EFFECT OF MICROSTRUCTURE CHANGES ON MARKET EFFICIENCY: A CASE STUDY OF NAIROBI STOCK EXCHANGE

BY

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE MASTER OF SCIENCE IN FINANCE DEGREE, SCHOOL OF BUSINESS, UNIVERSITY OF NAIROBI.

OCTOBER, 2015
DECLARATION

This research proposal is my original work and has not been presented in any other University.

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This research proposal has been submitted for presentation with my approval as University Supervisor.

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DEDICATION

I dedicate this research project to my loving family.
ACKNOWLEDGEMENT

I owe a debt of gratitude to the Almighty God for seeing me through all this time. I also would like to express my deepest appreciation to my supervisor Dr. Elly Duncan Ochieng for his overwhelming support and his incredible assistance.

Am also in-debted to place on record my sincere gratitude to my entire family for the material support and encouragement and also Wambui Nyaga her support cannot go unmentioned.

A special appreciation also goes to my mum and dad who believed in me and taught me that education is the best provision in life.
ABSTRACT

Mobilizing long term capital is a challenge in Africa with small capital markets. Although the evidence that long term finance influences economic growth saw a wave of capital market reform in Mid-1990s, stock markets are yet to make significant contribution to growth financing. Many stock exchanges across the world are gradually replacing their traditional physically convened markets with electronic markets. Securities markets efficiency in terms of price discovery process is necessary for the markets to contribute to wealth maximization objective of investors and economic growth. The Nairobi Securities Exchange (NSE) has also made various changes to its market microstructure, especially the introduction of an automated trading system in 2006. The main rationale behind the microstructure changes is to gain market efficiency. Information is however lacking on how such changes have affected the informational efficiency of the Exchange. This study tried to determine whether the introduction of the microstructure changes had improved the informational efficiency of the securities market. Using a data collection sheet, secondary data relating to the NSE 20 Share Index for the period spanning 13 years (2001-2014) was obtained. The data was analysed using non parametric approaches to measure market efficiency before and after market automation. The results indicate that mean market returns in the post automation period were higher than those in the pre automation period. This higher market returns can be attributed to improved price discovery process. The results from normality tests show that market returns are not normally distributed in both the periods. In addition, the runs test results reveals that market returns are more random in the period following automation than the prior period, implying that the market has improved in efficiency. The general conclusion of the study is that introduction of automation in the Kenyan securities market has led to improved market efficiency. The study recommends that the NSE and CMA should pursue full market automation by enabling online and internet securities trading and use of mobile money transfer platforms in paying for stock transactions. The study also suggests further research on specific market automations (CDS, BBO, CMS) to determine whether the results would be the same. The research could also be extended to all the individual stocks as opposed to the NSE 20 share index companies used by the study to determine whether the results would be similar.
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<th>Description</th>
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<tr>
<td>ATS</td>
<td>Automated Trading System</td>
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<td>AMH</td>
<td>Adaptive Market Hypothesis</td>
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<td>BBO</td>
<td>Broker Back Office</td>
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<td>CBK</td>
<td>Central Bank of Kenya</td>
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<td>CDS</td>
<td>Central Depository System</td>
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<td>CDSC</td>
<td>Central Depository and Settlement Corporation</td>
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<td>CMA</td>
<td>Capital Markets Authority</td>
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<td>ECN</td>
<td>Electronic Communication Networks</td>
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<td>EMH</td>
<td>Efficient Market Hypothesis</td>
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<td>EMT</td>
<td>Efficient Markets theory</td>
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<td>ICT</td>
<td>Information communication technology</td>
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<td>NSE</td>
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<td>OTC</td>
<td>Over the Counter</td>
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CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Security markets/exchanges in the world individually and collectively play a critical role in the most national economies. The main aim of a security exchange/market is to provide facilities for trade of company stocks and other financial instruments. Securities markets enable firm to easily raise finance, while ensuring efficient capital allocation in an economy, they also contribute to price discovery, provide liquidity, assist in risk transfer, facilitate corporate governance, and a measure of company performance. Security exchanges have always been found in central locations for ease of transactions. Nowadays, modern exchange stock markets are electronic networks with the evolution of information and communication technology infrastructures, which gives them speedy and less costly transactions (Helen, Hawkins and Sato, 1997).

Madhavan (2000) observed that several structural, technological and regulatory changes such as; increased competition between exchanges and electronic trading platforms, rapid internet growth, unprecedented financial innovations, and economic integration have transformed the financial industry. The literature on microstructure considers the detailed interactions between traders that culminate in transactions. Actual security markets are highly structured environments with detailed rules and procedures that govern the way orders travel from customers to brokers to the point at which execution (the creation of a binding contract of purchase and sale) takes place. Security markets involve diverse personnel such as retail investors, institutional
investors, brokers and so on. Market microstructure models attempt to capture some of this important feature of actual securities markets and study the price formation process at the level of individual interactions.

1.1.1 Market Microstructure

Market microstructure as explained by (Madhavan, 2000; Harris, 2003) is a branch of finance concerned with the details of how exchange occurs in markets. Market microstructure research examines the ways in which the working processes of a market affects determinants of transaction costs, prices, quotes, volume, and trading behaviour. Microstructure theory focuses on how specific trading mechanisms affect the price formation process [O'Hara, 1995]. It is devoted to theoretical, empirical, and experimental research on the economics of securities markets, including the role of information in the price discovery process, the definition, measurement, control, and determinants of liquidity and transactions costs, and their implications for the efficiency, welfare, and regulation of alternative trading mechanisms and market structures. The theory of market microstructure applies to the exchange of real or financial assets in financial markets. Market microstructure deals with issues of market structure and design, price formation and discovery, transaction and timing cost, information and disclosure, and market maker and investor behaviour.

Three main characteristics define the financial market microstructure namely; Trading sessions which are time intervals at which trades take place. Trading sessions differ across different types of markets. Continuous markets arrange trades continuously as orders arrive. Call markets collect orders for batch processing (Garman, 1976).
Execution systems which are the procedures for matching buyers and sellers. These include: Quote-driven systems which are primarily organised by dealers (e.g. NASDAQ, London International Stock Exchange (SEAQ), OTC Bond markets, Forex markets). Order-driven systems (auction markets) are organised by exchanges and follow order precedence trading rules to match buyers and sellers and a set of pricing rules to determine the trade prices (e.g. Tokyo Stock Exchange; Paris Bourse; Toronto Stock Exchange). Since traders cannot choose with whom they trade, order-driven markets require clearing houses. Brokered systems: are organised by brokers who actively search for matching buyers and seller. Brokered markets usually arise when the item traded is somehow unique and when dealers are unwilling to hold inventories. Brokered market examples include block trading market, market for ongoing concerns (businesses) and real estate market. Hybrid systems are a mixture of order driven, quote driven and brokered market. Hybrid systems are order-driven auction markets in which the specialist must provide liquidity under some circumstances. Many US stock and options exchanges have specialist systems (Garman, 1976).

Information Systems collect, organize, present, store, and transmit information about orders, quotes and trades. Electronic trading systems facilitate collection of information from market participant. Order routing systems, order presentation systems, and order books reused to transmit, present, and manage standing orders. Electronic order routing systems transmit standardized orders with great accuracy at low cost. These systems may be maintained by brokers, dealers or exchanges. Complex orders are often communicated by telephone. (Garman, 1976)
1.1.2 Market Efficiency

The concept of efficiency is central to finance. Primarily, the term efficiency is used to describe a market in which relevant information is impounded into the price of financial assets. A securities market is deemed to be informational efficient if security prices, at any time, fully reflect all the available information (Fama, 1970). The more efficient the market, the more random the sequence of price changes generated by such a market. The most efficient market is one in which prices are completely random and unpredictable. Until the 1970s, securities markets were believed to be informational efficient until market anomalies started to be documented. These market anomalies seemed to be at odds with the efficient markets theory (EMT) and led to the emergence of behavioural finance. According to the proponents of behavioural finance, markets are not absolutely efficient as portrayed by the EMT but rather relatively efficient (Chuvakhin, 2000).

Recently, there has been an attempt to reconcile these two opposing schools of thought which has given rise to the Adaptive Markets Efficiency (AME). The AME combines principles of the well-known and often controversial Efficient Market Hypothesis with principles of behavioral finance. The AME contends that market efficiency is a characteristic that varies over time. As such, market efficiency is highly context dependant as influenced by various environmental factors such as regulatory reforms, number of participants and micro-structural changes (Lo, 2004) undertaken in a market. Whether this new theory will end the debate as to whether securities markets are efficient or not is yet to be established but it gives a better understanding as to why some markets are found to be efficient at some period and inefficient at another period or rather why some markets are more efficient than others.
Studies have been done on securities market efficiency both in Kenya and the world over. However, few studies have examined the impact of market microstructure reforms on market efficiency, particularly for an emerging market like the NSE. Additionally, studies done on weak form market efficiency have resulted into adopting a fixed approach when testing for efficiency levels, which results into the conclusion that a market is weak form efficient or inefficient. This tends to ignore the environmental factors that may influence market efficiency. According to the AME championed by Lo (2005), market efficiency is highly context dependant as influenced by environment factors such as regulatory changes, microstructure improvement and the number of market participants. As a result, the efficiency of a securities market may change as influenced by these environmental factors. Thus, a more appropriate way to look at market efficiency would be whether the market is becoming more efficient as a result of these factors rather than concluding that a securities market is weak form efficient or inefficient.

1.1.3 Market Microstructure and Market Efficiency

The major thrust of market microstructure research examines the ways in which the working processes of a market affects determinants of transaction costs, prices, quotes, volume, and trading behavior. Microstructure theory focuses on how specific trading mechanisms affect the price formation process (O'Hara, 1995) The financial market microstructure has several characteristics namely trading sessions(time intervals at which trades take place),execution systems (matches buyers with sellers) and information systems(which collect, organize, present, store, and transmit information about orders, quotes and trades).
The classic paper on market microstructure is Jack Treynor’s short article on The Only Game in Town (written under the pseudonym of Bagehot, 1971). In this article, Treynor explains why investors as a whole lose from trading, and why informed investors win. The key is to understand the role of the dealer or market-maker, who loses when trading with informed investors, but aims to more than recoup these losses through trading with uninformed investors. Grossman and Stiglitz (1980) observed that in a world with costly information, it is impossible for markets to be informationally efficient. They resolve this paradox by drawing on Treynor’s idea of assuming that the market also entertains transactions from uninformed noise traders. This focus on the way that markets function has grown into an extensive literature on the microstructure of financial markets. The Bagehot (1971) article provided an early insight into the way information is incorporated into security prices through the activities of investors, and how market structure can have an impact on the efficiency of the stock market.

Glosten and Milgrom (1985) showed that the very possibility of trading on information can be sufficient to induce a positive bid-ask spread. Building on earlier work by Copeland and Galai (1983), Glosten and Milgrom identify the element of the spread that is attributable to adverse selection. Taken together with Demsetz’s (1968) order processing costs, and Ho and Stoll’s (1981) measure of inventory control costs, this has provided a framework that this is now used widely for analysing the bid-ask spread confronted by investors.
The efficiency of financial markets can be classified as allocation efficiency, operation efficiency and information efficiency. Allocation efficiency looks at how well capital markets can channel funds to their most productive use. Operation efficiency deals with the execution of transactions at minimal costs while informational efficiency looks at how well information is impounded into security prices. Finance theory and research over the years has been mainly concerned with the speed at which information is incorporated in prices. In this regard, Fama (1970) developed three versions of information efficiency with respect to information available i.e. the weak form efficiency, the semi strong form efficiency and the strong form efficiency. African capital markets are said to be characterised by illiquidity, thin trading and high volatility (Mlambo and Biekpe, 2007). It’s these limitations that have led to microstructure changes so as to increase liquidity and transparency, enhance efficiency, and reduce transaction costs and volatility (Asewe Stephen, Mule et al., 2013)

Several reasons have been cited to account for the inefficiency in capital markets. Prominent among them was the hitherto manual listing and paper certification on the exchanges which hindered information flow thus the automation of the securities markets like the NSE has had the biggest effect on their efficiency. The manual system of clearing and settlement had a serious impact on the liquidity and efficiency of the stock market. The trading system employed by the NSE for over five decades was manual – first, a call over system and then the open out-cry system. The call over and open out-cry systems of trading have great limitations in terms of the traded volumes they can handle and the speed at which trade can be executed (Mbugua, 2007) and hence the need for market automation.
Automated stock trading is a growing research area for both developed and developing markets enthusiasts. The advent of the Internet has radically transformed the nature of stock trading in most stock exchanges. Traders can now readily purchase and sell stock from a remote site using Internet-based order submission protocols. Additionally, traders can monitor the contents of buy and sell order books in real-time using a Web-based interface (Hendershott, et al., 2011). The electronic nature of the transactions and the availability of up-to-date order-book data make autonomous stock trading applications a promising alternative to immediate human involvement. In the past, trading in financial instruments has traditionally required face-face communication at physical locations. However, advances in electronic communications have led to the mushrooming of new trading systems. This development has seen numerous stock exchanges across the world facing off the traditional stock markets and replacing them with electronic markets.

1.1.4 Nairobi Securities Exchange

One of the main goals of Nairobi Securities Exchange when carrying out various legal and market infrastructural changes, is to improve market efficiency. In 2006, Capital Markets Authority (CMA) together with the NSE oversaw the automation of the trading system in order to fully computerize the operations of the securities market. This has significant implication on improving market liquidity, turnover and capitalization, and operational efficiency of the market.

The NSE manual clearing and settlement system which had a serious impact on the liquidity and operational efficiency of the market. For example it would take about two weeks between the actual security sale and confirmation. Some notable problems
with manual trading are that transparency for floor trading, pre-trade transparency in particular, was low at the former Nairobi Stock Exchange. Stock quotes were not distributed publicly as they were available on the floor only. Market manipulation and other abuses of power and position were believed to be rife on the NSE floor. Investors also waited for long as transactions were settled after many days. Given the appreciable market fragmentation, poor transparency, imperfect inter-market linkages with other EAC exchanges, and dubious trading floor behaviour, transaction costs were high (Onyuma, 2012). Changes, both structural and regulatory, were therefore called for. This led to the need to institute a better trading system. Automation is touted as one of the policies on how to promote the development of African stock markets. Automation is expected to reduce the costs and inefficiencies associated with manual systems, increase trading activity, improve market transparency and liquidity in the stock markets by speeding up operations (Capital Markets Authority, 2010).

These changes have led to increased participation from local and institutional investors evident in the increasing number of central depository system (CDS) accounts opened due to growing number of listed firms with oversubscription and increased securities investors (CMA, 2013). The improvement in the microstructure of the Exchange is to achieve more transparency, high trading speed, and increased market surveillance so as to increase its market efficiency.

On 11th September 2006 the Nairobi Securities Exchange went into full automation after years of operating as a floor-based oral auction. This event marked a major milestone in the market infrastructure development process of the NSE and was expected to boost market liquidity, increase operational and informational efficiency,
reduce settlement risk and elevate the market to international standard. Notably, a series of microstructure reforms have been undertaken at the NSE through the collaboration between the market regulator, CMA and the Exchange itself. Whether these microstructure changes have improved the efficiency of the market still remained unknown. In addition, whether there had been improved information efficiency as a result of automation of the Kenyan securities market also remained unclear. Therefore, it was important to study whether automation of the NSE had achieved the desired outcomes particularly in terms of improving the information efficiency.

After various complications, the NSE launched a central depository system (CDS), on 24th November 2004, having been procured from Millennium Information Technologies (MIT) of Colombo, Sri Lanka at a cost of Ksh.100 million. The many functions of the CDS include: to facilitate the faster change of ownership of securities electronically between parties, without the need for the movement of physical documents. It is meant to minimize the delivery and settlement risks, speeds up securities distribution, attract more firms to list and facilitate the process of securities markets integration (Onyuma et al. 2011).

An automated securities trading system is one in which trading is conducted by a network of computers connected to a trading engine, and where brokers simply enter, using a computer, the volume they want to trade and their preferred price (Jallow, 2009). On 11th September 2006, the automated trading system (ATS) was launched by the Exchange, in which the human interface was eliminated and replaced with computers and computer networks (Onyuma, et al. 2011). The structure of the market
changed from the floor based oral auction system to an electronic auction. With the ATS, trading hours has increased from 9.00 am to 3 pm and settlement period reduced from T+7 to T+3 days (NSE, 2012a).

Recently, the NSE introduced a live trading board that enables the public to view the order book in order to encourage transparency and efficiency. Also, some brokerage firms provide their clients with access to the order book as well as allowing them to submit orders remotely, through an online trading system (Kariuki and Onyuma, 2012).

In October 2011, through a stakeholder driven process, the Exchange implemented a Broker Back Office system (BBO) which is tightly coupled and interfaced with the ATS and CDS (NSE, 2011b). This system automates order collection, contracting, settlement and accounting. It has an audit trail functionality that tracks all changes made to trade data, and keeps a record of who changed it and when. Such changes are made available in a form that is easy to understand. The administrator can place restrictions on the value of financial entries that individual users can book into the system. All entry or modification of sensitive data can be configured to require an additional level of authorization through a maker checker policy.

1.2 Research Problem

Several studies have been done in Kenya assessing whether the NSE is efficient at different forms or not. This tends to ignore the environmental factors that may influence market efficiency. Adaptive market hypothesis contends that market efficiency is highly context dependent as influenced by many environment factors.
such as microstructure improvement of the trading system, regulatory reforms and the number of market participants. As a result, the efficiency of the market may change as influenced by these factors. A more appropriate approach to look at securities market efficiency is to assess if the market is improving in efficiency due to such changes instead of inferring that the market is efficient at a particular form or not.

Microstructure changes in the Kenyan securities market has been undertaken in stages. It began with the computerization of the central depository, clearance and settlement system; automation of the trading system, and installation of the broker back office system and the automated market surveillance system. Microstructure changes are within the control of Exchanges themselves and market regulatory authorities as opposed to macroeconomic changes, undertaken by the government through other entities like CBK. The NSE and CMA introduced a series of microstructure changes in the market in 2004, 2006, 2011, and 2012. The introduction of the microstructure changes at the NSE was expected to improve the efficiency of the price discovery process by increasing liquidity and transparency. There is scanty conclusive empirical evidence of whether the efficiency of the Kenyan security market has improved following the microstructure changes. In fact, Hendershott and Moulton, (2011) have maintained that the effect of changing automation within a market is an important and understudied area. Therefore, it was important to study whether the automation of securities market had led to improved market efficiency. This study therefore tried to fill this gap.
The role played by stock exchanges has remarkably transformed over the last couple of decades due to the increasing and effective role information and communication technology platforms play. Emerging markets improved their microstructures by adopting electronic trading in order to take advantage of existing technology such as Tunisia in 1996 and Jordan in 2000 (Sioud and Hamied, 2003). Kibuthu (2005) showed that automated exchanges can be deeper and more liquid than open outcry exchanges. Dickinson and Muragu, (1994), noted an increase in liquidity and an improvement in efficiency, but volatility increased following the automation of the Singapore stock exchange. Naidu and Rozeff (1994) in their study they established reduced autocorrelations of returns, which leads to the conclusion that market efficiency, improves after automation at the Singapore Stock Exchange.

Derrabi (1998) studied the effect of automation on the Morrocan exchange, which uses both call and continuous markets. A permanent stock-price increase was observed for securities transferred, but volatility and efficiency improved only for securities transferred to the call-based trading system. In contrast, some authors find that automated trading can have a negative effect on liquidity when transactions are based on human interactions. Bodie et al. (2002) suggest that automation decreases liquidity because for important transactions traders cannot negotiate directly and so have no control on trading conditions. The NSE has installed an automated trading system aimed at increasing the efficiency of its market. Whether the microstructure changes in the trading system have attained this objective in Kenya still remains unknown.
A number of efficiency studies have been conducted at the Kenya securities market. However, these studies provide mixed evidence on the efficiency of the NSE. Using runs tests and autocorrelation analysis, Dickinson and Muragu (1994) examined the weak form efficiency of the NSE from 1979-1989 using 30 stocks at the NSE and found the market to be weak form efficient. Mlambo and Biekpe (2005) and Magnusson and Wydick (2002) found the NSE to be weak form efficient. In addition, Rioba (2003) examined the predictability of stock returns in the NSE and found weak evidence of predictability which implies that the market is weak form efficient. Parkinson (1987) on the other hand found the NSE to be weak form inefficient using data from 50 listed companies and a series of runs test. In addition, Jefferis and smith (2005) found the NSE to be weak form inefficient.

On the other hand, Onyuma (2009) found presence of the day of the weak and month of the year effect on returns at the NSE, while Mokua (2003) found no evidence of the weekend effect at the NSE. Atiti (2005) found that it was possible to generate abnormal returns at the NSE by using momentum strategies. These studies provide evidence for and against the weak form of efficiency. These studies only infer the level of efficiency in the NSE. However, market efficiency is highly context dependant as influenced by many environment factors such as microstructure improvement of the trading system, regulatory reforms and the number of market participants. As a result, the efficiency of the market may change as influenced by these factors. A more appropriate approach to look at securities market efficiency is to assess if the market is improving in efficiency due to such changes instead of inferring that the market is efficient at a particular form or not.
1.3 Research Objectives

The general objective of this study was to evaluate the effect of microstructure changes on market efficiency a case study of Nairobi stock exchange. Specifically, the study aimed at achieving the following specific objectives:

1. Determine the distribution of market returns before and after automation of the Exchange.
2. Assess if the market automation had affected the price discovery process at the Exchange.
3. Examine whether the efficiency of the market improved following the automation of the Exchange.

1.4 Value of Study

The efficiency of the securities market has a lot of implications on finance theory and investment strategies and therefore plays an important role to academicians, investors, the securities exchanges and regulatory authorities. Several models in finance are based on the assumption that stock prices follow a random walk and are normally distributed – the market is efficient. Therefore, the findings of this study was expected to be of interest to scholars as it would add to the stock of knowledge in the pursuit of understanding the efficiency of the securities markets, thus adding to the ever growing literature on market efficiency.
The NSE and the CMA, who make important policies aimed at the development of the securities market, will utilize the finding to assess the level of efficiency brought about by microstructure changes effected by them and any more changes required to take the market to a strong level of efficiency. Financial analysts and investors were also expected to utilize the findings in designing different trading strategies that take into account the existence of random walk or persistence in the short-run and mean reversion in the long-run. If the market is more efficient investors would get fair returns for their investments.

The government also stands to benefit as this will show how the automation of the NSE has improved and could increase investment in the local capital markets instead of looking for funds from international markets where country sought to raise $1.5bn through the Eurobond, but eventually raised $2bn. The government could obtain funds at a cheaper rate locally. This could lead to development in various sectors as the government has cheap funds.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
This chapter reviews the pertinent literature on market microstructure and efficiency relevant for this study. It begins by detailing microstructure changes which have taken place at the NSE’s trading systems and examines the empirical literature on market automation and efficiency in order to develop a conceptual framework for the study.

2.2 Theoretical review
The microstructure literature challenges the hypothesis of efficient markets by studying how prices can deviate from or converge towards informationally efficient equilibrium prices as a result of rational participants behaving strategically (Biais et al., 2004). Strategic behaviour can be put down to unequal access to information or to limited liquidity in the secondary market. While the EMH abstracts from the actual process which leads to buyers and sellers finding one another and agreeing on a price, the microstructure literature focuses on the functions performed by the marketplace. (Naes and Skjeltorp, 2006)

Themes in the microstructure literature are divided into three (Naes and Skjeltorp, 2006): the actual transaction process, the effects of market structure and trading rules on the transaction process, and the transaction process’s implications for fundamental economic decisions. This subdivision also largely reflects the chronological development of this research field. There are two main groups of models of transaction process. The first (inventory models) studies how an intermediary (like
dealers) can solve the problem of buyers and sellers not being present in the market simultaneously. The second (information models) analyses how information which is asymmetrically distributed between participants in the market is reflected in the prices of securities.

Microstructure research rejects the hypothesis that the transaction process and the organization of markets have no effect on the prices of securities. Some studies elsewhere have looked at whether the stock market’s microstructure can also have long-term effects on prices and returns. The development of market microstructure as a subject has coincided with a period of establishment of new stock markets and revitalization of existing markets in many developing and transitional economies (Jallow, 2009). The revitalization of these emerging stock markets is typically characterized by institutional reforms, including modernization of the trading and information systems, expanding stock market membership, revamping the regulatory framework, and opening access to foreign capital. The developments are aimed at improving stock market performance by increasing liquidity and transparency, enhancing efficiency, and reducing volatility and trading costs (Kariuki and Onyuma, 2012).

Efficient market is one where the market price is an unbiased estimate of the true value of the investment as these deviations are random. Major theories on market efficiency are discussed below.
2.2.1 Efficient Market Hypothesis

The efficient market hypothesis (EMH) championed by Fama (1965) forms the cornerstone of modern finance. When the market is efficient, all available information is fully and instantaneously reflected in price, and no investor or trader is capable of making abnormal profit. When the information set is limited to past price and return, the market is said to be weak-form efficient and the asset return is purely unpredictable from the past information. According to the EMH, a market is said to be informational efficient if security prices at any time fully reflect all the available information (Fama, 1970). Information refers to anything that may affect stock prices and is unknowable in the present and thus appears randomly in the future. It follows that if new information is unpredictable then security prices should move randomly and unpredictably and the best predictor of tomorrow’s price would be today’s price. In its weakest form, the EMH states that past prices cannot be used to predict future prices. Therefore, the use of technical and fundamental analysis is of no real value in securities market analysis.

Where the participants in the securities market behave rationally and have the same information, share prices will at all times reflect all available information about firms’ fundamental value. Since it was first advanced in the 1960s, this has been one of the most important hypotheses in financial economics. However, over the years, both the theoretical foundation for this hypothesis and the previously strong empirical support for it have been challenged.
2.2.2 Adaptive Market Efficiency

The evolving nature of return predictability can be rationalized in the framework of Lo’s (2004) adaptive markets hypothesis (AMH). With investor rationality at the heart of the controversy between advocates of the efficient market hypothesis and its behavioural critics, Lo (2004) provides reconciliation through the AMH in which market efficiency is explained from an evolutionary perspective. It is an application of the evolutionary principle to financial markets, which argues that constantly changing market conditions govern key market features such as return predictability.

Therefore, the market efficiency cannot be evaluated in a vacuum, but is highly context dependent and dynamic environment (Lo, 2007). As such, market efficiency is highly context dependant as influenced by various environmental factors such as regulatory reforms, number of participants and micro-structural changes (Lo, 2004) undertaken in a market. This means stock markets such as the NSE are affected by many factors including the microstructure changes and this study wants to acquire evidence of the any effect of microstructure changes to market efficiency.

2.3 Determinants of Efficiency

A securities market is deemed to be informational efficient if security prices, at any time, fully reflect all the available information (Fama, 1970). The more efficient the market, the more random the sequence of price changes generated by such a market. The most efficient market is one in which prices are completely random and unpredictable. The efficiency of a market is affected by many factors but the following stand out as the major determinants.
2.3.1 Time Frame of Price Adjustments

An efficient market is a market in which asset prices quickly reflect available information and trades are the mechanism by which information can be incorporated in price. If the time frame of price adjustment allows many traders to earn profits with little risk, then the market is relatively inefficient. In certain markets, such as foreign exchange and developed equity markets, market efficiency relative to certain types of information has been studied using time frames as short as one minute or less. Chordia, Roll, and Subrahmanyam (2005) suggest that the adjustment to information on the New York Stock Exchange (NYSE) is between 5 and 60 minutes. Under weak form efficiency, the current price reflects the information contained in all past prices, suggesting that charts and technical analyses that use past prices alone would not be useful in finding undervalued stocks.

Under semi-strong form efficiency, the current price reflects the information contained not only in past prices but all public information (including financial statements and news reports) and no approach that was predicated on using and massaging this information would be useful in finding undervalued stocks. Under strong form efficiency, the current price reflects all information, public as well as private, and no investors will be able to consistently find undervalued stocks. (Aswath Damodaran, 1993).

2.3.2 Market Value versus Intrinsic Value

Market value is the price at which an asset can currently be bought or sold. Intrinsic value (sometimes called fundamental value) is the value that would be placed on an asset if investors if had a complete understanding of the asset’s investment
characteristics. If investors believe a market is highly efficient, they will usually accept market prices as accurately reflecting intrinsic values. Efficient market is one where the market price is an unbiased estimate of the true value of the investment. Market efficiency does not require that the market price be equal to true value at every point in time. All it requires is that errors in the market price be unbiased, i.e., that prices can be greater than or less than true value, as long as these deviations are random. Randomness implies that there is an equal chance that stocks are under or over valued at any point in time. The fact that the deviations from true value are random implies, in a rough sense, that there is an equal chance that stocks are under or over valued at any point in time, and that these deviations are uncorrelated with any observable variable. For instance, in an efficient market, stocks with lower PE ratios should be no more or less likely to under value than stocks with high PE ratios. If the deviations of market price from true value are random, it follows that no group of investors should be able to consistently find under or overvalued stocks using any investment strategy. (Aswath Damodaran, 1993).

2.3.3 Transaction Costs and Information-Acquisition Costs

Investors should consider transaction costs and information-acquisition costs when evaluating the efficiency of a market. A price discrepancy must be sufficiently large to leave the investor with a profit (adjusted for risk) after taking account of the transaction costs and information-acquisition costs to reach the conclusion that the discrepancy may represent market inefficiency. The probability of finding inefficiency in an asset market increases as the transactions and information cost of exploiting the inefficiency increases. The cost of collecting information and trading varies widely across markets and even across investments in the same markets. As
these costs increase, it pays less and less to try to exploit these inefficiencies. Investors who can establish a cost advantage (either in information collection or transactions costs) will be more able to exploit small inefficiencies than other investors who do not possess this advantage. Establishing a cost advantage, especially in relation to information, may be able to generate excess returns on the basis of these advantages. (Aswath Damodaran, 1993).

Other factors affecting market efficiency include the number of market participants and their trading activity, financial disclosure and limits to trading (restrictions on short selling).

### 2.4 Empirical Studies

Microstructure research rejects the hypothesis that the transaction process and the organization of markets have no effect on the prices of securities. Some studies elsewhere have looked at whether the stock market’s microstructure can also have long-term effects on prices and returns. The development of market microstructure as a subject has coincided with a period of establishment of new stock markets and revitalization of existing markets in many developing and transitional economies (Jallow, 2009).

The revitalization of these emerging stock markets is typically characterized by institutional reforms, including modernization of the trading and information systems, expanding stock market membership, revamping the regulatory framework, and opening access to foreign capital. The developments are aimed at improving stock market performance by increasing liquidity and transparency, enhancing efficiency,
and reducing volatility and trading costs (Kariuki and Onyuma, 2012). The wider goal is to promote the development of local capital markets and facilitate access to long-term capital.

The main issue in stock markets is whether and how market microstructure changes can create a positive value in terms of liquidity, efficiency and price discovery. Previous studies on more established markets, which have implemented changes in trading systems, have reported a positive impact, creating gains in market efficiency, increased liquidity and lower volatility. There are global and local studies on this study.

2.4.1 Local Studies

A number of efficiency studies have been conducted at the Kenya securities market. However, these studies provide mixed evidence on the efficiency of the NSE. Using runs tests and autocorrelation analysis, Dickinson and Muragu (1994) examined the weak form efficiency of the NSE from 1979-1989 using 30 stocks at the NSE and found the market to be weak form efficient. Mlambo and Biekpe (2005) and Magnusson and Wydick (2002) found the NSE to be weak form efficient. Rioba (2003) examined the predictability of stock returns in the NSE and found weak evidence of predictability which implies that the market is weak form efficient. Parkinson (1987) on the other hand found the NSE to be weak form inefficient using data from 50 listed companies and a series of runs test. In addition, Jefferis and smith (2005) found the NSE to be weak form inefficient. On the other hand, Onyuma (2009) found presence of the day of the week and month of the year effect on returns at the NSE, while Mokua (2003) found no evidence of the weekend effect at the NSE. Atiti
(2005) found that it was possible to generate abnormal returns at the NSE by using momentum strategies. These studies provide evidence for and against the weak form of efficiency.

Event studies have also been conducted in the NSE. For example, Aduda and Chemarum (2010) studied the reaction to stock splits at the NSE and found evidence of abnormal returns in the days preceding the split date. In contrast, Atogo (2010) found that the returns earned on stocks that had announced a split were not statistically significant after the announcement. This implied that there is no opportunity to make abnormal returns following a stock split announcement. Kakiya (2010) found evidence of abnormal returns following earnings announcement by companies in the NSE. The above studies provide mixed evidence of weak form efficiency of the NSE, warranting further research on securities market efficiency in Kenya.

In relation to relationship between automation and market performance, one study comes to the fore. Using prices of securities listed at the NSE, Mbugua (2007) identified the behaviour of volume, volatility and liquidity under three trading systems: manual trading, CDS and ATS with a view to determine whether automation had affected the three market characteristics, and revealed that automation was associated with increased volume of trading, increased volatility of quoted stocks and increased liquidity. Greater volumes of trade and volatility were noted when NSE was fully automated compared to manual or partial automated systems. However though there was a noted increase in liquidity on introduction of CDS, but the liquidity declined on introduction of ATS. Lastly, Mbuva (2010) and Maobe (2012) have also
assessed the challenges facing financial performance of Kenya stock broking firms and how their performance may affect market performance.

2.4.2 Global Studies

These include studies in Milan (Amihud, et al., 1990), Tokyo (Amihud and Mendelson, 1991) and Tel Aviv (Amihud, et al., 1997). Blennerhassett and Bowman (1998) reported a fall in transactions costs on the New Zealand stock exchange following the move from open outcry to screen trading, and Majnoni and Massa (2001) report broadly positive results after implementing market microstructure changes in terms of trading regulations and transaction cost introduced by the Italian Stock Exchange. There are fewer such studies in emerging markets, and their results are more mixed.

Masulis and Shivakumar (2001) studied how different stock markets with different market microstructure affect the speed with which new information is incorporated into prices in the US and reported findings suggesting that differences in market microstructure can significantly accelerate or retard the incorporation of news into market prices. Some findings suggest that the entry of foreign investors is an important factor than internal market reform (although the former may be predicated on the latter), and that this is followed by increased liquidity and enhanced market efficiency, with market volatility either remaining unchanged or declining (Ngugi, et al., 2002).
Sunday (2011) found increased market turnover and liquidity in Nigerian market following installation of an ATS. Furthermore, Olujide (2000) found evidence that the automation of the Nigeria Stock Exchange in 1997 through the introduction of Central Securities Clearing System and the ATS had a positive impact on the liquidity of the market, transparency, investor confidence and foreign investment. However, Chang, et al. (1999) found no change in liquidity in the efficiency of the price discovery process, while volatility increased, following the introduction of a continuous auction system in Taipei Stock Exchange. Freund and Pagano (2000) discuss the mechanics of automated trading systems and the benefits and disadvantages of implementing such systems and the effects of automation on price efficiency. They examine price efficiency before and after automation on the NYSE and the Toronto Stock Exchange (TSE.)

Although they find that automation is associated with an improvement in market efficiency on the TSE relative to the NYSE, they do not detect any changes in the nonrandom patterns in returns before and after automation, which leads them to conclude that automation has not changed price efficiency on the TSE. However they point out that their results should be interpreted with caution since they rely on a relatively short sample.

On the contrary, Maghyereh (2005) found no evidence of improved efficiency following the automation of the Amman Stock Exchange. Similarly, Debysingh and Watson (2007) found that the Jamaican Stock Exchange, and the Trinidad & Tobago Stock Exchanges were informational inefficient both before and after automation.
Although the authors caution that these results should be interpreted with caution due to data limitations encountered.

2.5 Summary of literature review

Majnoni and Massa (2001) found evidence of increased efficiency at the Italian Stock Exchange after microstructure reforms (creation of specialised intermediaries, obligation to trade on the official markets, screen-based trading and cash settlement). Sinnakkannu and Nassir (2006) found that micro-structural changes (introduction of computerized trading, central depository system and clearing and settlement) implemented by Bursa Malaysia reduced the time to equilibrium, that is, speed for information adjustment from 14 days to 9 days in 2001. Recently, many securities exchanges across the world are moving from physical trading platforms to computer based system – automated trading. Although numerous studies have been conducted on the effects of automation, most of the studies examine the effect of automation on market characteristics such as volume, liquidity and volatility. Few studies have formally examined the effect of automation on information efficiency.
3.1 Introduction
This chapter presents the research design for the study and indicates the population and the sampling procedure adopted. The methods of data collection and data analysis are also presented. Finally, it describes and presents the model used to analyse the data.

3.2 Research design
This research used a longitudinal research design as it emphasises the status of time and the study of a phenomenon over time. It also involved taking repetitive measures over time for the purpose of comparing efficiency in the pre-automation and post-automation periods. The use of the time is a design characteristic in which the extent of a phenomenon is measured after successive time period, and the effect of intervention influences are time related (Amin, 2005), and data is collected several times, before and after an intervention. This design is therefore suitable in analysing and comparing the behaviour of returns during these two periods.

3.3 Population
The NSE currently has sixty-four (64) listed firms. The Exchange however uses prices of twenty (20) large and mostly traded listed companies to compute its NSE 20-Share Index, whose construction began in 1966. The NSE currently has two market indices; the NSE 20-Share Index which is price weighted and an all inclusive NSE All Share Index (NASI) which is market capitalization weighted. Price weighted indices are
based on a geometric mean of average prices of the constituent companies which are equally weighted. In line with best practice, the market indices are reviewed periodically to ensure that they reflect an accurate picture of market performance. The review is conducted by looking for the best company warranting inclusion in the constituent firms forming the NSE 20 Share Index. The criteria for inclusion includes market capitalization, shares traded, number of deals, and turnover during the period under review. This criteria used in reviewing the indices involves weighting market performance measures for a twelve-month period as follows: market capitalization 40 percent, shares traded 30 percent, number of deals 20 percent, and turnover 10 percent. The company must also have a free float of at least 20%, must have minimum market capitalization of Kshs.20million, a company should ideally be a blue chip with superior profitability and dividend record. (NSE, 2014c).

3.4 Sample

The target population for the study therefore comprised of the companies forming the NSE-20 Share Index. The NSE-20 Share index is a value weighted index consisting of the 20 highly capitalized and most actively traded companies picked from the various Kenyan economic segments. The Index tracks the daily performance of the market and acts as an indicator of the general market performance. The NSE 20 Share Index companies consist of companies from all sectors and so are representative of the market and the effect on this companies’ share prices will show the effect on the market, therefore the use of the NSE 20 Share Index companies will be better than using the Nairobi Securities Exchange Ltd All Share Index (ASI) which is a market cap weighted index consisting of all the securities on the NSE. Since the NSE 20
Share Index is an already predetermined sample, there was no need for a sampling procedure for the study.

### 3.5 Data collection

The daily secondary data on the NSE-20 Share Index was collected from the NSE. The data collected was for 13 years spanning September 2001 to September 2014. This is the period during both the manual and automated trading environment, this period also represents when the Exchange experienced both subdued and superior trading activity when the Index recorded 980 points in 2001 and 6060 points in 2007. The NSE database is most suitable because it contains the data required and other types of market statistics. The data collected was split into pre-automation period (11th September 2001 – 10th September 2006) and post-automation period (12th September 2006 – 11th September 2014). The key market microstructure changes implementation dates were obtained from the NSE and CMA media center archives and press release at www.nse.co.ke and www.cma.or.ke respectively. The key microstructure change investigated is automation and its effect on efficiency and the study looked at market returns, normality, effect of automation on price discovery process and correlation.

### 3.6 Data Analysis

The daily return on the NSE 20- Share Index was computed as the first difference of the logarithmic stock index, and a test conducted to determine whether they were related to different market microstructure conditions. The study used non parametric tests to assess the randomness and independency of the data. The advantage of nonparametric test statistics is that they allow the derivation of specific critical values
by simulating the exact sampling distribution (Lagoarde-Segot and Lucey, 2008). Normality tests were performed using skewness and kurtosis to test the distribution of returns. The efficiency of the market was tested using the non parametric Runs test to uncover any return independency. Finally, the Wilcoxon signed rank test was employed to determine the impact of automation on the price discovery process in the Kenyan securities market.

3.6.1 Computation of Market Returns

The daily return on the index (Rt) was computed consistent with (Washer, et al., 2011) as the first difference of the price index as below (because stock price index movement is usually exponential from one period of time to another, rather than linear):

\[ R_t = \frac{(P_t) - (P_{t-1})}{P_{t-1}} \]

\( R_t \) = Daily market returns for NSE 20-Share Price Index for day \( t \)

\( P_t \) = is the closing value of the NSE 20-Share Price Index for day \( t \).

\( P_{t-1} \) = is the closing value of the NSE 20-Share Price Index for day \( t-1 \).

3.6.2 Normality Tests for the Distribution in Market Returns

The random walk hypothesizes that in an efficient market, successive residual increments follow a normal distribution (Kalu, 2009). The standard measures for deviations from normality are skewness and kurtosis. Theoretically, the skewness of a normal distribution is zero and the Kurtosis of a normal distribution is 3. Positive skewness means that the distribution has a long right tail and negative skewness implies that the distribution has a long left tail. If the kurtosis of a distribution exceeds 3, the distribution is peaked relative to the normal. However, if the Kurtosis is less
than 3, the distribution is flat relative to normal. Skewness was used as measure of asymmetry of the distribution of a series around its mean, while kurtosis was used as a measure of the peakedness or flatness of the distribution. These measures have been widely used in other efficiency studies (Jefferis and Smith, 2005; Okpara, 2010; Kariuki, 2011; Kariuki and Onyuma, 2012).

3.6.3 Testing the Impact of Automation on Price Discovery Process

The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used when comparing two related samples, matched samples, or repeated measurements on a single sample to assess whether their population mean ranks differ – that it, is a paired difference test. It can be used as an alternative to the paired Student's t-test, t-test for matched pairs, or the t-test for dependent samples when the population cannot be assumed to be normally distributed (Mason et al., 2002).

The Wilcoxon signed rank test was employed to determine whether the change in market microstructure through ATS had a positive effect on the price discovery process. The proposition to be tested is that the median returns earned before market automation will not be significantly different from the median returns after market automation. Failure would mean that market automation had no impact on the price discovery process of the NSE.

3.6.4 Test for Market Efficiency

Runs test can be used to assess return distribution and infer on weak form efficiency. The test is regarded to be strong in capturing the random walk in prices as it disregards the properties of distribution. A run is a series of increasing values (+) or a
series of decreasing values (-). Therefore, a runs test determines whether successive securities price changes are independent of each other (Reily and Brown, 2002). For instance, if price changes are positively related it would be more likely that a (+) sign is followed by a (+) and a (-) is followed by a (-). Again, runs tests have been extensively used to test for serial independence of stock returns (Dickinson and Muragu, 1994; Mlambo and Biekpe, 2005; Okpara, 2010).
CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the research findings and discusses the results with reference to the specific research objectives. The main objective of the study was to determine the effect of the microstructure changes of the market efficiency at the Nairobi Securities Exchange. It begins by presenting the descriptive results for normality tests, followed with results from the Wilcoxon signed rank test and the Runs test, which were conducted both for the pre market automation and post market automation periods.

4.1 Test of Normality Distribution of Market Returns

The results from the skewness and kurtosis tests are presented in Table 4.1 below. The mean return in the post market automation period was higher than mean return in the pre market automation period. Similarly, the median return in the post automation period was higher than the median returns in the pre automation period.

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Post automation</th>
<th>Pre automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1979</td>
<td>1250</td>
</tr>
<tr>
<td>Mean</td>
<td>4310.8252</td>
<td>2592.3951</td>
</tr>
<tr>
<td>Median</td>
<td>4463.6500</td>
<td>2673.6900</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>806.55877</td>
<td>1099.02911</td>
</tr>
<tr>
<td>Skewness</td>
<td>-.269</td>
<td>.099</td>
</tr>
<tr>
<td>Std. Error of Skewness</td>
<td>.055</td>
<td>.069</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-.952</td>
<td>-1.311</td>
</tr>
<tr>
<td>Std. Error of Kurtosis</td>
<td>.110</td>
<td>.138</td>
</tr>
</tbody>
</table>
Figure 1 Pre Automation Histogram

Source: Data Analysis (2015)

Figure 2 Post Automation Histogram

Source: Data Analysis (2015)
The random walk hypothesis posits that market returns should follow a normal distribution. In order to test for this property, the Skewness, and Kurtosis tests were used. The results of these tests are presented in Table 4.1 above. The Skewness and Kurtosis values show likely departure from normality in both periods as none had a Skewness value equal to zero and Kurtosis value equal to 3. The returns in the pre market automation period are positively skewed, an indication that market returns in the pre market automation had a long right tail and slightly peaked. However, the returns in the post market automation period were negatively skewed, an indication that the returns had a long left tail with a relatively flat peak. Although both periods are considered bearish periods, the negative skewness value in the post market automation period shows a greater chance of extreme negative values while the positive skewness value in the pre market automation period imply a lesser chance of extreme negative values. These results are not surprising given that the NSE was adversely affected by the global financial crisis in 2008 (Kilonzo, 2008) and debt crisis of 2012, and the volatility was likely to arise from the changes in market microstructure following advances in the trading system.

### 4.2. Impact of Market Automation on Price Discovery Process

An efficient price discovery process ensures that investors realise the best prices for their stocks which should ideally be closer to the fundamental values. The introduction of market automation was expected to improve the efficiency of price discovery process by targeting liquidity and transparency among other factors. Therefore, if market automations have had a positive impact on the price discovery process, investors would lower their required rate of return due to increased liquidity and transparency and in turn securities prices should appreciate. In other words, the
returns earned in the post market automation period would be higher than returns earned in the pre automation period. To test whether automation had a positive effect on the price discovery process, the Wilcoxon signed rank test was used. The Wilcoxon signed rank test is a non parametric test for matched pairs and uses the median value. The proposition was that returns in the post market automation period are not significantly different from returns in the pre market automation period. The results of the test are presented in Table 4.2 below.

Table 4.2: Impact of Market Automation on Market Returns

<table>
<thead>
<tr>
<th>Ranks</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre – post</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
<td>1246&lt;sup&gt;a&lt;/sup&gt;</td>
<td>627.48</td>
<td>781844.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.75</td>
<td>31.00</td>
</tr>
<tr>
<td>Ties</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- a. pre market automation < post market automation
- b. pre market automation > post market automation
- c. pre market automation = post market automation

Test Statistics<sup>a</sup>

<table>
<thead>
<tr>
<th></th>
<th>pre – post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-30.622&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.000</td>
</tr>
</tbody>
</table>

- a. Wilcoxon Signed Ranks Test
- b. Based on positive ranks.

*Source: Data Analysis (2015)*

The results in Table 4.2 show that post automation market ranks higher than the pre automation market. Thus, at 5 percent level of significance the study concluded that returns earned in the post market automation period were higher than the returns
earned in the pre market automation period. These results confirm that the introduction of market automation had a positive impact on the price discovery process. This finding is in line with other studies that have shown that the introduction of market automation, particularly touching on the trading system, did improve the efficiency of the price discovery process at the Bursa Malaysia Exchange by Sinnakkmiannu and Nassir (2006). Green et al. (2002) also found positive price reactions due to improvement in liquidity following installation of BOLT in Mumbai Stock Exchange in India. The speed of trading in a securities market is important because delay induces uncertainty about the probability of order execution and the price at which such execution may occur. If market automation and resultant trade execution speed reduce transaction costs, they should enable more efficient allocation of securities among heterogeneous investors, improve risk-sharing and consumption smoothing, and can raise asset prices (Acharya and Pedersen, 2005). More efficient price discovery contributes to better informed financing and investment decisions, benefiting shareholders by facilitating better corporate decisions.

4.3 Run Test of Independency in Market Returns

The study tested whether market automation has led to improved market efficiency at the NSE. The non-parametric runs test was used to assess the efficiency of the market in the pre market automation and post market automation periods. This test ignores the properties of the distribution and is robust especially where data is not normally distributed. If market automation had improved market efficiency, then the speed at which information is incorporated into securities prices should increase and so returns should become more random. The runs test was performed using the median value, with the results for the pre market automation period presented in Table 4.3 below.
From Table 4.3 below, the observed numbers of runs were 18. The cases above and below the test value which is the median of 2673.69 are equal which imply randomness in the return series. Therefore, at 5 percent significance level the study implied that the returns in the pre market automation period followed a random walk.

### Table 4.3: Results of Run Test for the Pre Automation Period

<table>
<thead>
<tr>
<th>Runs Test</th>
<th>Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Value&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2673.69</td>
</tr>
<tr>
<td>Cases &lt; Test Value</td>
<td>625</td>
</tr>
<tr>
<td>Cases &gt;= Test Value</td>
<td>625</td>
</tr>
<tr>
<td>Total Cases</td>
<td>1250</td>
</tr>
<tr>
<td>Number of Runs</td>
<td>18</td>
</tr>
<tr>
<td>Z</td>
<td>-34.407</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.000</td>
</tr>
</tbody>
</table>

<sup>a</sup> Median

Source: Data Analysis (2015)

Similarly, the runs test results for the post market automation period presented in Table 4.4 below reveal that the observed number of runs was 13. The cases above and below the test value which is the median of 4463.65 are equal implying randomness of returns. Therefore, at 5 percent level of significance the study indicated that the returns in the post market automation period also followed a random walk.
Table 4.4: Results of Runs Test for the Post Market Automation Period
Runs Test

<table>
<thead>
<tr>
<th></th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Value⁴</td>
<td>4463.65</td>
</tr>
<tr>
<td>Cases &lt; Test Value</td>
<td>989</td>
</tr>
<tr>
<td>Cases &gt;= Test Value</td>
<td>990</td>
</tr>
<tr>
<td>Total Cases</td>
<td>1979</td>
</tr>
<tr>
<td>Number of Runs</td>
<td>13</td>
</tr>
<tr>
<td>Z</td>
<td>-43.958</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Median

*Source: Data Analysis (2015)*

The Z score is the result of the runs test and will tell us if our system has more (or fewer) streaks of consecutive wins and losses than a random distribution. The Z score shows us how many standard deviations we are away from the mean of a distribution. Although results in both periods indicated that returns follow a random walk, a closer look at the results of the two periods showed that the Z score of the post automation market is higher at -43.958 compared to the pre automation market at -34.407 which shows the returns of the post automation market are further from the mean of the distribution implying than they are more random than the pre automation market returns an indication of improved market efficiency. These findings are in line with others that have reported positive gains in efficiency with the introduction of market automation (Maghyereh, 2005; Sunday, 2011; Debysing and Watson, 2007).

However, the findings differed with those by Freund and Pagano (2000) who found non-random price behaviour for some stocks at the Toronto and New York Stock Exchanges following microstructure changes.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the research findings, presents the conclusions derived from the data analysis and the findings, and makes recommendations for improving the efficiency of the securities markets in Kenya, and proposes further area of research.

5.1 Summary of the Findings
The NSE initiated a number of microstructure changes in the market beginning 2004 aimed at improving market liquidity and efficiency, reducing transaction costs and information asymmetry, in addition to increasing market turnover. This study examined the effect of microstructure changes of automations on market efficiency by constructing two sub samples representing the pre market automation and post market automation periods.

To begin with, non parametric tests performed, in addition to other descriptive analysis, show that the mean returns in the post automation period was higher than the mean returns in the pre market automation period. Normality tests through Skewness and Kurtosis were conducted. Regarding Skewness and Kurtosis, the pre market automation period was found to be positively skewed and leptokurtic while the post automation period was found to be negatively skewed and platykurtic. This is an indication that market returns in both the periods are not normally distributed.
The Wilcoxon Sign Rank test was used to perform a test of significance to determine whether the microstructure changes undertaken by the NSE had a positive impact on the price discovery process. The study advanced the proposition that if automation has improved the price discovery process, then the prices in the post market automation period would be higher than the pre market automation period. The Wilcoxon Signed Rank test was therefore used to test whether returns in the post market automation period were higher than returns in the pre market automation period. The results revealed that returns in the post market automation period were higher than returns in the pre market automation period. This implies that automations in the NSE have had a positive effect on price discovery process.

Lastly, a runs test was performed on the pre market automation and post market automation periods to uncover any independency in returns. The results indicate that the market followed a random walk in both the periods. However, the efficiency of the market seemed to have improved in the post market automation period, an indication that market automation had resulted into improved market efficiency.

5.2 Conclusions of the Study

The results indicate that mean market returns in the post market automation period were higher than those in the pre market automation period. This higher market returns can be attributed to improved price discovery process. The results from normality tests also show that market returns are not normally distributed in both the periods, though the post automation period is almost a normal distribution as seen in the histogram. As regards efficiency of the market, the runs test results reveals that
market that market returns are more random in the period following automation than the prior period. This implies improved market efficiency.

These results corroborate the findings by Cornelius (1994), who argued that when a market first starts trading, it takes time for the price discovery process to become known. As markets operate and market microstructures develop, emerging stock markets are likely to become more efficient. The changing efficiency in the two periods also provide support for the adaptive market hypothesis which states that market efficiency undergoes cycles overtime as influenced by environmental factors, in this case, automation of the trading system. The general conclusion of the study is that introduction of automation in the Kenyan securities market has led to improved Market efficiency, thereby providing support for the adaptive market hypothesis.

NSE’s introduction of its ATS increased its automation process and speeded up electronic trading. This led to a drop in the execution time for market orders. Price efficiency is a public good that can inform corporate investment and financing decisions. A faster market can also enhance welfare by reducing risk-averse traders’ uncertainty about the probability and price at which execution may occur. Furthermore, faster trading can facilitate more complex trading strategies.

The main goal of the NSE and CMA is to enhance competition between markets and market intermediaries. By allowing faster markets to replace slower manual trading markets, the regulator investor protection rules effectively preclude traditional floor trading because human interaction is too slow. The goals of the NSE is to give investors, particularly retail investors, greater confidence that they will be treated
fairly when they participate in the securities markets, and to promote deep and stable markets that minimize investor transaction costs. Increasing the speed of order execution and the efficiency of prices formation likely gives investors greater confidence of fair treatment.

5.3 Recommendations

The findings of this study are important for policy making, especially those interested in improving the efficiency of the Kenyan securities market. The main implication of the study is that stock market automation is important in enhancing market efficiency. Market efficiency is a multi faceted issue and can be enhanced by increasing market liquidity and transparency, reducing transaction costs and removing impediments to market access. Although automation have been introduced in the Kenyan securities market to address liquidity and transparency, the market turnover is still low and access to the NSE by retail investors is still limited as all the stock broking firms are still located in Nairobi. Avenues worth considering include licensing more market players, adoption of a hybrid trading system, introducing internet securities trading in Kenya, and adopting the thriving mobile money transfer and payment systems in trading.

Kenya has increasingly embraced ICT which may be attributed to the comparative lower cost of access to internet via computers. Therefore, the NSE and CMA should consider pursuing full market automation of the market through adoption of both online and internet securities trading. Through these, investors would not have to travel to Nairobi where the brokers have offices to trade in securities, but can rather log into the online trading platforms operated by brokers wherever they are and be
able to access the electronic order book within the ATS of the NSE. One area worth considering is the use of the Internet. Internet stock trading has been a success in developed securities markets in Europe and North America. Securities markets policy makers should consider this avenue.

Pal and Mittal, 2011 noted information and communication Technology (ICT) has made information describing the macro and micro environment of economies readily accessible to stakeholders making them better placed to access and act in markets in accordance with changing dynamics in the environment. ICT is therefore expected to play a big role in making security markets efficient by driving security prices closer to their true values and therefore erasing trading patterns. This may result in the market becoming more efficient as information is readily and equally available and buyers are able to value securities fairly. This development would have the effect of increase the number of rational buyers in the market, none of whom can influence prices in the market, thus making the market more efficient.

Furthermore, the licensing of more stock dealers – the market makers – can assist in Improving liquidity and transparency. This will lead to a greater choice for investors and reduce further the cost of trading. The increased competition between the brokers will lead to better services for the investor. Investor education should also be considered as to the rights of investors in transactions and avenues incase of any disagreement.
Mobile phone technology and the invention of bundles have reduced the cost of accessing internet in Kenya. Therefore, the CMA and NSE should work with the ICT industry practitioners in order to harness the benefits of mobile telephony so that the thriving mobile money financial framework can be meshed with the broker payment systems together with ATS and CDS in order to enable the securities buying, selling and making payments for such transactions through mobile money transfer system such as M-Pesa, yuCash, Orange money and Airtel Money services and other emerging mobile money transfer platforms, such as Tangaza. The end result will be increase in market activity, enhanced liquidity and transparency, and heightened investor confidence, thus leading to improvement in securities market efficiency.

Lastly, the Exchange should however look to enhance its IT security infrastructure to secure online access to NSE systems by internal and external users. To benchmark NSE systems against best practice, the Exchange should also subject its security systems to audit by an independent and reputable third party. This is necessary given that the installation of the CDS in Kenya has witnessed an upsurge in fraudulent trading activities undertaken by brokers. Indeed, the electronic trading and depository systems have not stopped human manipulation to personal advantage, both by brokerage and CDSC staffs, despite the promised efficient monitoring of transaction and audit of broker activities. In addition more resources need to be put to cyber security to prevent hacking, eavesdropping, virus and malware attack, identity theft and theft of investors’ money in general.
5.4 Limitations of The Study

The NSE has undergone several stages of automation starting with the CDS in 2004, then the automated trading system in 2006, this was followed by a live trading board at the floor and recently the introduction of the BBO. However, this study was limited itself to the automated trading system of the NSE, despite having other systems before and after the automated trading systems.

The second limitation relates to the use of the NSE 20-Share Index as a market benchmark index which may have some limitations since it only captures the 20 highly capitalized and most actively traded companies at the securities market as opposed to all the current 64 listed firms, in addition to its accuracy being questioned (Odera, 2001). However, this did not have a serious draw back as the Index provide a good representation of the market sectors and a review of the 20 companies is done so as to best represent the various sectors and data was readily available as opposed to dealing with individual listed companies.

The study restricted itself to effect of automation on companies in the main investment market segment (MIMS) where the NSE 20 share index companies belong. This is despite the NSE having various market segments namely; Main Investment Market Segment (MIMS) which is the main quotation market with stringent listing requirements, Alternative Investments Market Segment (AIMS) which provide access to capital markets to small and medium sized companies, Fixed Income Securities Market Segment (FISMS) which deal with fixed income securities like treasury bonds and Futures And Options Market Segment (FOMS) to be introduced in the future.
5.5 Suggestions for Further Research

This research evaluated the effect of overall market automations on market efficiency. In future studies can be done on the specific market automations (CDS, BBO, CMS) to determine whether the results would be the same. The different automations may have had different effect on the market efficiency. Studies could also be done on the overall effect of the various automations on market efficiency.

The research could also be extended to all the individual stocks as opposed to the NSE 20 share index companies which are a sample representative of all the market sectors to determine whether the results would be similar. This could increase the accuracy of the results as you can authoritatively report as all companies are part of the sample.

The NSE 20 share index companies belong to the NSE’s Main Investment Market Segment (MIMS), studies should also extend to the other market segments in the NSE namely; Alternative Investments Market Segment (AIMS) which provide access to capital markets to small and medium sized companies, Fixed Income Securities Market Segment (FISMS) which deal with fixed income securities like treasury bonds.


NSE (2012b) Speech by NSE Vice Chairman Mr. Bob Karina During the Launch of The NSE Broker Back Office at Nairobi Securities Exchange Trading Floor, on 31st August 2015.


APPENDIX 1: NSE 20 SHARE INDEX COMPANIES

Agricultural Sector
Sasini Limited

Commercial & Services Sector
Kenya Airways Limited
Nation Media Group
Scangroup Limited
Centum Investment Company Ltd

Banking Sector
Kenya Commercial Bank Limited
The Cooperative Bank of Kenya Limited
Standard Chartered Bank Limited
Barclays Bank Limited
Equity Bank Limited
CfC Stanbic Holdings Limited

Manufacturing & Allied Sector
East African Breweries Limited
British American Tobacco Kenya Limited
Athi River Mining Limited
Bamburi Cement Limited
Energy & Petroleum Sector
KenolKobil Limited
Kenya Power Limited
Kenya Electricity Generating Company Limited

Insurance Sector
British-American Investments Company (Kenya) Limited

Telecommunications and Technology Sector
Safaricom Limited