 7

Random Walk with a Trend

Test Statistic	1% Critical Value	5% Critical Value		10% Critical Value	
Z(t) -18.383	-3.960	-3.410		-3.120	
MacKinnon approximate p-value for Z(t) = 0.0000					
D.ln_Rmt ln_Rmt	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]

L1.	-.5874895	.0319587	-18.38	0.000	-.6501882	-.5247909
LD.	-.0926194	.0281067	-3.30	0.001	-.1477611	-.0374777
_trend	7.02e-07	7.32e-07	0.96	0.338	-7.34e-07	2.14e-06
_cons	-.0005178	.0005406	-0.96	0.338	-.0015785	.0005428

For the random walk with a trend, the computed test statistic is -18.383, and is significantly less than the critical values at 1% (-3.960), 5% (-3.410) and 10% (-3.120) significance levels. The null hypothesis (presence of a unit root in the return series) is therefore rejected and the series is concluded to be stationary.

TABLE 8

Random Walk with a Drift

Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value			
Z(t) -18.359	-2.329	-1.646	-1.282			
p-value for Z(t) = 0.0000						
D.ln_Rmt ln_Rmt	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
L1.	-.5856641	.0319009	-18.36	0.000	-.6482494	-.5230787
LD.	-.0935641	.0280886	-3.33	0.001	-.1486701	-.0384581
_cons	-.0000667	.0002667	-0.25	0.802	-.0005899	.0004564

The third unit root test performed was the random walk with a trend, which had a computed test statistic of -18.359, a value much smaller than the absolute critical values at 1% (-2.329), 5% (-1.646) and 10% (-1.282) significance levels. The null hypothesis was therefore rejected and the return series adjudged to be stationary and therefore the random walk model did not apply to the NSE.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The data analysis in chapter four used descriptive statistics, non-parametric tests (the Kolmogrov-Smirnov test and runs test), parametric tests (autocorrelation tests) and finally the unit root test. The descriptive statistics were important in studying the distribution of the return series and analyzing the properties of data distribution.

5.1.1 Descriptive Statistics

Table 1 in the previous chapter presented the distribution of data, followed by the respective interpretations. A mean of -0.0001794 signified that the NSE has a negative return and that the prediction of the same brings negative returns to investors. The study found the standard deviation to be relatively low at 0.0101531, meaning the risk of investing in the NSE is quite low for investors. The least return an investor can reap from the bourse is -0.0804511, with the highest return an investor can make being 0.0773313. The NSE return series was found to be Leptokurtic with many extreme returns observed and a skewness of 0.6714979 meaning most of the investors made returns above zero. The return series, however, was not normally distributed as confirmed by the confirmed Kolmogrov-Smirnov test in table 2.

5.1.2 Runs Test

To test whether the daily market returns were random, the runs test performed on the NSE daily return series gave a z value of -1.86 as observed in table 3, and since it fell between the required

±1.96, the successive returns on the NSE were concluded to be generated randomly and the null hypothesis was accepted.

5.1.3 Autocorrelation Tests

The study employed a couple of tests to test for independence of successive stock market returns on the NSE, the first one being the Durbin Watson alternative test for autocorrelation. The NSE return series was found to be serially correlated, so the successive returns were not independent of each other. This means the returns are predictable and the null hypothesis was rejected.

The Durbin Watson d-statistic was also computed and the value of 1.284811 was observed in table 5. This regarded the NSE returns as very strongly correlated, hence successive returns were said to be predictable.

5.1.4 Unit Root Test

The third and final test was conducted to test the NSE return series for presence of a unit root, that is, the presence of non-stationarity in the series. This, the researcher achieved, by first plotting a line plot using the natural logarithm of daily market returns. The line plot on figure 2 indicated the NSE daily market return was stationary, thereby rejecting the null hypothesis that the series bourse was non-stationary.

A correlogram was then generated to confirm the findings and the result also concluded the NSE return series to be stationary. The lags as observed in figure 3 started decaying after lag 3 and therefore the slow decay to zero that was required to accept the null hypothesis of stationarity was rejected. This meant that a unit root was absent and the returns were not random.

The third test employed was the Augmented Dickey-Fuller test, which also tested for stationarity of the NSE daily market return series. The research employed the three models for the ADF test, namely; pure random walk, random walk with a drift and random walk with a deterministic trend. The three models, as observed in tables 6, 7 and 8 all gave a result of the computed test statistics being significantly smaller than the t statistic critical values at 1%, 5% and 10% significance levels, concluding that the series had no unit root and therefore was stationary.

5.2 Conclusion

The general argument based on the reviewed literature is that for a stock market to be efficient in weak form, the prices and market returns have to be random and unpredictable. This is done using three main tests, namely the runs test, autocorrelation tests and the unit root test which tests a time series for stationarity.

Mixed results were obtained from the research, with the runs test agreeing with the null hypothesis that the successive NSE returns are random in nature. The runs test, however, could be considered a test for linearity and therefore not very reliable for the study. Mlambo and Biekpe (2007) in their test of efficiency of ten African stock markets concluded that market returns are generated in a non-linear process and the weak structures of the African markets violate linearity. Linear models would therefore lead to wrong conclusions.

The autocorrelation tests all found serial correlation in the return series, rejecting the assumption that successive daily market returns in the NSE are independent of each other. This led to the researcher concluding that the Nairobi Securities Exchange was not efficient in weak form. In their study of the Nigerian Stock Exchange, Nwosa and Oseni, 2011, found positive correlation of successive stock prices and concluded that the stock prices would be predicted using previous prices and therefore the market was not efficient in weak form. The study further pointed out that the Nigerian stock market had made positive strides with regard to making the stock market more efficient, but the global financial crisis in 2008 slowed down the market. This can be compared to the Nairobi Securities Exchange, where in addition to the financial crisis; the post-election violence took a toll on the market and slowed down the progress that had been earlier made. The positive correlation in the daily market returns implied the returns were predictable and therefore the market was not efficient in weak form. Batuo, Guidi and Mlambo (2009) explained that positive correlation found in their study of African stock markets meant that successive prices were predictable and therefore the markets were not informational efficient to be efficient in weak form.

The unit root tests failed to find a unit root in the NSE return series, with the Augmented Dickey-Fuller test, the line plot and the correlogram finding the series to be stationary. This led to the conclusion that the NSE return series is not efficient in weak form.

The conclusion that the Nairobi Securities Exchange is not efficient in weak form does not mean that the bourse is inefficient. The presence of a unit root in a time series and the absence of autocorrelation in the same is a requirement for the random walk model, but lack of the same does not mean inefficiency. Kwang-Soo and Sang-Bin (1991) put across the argument that if the random walk model holds, the weak form efficient market hypothesis holds, but the vice versa is not applicable. Violation of the random walk, however, does not imply market inefficiency. The autocorrelation tests and the unit root tests that show the Nairobi Securities Exchange does not conform to the random walk model therefore do not mean that the Nairobi Securities Exchange is inefficient.

5.3 Recommendations

The Nairobi Securities Exchange was concluded not to be weak form efficient, although it was made clear this does not mean that the bourse is inefficient. Some reasons could be behind this, such as weak institutional policies and thin trading. It is therefore recommended that the Capital Markets Authority should ensure that relevant information regarding listed firms on the NSE should be released immediately to give each and every investor a fair playing ground. It should also be noted that infrequent trading on the market may be a cause for the market not conforming to the random walk model. The NSE should take it upon them to properly educate the public and potential investors on the advantages of investing in the NSE.

The researcher would also propose that future studies include weekly and monthly return series in addition to the daily return series. This would improve the consistency of the results on the three levels and give the findings more weight and relevance. The use of a longer period of time, that is, more than the five year period used for the study, would give better results, since more data is collected.

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