THE EFFECT OF AUTOMATION ON STOCK MARKET PERFORMANCE: A CASE OF NAIROBI SECURITIES EXCHANGE

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DECLARATION AND RECOMMENDATION

Declaration

This research project is my original work and has not been submitted for any degree/diploma award in any other University or Institution.

_____ _____

Signature Date

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CM11/0534/09

Approval and Recommendation

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

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Jonathan Ang'ani Omuchesi

DEDICATION

This project is dedicated to my loving parents Mr. and Mrs. Paul Omuchesi Ang'ani, my dear wife Salome and our daughter Judith Hildah for their support and sacrifice which have made the development of this project possible.

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May God bless you all!

ABSTRACT

The automation of the Nairobi Stock Exchange (NSE) in 2006 was expected as part of its objectives to improve the performance of the market. This study investigated the effect of the automation on stock market capitalization, liquidity, efficiency, returns and volatility of the Nairobi Securities Exchange (NSE). Two study periods were considered pre-automation period (January 2002 to June 2006) and post-automation period (July 2008 to December 2012). This study therefore provided information valuable to the existing and potential investors in evaluating their investment positions. The study is of use to scholars through contribution to advance knowledge and research programs in finance and financial markets. The information from the study is valuable for policy, legal framework and stock market development to government and pseudo government bodies. Additionally it provides the institutions with an external audit assessment of the performance of NSE under automation regime. The study adopted a longitudinal research design and considered data on monthly returns, prices, volumes and monthly/quarterly GDP on 37 NSE listed firms from January 2002 to December 2012. The listed firms had data spanning the study period. The study used secondary data in its analysis. Descriptive and inferential statistics were used for analysis. The first objective was analyzed using a chi-square test and paired t-test, the second objective were analysed using a chi-square test, paired t-test and Wilcoxon signed rank test. The third Objective was analysed using the Wilcoxon signed rank test and t-test. A chi-square test and t-test were used to analyse objectives four and five. The results indicated that of automation of the NSE had a significant positive effect on market size, had a significant negative effect on market liquidity, and had no significant effect on market returns, market efficiency and price volatility at the NSE.

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LIST OF ABBREVIATIONS AND ACRONYMS

NSE	Nairobi Securities Exchange
GDP	Gross Domestic Product
MCR	Market Capitalization Ratio
ATS	Automated Trading System
NSEATS	Nairobi Securities Exchange Automated Trading System
CMA	Capital Markets Authority
CDS	Central Depository System
CDSC	Central Depository and Settlement Corporation Ltd
BBO	Broker Back Office
NYSE	New York Stock Exchange
NASI	NSE All Share Index
KBNS	Kenya National Bureau of Statistics
CBK	Central Bank of Kenya
ACCE	American Chamber of Commerce in Egypt
ASEA	African securities Exchange Association

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. Security exchanges have always been found in central locations for ease record 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).

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). Introduction of fully automated electronic trading systems, is one of the of six capital market-specific and related reforms among them stock market liberalization, enforcement of insider trading laws, privatization programs, structural pension reform, and institutional reform (de la Torre, Gozzi, and Schmukler, 2006). Security exchange automation started in the early 1970s and the transaction of securities became electronically traded through the support of information and communication technology (Jain, 2005).

Automation of the trading system usually either precedes or is preceded by the adoption of a Central Depository System (CDS) (Yartey and Adjasi, 2007). Capital markets automation does not only benefit one of the players of the financial trading game, but also all the players in the sector gain from such technological breakthrough. After the automation, investors were not entitled to go and deal directly with stock exchanges; they did not have to go to a stock broker's office or deal with the hassles of calling him/her on the phone. Initially,

investors had to compete for the broker's time through regular and continuous access. The application of information technology allowed the investor to reach the information he/she requires any time anywhere.

Since its inception in 1954 as the Nairobi Stock Exchange, the Nairobi Securities Exchange Ltd, which was initially operating based on the call-over system, facilitates trade in shares on the trading floor of the Exchange through the Automated Trading System (ATS), which was introduced in September, 2006 prior to installation of the CDS in 2004 (NSE, 2013).

In recent comparable studies on African a stock markets the low turnover performance in African stock markets and specifically Kenya has been partly attributable to the existence of manual systems. Automation has been 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 increases trading activity, improving market transparency and liquidity in the stock markets by speeding up operations (Capital Markets Authority, 2010).

Benimadhu (2003) indicates that exchange specific issues affecting stock markets in Africa are low level of liquidity, few listed companies and the small size of the exchange as well as efficiency. The study will assume that the stock exchanges in Africa face the same challenges. Policy options for promoting the development of the stock markets in Africa have been discussed (Yartey and Adjasi, 2007). To address the challenges of stock exchanges in Africa, they recommended robust electronic trading systems and central depository systems as being very crucial. The performance Stock markets are influenced by a number of factors notably the activities of governments and the general performance of the economy. There is a direct correlation between the level of development of a nation's capital market and her overall social and economic development (Okereke-Onyiuke, 2000). There is therefore, the need for a fast growing capital market, through technological innovation so as to facilitate the speedy growth and development of

an economy. Since the main objective of automation is to create a well-functioning stock market, automation can have positive effects on market microstructure-related characteristics of volume and volatility. Automated exchanges can be deeper and more liquid than open outcry exchanges (Kibuthu, 2005).

The Stock Exchange of Mauritius (SEM) (2004) identified the operational advantages derivable from automation and the application of the automated trading system (ATS) as; electronic matching of orders, internet trading facilities, enhancing internationalization of the stock market' multiple prices for an order, quick order execution prices and volume levels available in real time. Automation also improved market data or information, online report of prices, higher volume of trade and index, online corporate reporting, transparency of dealings and fairness in establishing order priority. Conceptually, an automated stock market will ensure automatic monitor and a user friendly stock market. All this operational advantages of automation were to translate into improved market performance measurable in terms of market liquidity, volatility, size and efficiency.

The performance of a stock market of an economy is of interest to various parties including investors, capital markets, the stock exchange and government among others. There is evidence that stock markets promote economic growth in Africa (Yartey and Adjasi, 2007). They find that stock markets contribute to financing corporate investments and growth of listed firms in Africa i.e. stock markets impact aggregate economic performance through corporate financing.

1.2 Statement of the Problem

There has been an upward trend in securities market automation in Sub-Saharan Africa in the last two decades (Senbet & Otchere, 2008). Complete automation of the market microstructure has been advanced one of the Policies for building capacities of African Securities Markets and a solution to the recurrent problems in stock market performance (Capital Markets Authority, 2010). African stock

markets are known to be illiquid and characterized by thin trading (Mlambo and Biekpe, 2005). NSE is not an exception. The Kenyan market had an upsurge in activity since 1993 due to economic reform, privatization, and relaxation of restrictions on foreign investors and of exchange controls. However, implementation of the economic reform programme has been inconsistent and political problems remain, leading to market volatility, especially in dollar terms and liquidity has remained low throughout (Jefferis and Smith, 2005). The automation of NSE was a key to achieving enhanced operational efficiency, transparency, reduced cost of doing business, and enhanced market integrity and investor confidence (Capital Markets Authority, 2007). Higher volatility in stock markets in developing countries reduces the efficiency in allocating investment resources (Yartey & Adjasi, 2007). Low liquidity should be of great concern to Africa as market liquidity is a vital channel for linking stock market development with economic performance (Capital Markets Authority, 2010). Liquidity induces firms to list on their exchange, as it is a determinant of their cost of capital and their decision about the optimal capital structure (Gunther, 2007). Studies by Okumu (2013), and Naidu and Rozeff (1994) show an improved market efficiency and a more volatile market, (Benouda and Mezzez (2003) show an improvement in the liquidity of shares, decreased returns and no chnage on volatility or efficiency as well as Mensah, Pomaa-Berko and Adom (2012) finding no change in the efficiency of the exchange following automation of the exchange. In view of this, there was need to determine the performance of NSE under the automation regime. Automation was deemed to influence market performance positively and thus enhancing effective and efficient resource mobilization and allocation in the Kenyan economy thus affecting economic growth. The study sought to determine the effect of automation on the performance of NSE.

1.3 The Main Objectives of the Study

The main objective of the study was to determine the effect of automation on the performance of the Nairobi Securities Exchange.

1.3.1 Specific Objectives

The specific objectives of the study were to;

i. To determine the effect of automation on stock market size at the NSE.
ii. To determine the effect of automation on stock market liquidity at the NSE.
iii. To determine the effect of automation on stock market returns at the NSE
iv. To determine the effect of automation on stock market efficiency at the NSE.
v. To determine the effect of automation on stock price volatility at the NSE.

1.4 Research Hypotheses

i. Automation does not have a significant effect on stock market size at the NSE.
ii. Automation does not have a significant effect on stock market liquidity at the NSE.
iii. Automation does not have a significant effect on stock market returns at the NSE.
iv. Automation does not have a significant effect on market efficiency at the NSE.
v. Automation does not have a significant effect on stock price volatility at the NSE

1.5 Significance of the Study

Capital market automation may or may not have an effect on security market performance. As such, existing, potential investors and other stakeholders need to take stock of innovations and inventions in the capital markets to determine how they will influence their investment and policy positions. The study provides information valuable to the existing and potential investors on potential benefits/losses of automation with regard to their investments and evaluate their investment positions.

Evidence emanating from this study is of use to scholars through contribution to advance knowledge and research programs in finance and related fields. This will

be a point of reference by researchers in the area automation and security market performance.

The information in the study is valuable for policy, legal framework and stock market development to government and pseudo government bodies such as the Nairobi Securities Exchange (NSE) and the Capital Markets Authority (CMA). The study enhances financial deepening activities that will inspire investor confidence. Additionally it provides the institutions with an external audit assessment of the automation innovation progress at the NSE and will guide in subsequent implementation of other initiatives of enhancing market performance.

Generally the study gives an insight on the pattern of stock market size, stock market liquidity, stock market efficiency, stock market returns and price volatility before and after automation. This information is helpful to stock brokers in advising their clients and potential clients on how their investments will be or have been affected and how they can reap maximum returns on their portfolios.

1.6 Scope of the Study

The study was on the NSE. Specifically the study considered the secondary market equity performance. The study covered an 11-year period i.e. from January 2002 to December 2012. The study was divided into two periods: pre-automation (January 2002-June 2006 i.e. 54 months) and post-automation (July 2008-December 2012 i.e. 54 months). The pre-automation period considered NSE performance after major restructuring and reforms in the Kenyan capital market, the post automaton period considered the performance of the NSE 2 years (24 months) after automation to determine its effect on NSE performance.

1.7 Limitations of the Study

The study considers secondary data in its analysis. This data is compiled by independent institutions charged primarily with the responsibility of collection and dissemination.

Security market performance could be influenced by several economy-wide factors which may have a positive impact, negative or no effect on its performance. The study analyses NSE performance considering two periods. The

pre-automation period captures to a larger extend when most of the economy-wide factors that could influence security market performance were being undertaken and therefore its effects are already captured in pre-automation period.

The automation of the NSE is a process that started with the installation of the CDS in 2002 and subsequent implementation of the ATS in 2006. There is possibility of an issue of separation of CDS and ATS in terms of its effect on stock market performance. The study considers automation of NSE to be when the CDS and ATS were both operational and this is what represents the post automation period.

The time lag after implementation of the ATS is two years. This may be considered too long and some important information after implementation may not be captured in the study. However the study allowed for this considerable time in order to give enough time for the market to respond and adjust to the change. Moreover the study was being considered for a longer period (monthly). This lag will not significantly affect the results.

1.8 Operational Definition of Terms

Market Liquidity: the ease and speed with which individuals and institutions can buy and sell securities.

Electronic trading: a trading in which all transaction takes place through using screen for each stock broker, so that each stock broker place buy and sell orders into a trading system which matches the orders to generate a trade.

Market transparency: the possibility of participants in the securities market to observe the size and the direction of the order flow.

Market efficiency: The degree to which share prices reflect all available and relevant information

Market Volatility: Changeability or randomness of security prices in the securities market.

Market Return: The gain or loss of a security in a particular period in the securities market

Automation: Operation or control of a process by highly automatic means involving use of electronic devices and minimum human intervention. In this study it refers to the period at NSE when the CDS and ATS were both operational

Stock Market Automation: computerization of stock market buy and sell order processes through an information system at the capital market

Stock Exchange: The market in which shares are issued and traded either through exchanges or over-the-counter markets.

Stock market size: the level of activity in the stock market as measured by number of listed firms and market capitalization with respect to economic activity market

Securities Exchange: organized market for buying and selling financial instruments (securities), which include stocks, bonds, options, and futures.

Stock market liberalization: a decision by the government of a country to allow foreigners to purchase shares in that country's stock market.

Capital market: A market in which individuals and institutions trade financial securities.

Market capitalization: is the market value of a company's outstanding shares.

Stock Market Performance: the indicator of the stock market as a whole or of a specific stock.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview of Nairobi Securities Exchange

In Kenya, dealing in shares and stocks started in the 1920s when the country was still a British colony. There was, however, no formal market, nor rules or regulations to govern stock broking activities. Trading took place on gentleman's agreement, in which standard commissions were charged, with clients being obligated to honour their contractual commitments (Gray, 2001).

The Nairobi Stock Exchange was constituted in 1954 as a voluntary association of stock brokers registered under the Societies Act. In the same year Nairobi Securities Exchange formerly Nairobi Security Exchange started its operations as an overseas stock exchange when Kenya was a British colony with the permission of the London Stock Exchange. NSE is one of the four (4) securities exchanges forming the EAC securities market. NSE is the oldest and largest in EAC followed by Dar-es-Salaam Stock Exchange (DSE) incorporated in September 1996 as a private limited company, the third is the Uganda Securities Exchange (USE), which was launched in June 1997 and lastly, the Rwanda Stock Exchange (RSE) is the youngest exchange in EAC, having opened for business on 31st January 2011 (ASEA Newsletter, 2012 and NSE, 2013).

The Nairobi Securities Exchange (NSE) is one of the active capital markets in Africa. The NSE is sub-Saharan Africa's fourth largest bourse with 58 listed companies and 24 brokerage firms (Onyuma et al, 2012). NSE reclassified the industry sectors under which listed companies are placed. Equities are now classified under ten (10) industry sectors. Debt securities including preference shares are classified under three (3) categories. This reclassification brings NSE closer to international best practice and will enable domestic and international investors to more easily compare company and sector performance. NSE's Vision is "To be a leading securities exchange in Africa, with a global reach" (NSE, 2013).

Reforms for improvement of NSE started way back through consulted efforts by the government other stakeholders; In 1984, A Central Bank of Kenya study, titled, "Development of Money and Capital Markets in Kenya" was a blueprint for structural reforms in the financial markets helped in the creation of a regulatory body 'The Capital Markets Authority' (CMA) in 1989. The first privatization activity at NSE was the sale of 20% government stake in Kenya Commercial Bank in 1988. Notably, in 1994 the NSE 20-Share Index recorded an all-record high of 5030 points and subsequently on February 18, 1994 the NSE was rated by the International Finance Corporation (IFC) as the best performing market in the world with a return of 179% in dollar terms. In July of the same year NSE moved to more spacious premises at the Nation Centre setting up a computerized delivery and settlement system (DASS). After the privatization of Kenya Airways in 1996 more than 110,000 shareholders joined the NSE and in July 2000, the Central Depository System (CDS) Act was passed by Parliament and sanctioned by the President in August 2000 (NSE, 2013).

In February 2001, basic reformation of the capital market of Kenya took place and divided the market into four independent market segments: the Main Investments Market Segment (MIMS), the Alternative Investments Market Segment (AIMS), the Fixed Income Securities Market Segment (FISMS) and later Futures and Options Market Segment (FOMS).

In the 2001/2002 budget, the Government offered the extra incentives to capital markets investments. On17th April 2002, the CMA declared the sanction of the new NSE trading and settlement rules with amendments. There are three categories of investors on the Kenyan capital market; local, East African and foreign after the introduction New Foreign Investor Regulations in 2002. The central depository system (CDS) was installed in 2004 after the establishment of the Central Depository and Settlement Corporation (CDSC) in 2002 (NSE, 2013).

In 2006 there was implementation of live trading on the Nairobi Securities Exchange Automated Trading Systems (NSEATS). In the same year an MoU between the Nairobi Securities Exchange and Uganda Securities Exchange

was signed in November 2006 on mass cross listing. The MoU allowed listed companies in both exchanges to dualist. This was hoped it will facilitate growth and development of the regional securities markets. The innovation trend continued in 2007 and NSE upgraded its website to enhance easy and faster access of accurate, factual and timely trading information in February. The NSE 20-share index was reviewed to ensure it is a true barometer of the market. Likewise in the same year a Wide Area Network (WAN) platform was implemented and this eradicated the need for brokers to send their staff (dealers) to the trading floor to conduct business. Trading is now mainly conducted from the brokers' offices through the WAN (NSE, 2013).

In 2008, the NSE All Share Index (NASI) was introduced as an alternative index. Its measure is an overall indicator of market performance. The Index incorporates all the traded shares of the day. Its attention is therefore on the overall market capitalization. NSE launched the Complaints Handling Unit (CHU) in 2009 to bridge the confidence gap with NSE retail investors. Investors, both local and in the diaspora can forward their issues via e-mail, telephone, fax, or SMS and have the ability to track progress on-line (ASEA Year Book, 2008 and NSE, 2013).

Finally in 2011, the Nairobi Stock Exchange Limited changed its name to the Nairobi Securities Exchange Limited in July. The change of name reflected the strategic plan of the Exchange to evolve into a full service securities exchange that supports trading, clearing and settlement of equities, debt, derivatives and other associated instruments. In the same year, the equity settlement cycle moved from the previous T+4 settlement cycle to the T+3 settlement cycle. This allowed investors who sell their shares, to get their money three (3) days after the sale of their shares. The buyers of these shares will have their CDS accounts credited with the shares, in the same time. This is in line with international best practice. Also in September 2011 the Nairobi Securities Exchange converted from a company limited by guarantee to a company limited by shares and re-registered as the Nairobi Securities Exchange Limited.

Similarly in October 2011, the Broker Back Office commenced operations. The system has the capability to facilitate internet trading which improved the integrity of the Exchange trading systems and facilitates greater access to the securities market. Lastly in November 2011 the FTSE NSE Kenya 15 and FTSE NSE Kenya 25 Indices were launched. The launch of the indices reflected the growing interest in new domestic investment and diversification opportunities in the East African region. In March 2012 the delayed index values of the FTSE NSE Kenya 15 Index and the FTSE NSE Kenya 25 Index were made available on the NSE website www.nse.co.ke. The Nairobi Securities Exchange is a member of the Financial Information Services Division (FISD) of the Software and Information Industry Association (SIIA). As of 2011 the NSE currently had 57 listed companies (NSE, 2013).

2.2 Performance of the Nairobi Securities Exchange

One notable performance was in 1994 when the NSE was rated by the International Finance Corporation (IFC) as the best performing market in the world with a return of 179% in dollar terms with the NSE 20-Share Index recording an all-record high of 5030 points (NSE, 2013). The NSE 20 Share Index declined by 27.7% to close at 3,205.02 points at the end of 2011. The NSE All Share Index (NASI) declined by 30.6%, closing at 68.03 points at the end of 2011. The FTSE NSE Kenya 15 and FTSE NSE Kenya 25 indexes declined 3.15% and 3.31% respectively to 90.31 and 92.64 points (CMA Quarterly Statistical Bulletin, December 2011). See appendix 2 on summary of trends key market performance indicators of the NSE in the years 2002 and 2011

Market capitalization reached an all point high of 1166.7Bn in 2010, the Market Capitalization of Listed Companies (% of GDP) reached all point high of 69.39% in 2006, and volume traded reached an all point high of 7.55Bn shares and resulted in the highest turnover of 110.38 Bn in the period under study. The NSE 20-Share Index reached a historic high of 6161 points in January 2007 but closed the year at 5,445 points.

In 2006 The NSE 20-Share Index reached a historic 5646 points which was a 12-month average high in the period under the study. There were 51 and 58 listed companies at the NSE in 2002 and 2011 respectively. During the same period there was 2 companies were delisted and 6 were suspended of which 3 were readmitted. Farther in the same period there were 14 rights issues where a total of Kshs 48,804,052,635 million was raised from the 2,058,031,497 million shares on issue. Similarly in the same period there were 8 IPOs which raised a total of Kshs 71,155,563,000 million was raised from 15,171,900,000 million shares on issue. In the same period there was one Offer for Sale (OFS), one Public Offer (PO) and three Introductions; a total of Kshs 5,020,990,000 million was raised from the OFS and PO. Apart from a poor performance in 2005 with a low of 13.6Bn, the bonds market has been performing well since 2008 and as at December the market had a Turnover of 450.76Bn. 2011. This has been attributed to the automation of secondary trading in the bond market in 2009 (CMA Quarterly Statistical Bulletin, December 2011).

2.3 Measures of securities market performance

Mailafia (2011) examined the effect of automation of the trading system in the Nigerian stock exchange using the key capital market indicators; Market Capitalization, number of listed companies, equity turnover, Market Capitalization as % of GDP, traded volume, turnover ratio, Equity Turnover as a % of GDP, Annualized Index Returns and Annualized Growth in Market Capitalization.

Market capitalization is a measurement of corporate or economic size equal to the share price times the number of shares outstanding of a public company, providing a total value for the company's shares and thus for the company as a whole. Market capitalization represents the public opinion of a company's net worth and is a determining factor in stock valuation.

Market Capitalization Ratio MCR refers to the value of listed shares divided by Gross Domestic Product (GDP). Generally, this ratio is used to determine whether an overall market is undervalued or overvalued. The size of the stock market

depends on the activity of the primary market because it is only when more entities come into the market and raise funds, that more instruments are available in the secondary market. This measure assumes that the overall market size is positively correlated with the ability to mobilize capital and diversify risk on an economy wide basis (Agarwal 2001). These measures have also been applied by Yartey (2008) to measure the size of the Johannesburg Securities Exchange. Economic performance has a direct influence on investors' participation especially because it affects their earnings and therefore their ability to participate in the market (Ngugi, 2003). Similarly other studies have considered analysis of market performance by assessing capital markets in terms liquidity, volatility, returns and market efficiency etc.

2.3.1 Market Liquidity

Kyle (1985) suggests that market liquidity is an "elusive" and "slippery" concept which is not easy to define because it is composed of multiple dimensions. These include tightness, depth and resiliency. Tightness looks at the cost of transactions such as bid-ask spreads. Depth represents the ability of the market to absorb a large quantity without having a large impact on the price and resiliency considers the speed with which prices bounce back to equilibrium following a large trade. A market is considered to be liquid when it accommodates the ability to trade a large size quickly, at low cost, when one trades (Harris, 2003). The Value traded ratio can be used to stock market liquidity on an economy wide basis (Levine and Zervos, 1998). Likewise liquidity can also be measured by the Turnover ratio (Popovic, 2004). Theoretically, the trading volume of a given security is an increasing function of its liquidity, other things being equal. Thus, an increase in the trading volume of a stock after its transfer to the new trading system reflects an increase in its liquidity.

2.3.2 Volatility

The volatility of securities can be defined by fluctuations of stock prices can be estimated by the variance or the standard deviation of stock returns. Theoretically, a change in the volatility of either future cash flows or discount rates causes a

change in the volatility of share prices (Schwert, 1989).Volatility parameter as a measure of stock market performance conceptualizes the asset price movement in the stock market. There is an important link between financial market uncertainty and public confidence. Policy makers, therefore, rely on market estimates of volatility as a barometer of the vulnerability of financial markets. The existence of excessive volatility or noise also undermines the usefulness of stock prices as a signal about the true intrinsic value of a firm, a concept that is core to the paradigm of informational efficiency of markets (Goel and Gupta, 2011).

A higher degree of price volatility on stock markets in reduces the efficiency of the price signals in allocating investment resources especially in developing countries (Yartey and Adjasi, 2007). The perception of both the public and the press about stock market volatility, in fact, is largely based on point changes. There is an agreement among finance academicians that volatility should be measured in terms of percentage changes in prices or rates of return, thus discarding the use of absolute amount of changes in asset prices. Point changes usually exceed percentage changes because the index levels from where the prices move are often greater than 100 (Jones and Wilson, 1989). Thus, the point changes invariably overestimate and create a false impression regarding the magnitude of volatility among the investors.

The widely accepted concept of rates of return is, of course, the logarithmic difference of prices of two successive periods. Symbolically, the rate of return (r) may be stated as follows:

$$r_t = In(\frac{P_t}{P_{t-1}}),\ t = 1, 2\ldots, n$$

Where r_t is the rate of return for the period t, and P_{t-1} and pt are the prices for two successive periods $(t-1)$ and t.

The standard deviation of return (r) from a sample of n observations is the square root of the average squared deviation of returns from the average in the sample.

Thus

$$\sigma = [\frac{1}{n}\sum_{t=1}^{n}(r_t - m)^2]^{1/2}$$

Where,

$\sigma =$ standard deviation

$n =$ number of continuous returns

$r_t =$ continuous returns

$m =$ average returns

$r_t = In(\frac{P_t}{P_{t-1}})$ and r_t is the rate of return for the period t, and P_{t-1} and P_t are the prices for two successive periods $(t-1)$ and t,

$$m = \left\{\frac{1}{n}\sum_{t=1}^{n} r_t\right\}/n$$

There are number of alternative methods to measure volatility in finance. The method to use will depend on the suitability for the nature of data available for the study (Beckers, 1983).

2.3.3 Market returns

In measuring capital market returns many studies makes use national stock index. A market that registers an increase in the Index is deemed to be performing well. Capital Market Authority (2010) while comparing performance of African Capital markets makes use of annualized index returns and annualized growth in Market Capitalization. Annualized growth in Market Capitalization, measures growth/accumulation of investors wealth in the stock market and is measured in percentage terms.

An event study methodology of the transferred stocks is used and enables one to discern the effect of the transfer on the behavior of stock returns, by detecting some abnormal returns after the realization of the event (Brown and Warner, 1980).

Periodic returns are calculated on the basis of relative stock prices according to a given formula:

$$R_{it} = In(\frac{P_{it}}{P_{it-1}})$$

and R_{it} is the return on stock i in period t, and P_{it-1} and pit are the closing prices for two successive periods for each stock in period t.

To detect some abnormal returns after the transfer, the comparative periodic market returns are calculated on the basis of the stock market indexes as;

$$R_{mt} = In(\frac{N_t}{N_{t-1}})$$

Where R_{mt} is the monthly return of the NSE 20 index on month t; N_t is the closing value index on month t and N_{t-1} is the closing value of the index on month $t-1$.

Abnormal returns will be obtained thus;

$$\varepsilon_{it} = R_{it} - R_{mt}$$

2.3.4 Market efficiency

The performance of the stock market is highly influenced by the efficiency of the exchange. Market efficiency explains the degree to which share prices reflect all available and relevant information (Gupta and Basu, 2005). Efficiency on the exchange ensures accurate pricing of stocks by avoiding under and over valuation of stocks which encourages share buying. This is because when stocks are incorrectly priced, it deters potential investors from buying shares for fear of a perverse price when they decide to sell their shares and this ultimately reduces the availability of capital to firms for growth. Secondly, it ensures efficient allocation of resources in the sense that firm's performance is reflected in their stock prices which informs potential investors to take optimal investment decisions.

In Kenya, available studies on the efficiency of the NSE show that the exchange is weak-form efficient. For instance a Cross country analyses of the capital markets in Africa reveal that emerging capital markets including Kenya are weak-form efficient (Appiah-Kusi and Menyah (2003). Several reasons have been cited to account for the inefficiency of the Kenyan capital market. Prominent among

them was the hitherto manual listing and paper certification on the exchange which hindered information flow. During this era there were delays in adjusting stock prices to reflect available information on the market with the resultant effects of over and under valuation of stock prices. The automation of the Nairobi Securities Exchange was premised on the belief that it would improve the efficiency (both operational and informational) of the market. The installation of the CDS and automation at the NSE was expected to improve operational efficiency (Onyuma, 2009).

The methodology used in testing market efficiency analyzes the behavior of the market model residuals before and after the transfer to the automated trading mechanism. The decrease of the residual variance after the transfer will be interpreted as a reduction of the pricing error and therefore an improvement of efficiency. The Efficiency Market Hypothesis posits that a market is efficient when it is able to adjust instantaneously to take account of all available information, whether past, public inside or secret, such that no single agent in the market obtains more information than the information that is already reflected in the market prices. The theory outlines three main dimensions of capital market efficiency each depending on the set of information available: weak- form market efficiency, Semi-strong market efficiency and Strong market efficiency.

Weak-form market efficiency exists when current prices fully reflect all historical price information, such that prices automatically adjust to information changes without lags. With semi-strong form efficiency, market prices reflect available public information including company reports, annual earnings, stock splits and company public profits forecasts. The stronger forms of efficiency, however, exist when prices reflect both public and private information about earnings, book values, investment opportunities.

One might test the significance of an event by averaging the abnormal performance for the sampling of securities during the event periods. If abnormal returns are not statistically significantly different from zero during the relevant testing period, one can conclude that the test did not provide evidence indicating

the significance of the event. In this case, or if abnormal performance rapidly disappears, we have evidence of market efficiency with respect to that type of information. On the other hand, evidence of a slow security price reaction to the event suggests that the market does not react efficiently, and perhaps, abnormal returns might be earned with this event information.

2.4 Automation of the Nairobi Securities Exchange

Automation of the trading system usually either precedes or is preceded by the adoption of a central depository system (CDS) (Yartey and Adjasi, 2007). NSE automation was preceded by the establishment of the Central Depository and Settlement Corporation (CDSC) in 2002 after a Shareholder Agreement was reached and subsequent installation of the central depository system (CDS) in 2004. The automation of the NSE was three fold i.e. installation of the CDS in 2004, the ATS in 2006 and the WAN in 2007.

2.4.1 The Central Depository System

The Central Depository System (CDS) Act was sanctioned in August 2000. The Central Depository and Settlement Corporation (CDSC) were established in 2002 after a Shareholder Agreement was reached and subsequent installation of the central depository system (CDS) in 2004. The CDS System was an Oracle/Unix based system developed by Millennium Information Technologies (based in Sri Lanka and Boston) and it is also running in Sri Lanka, Croatia and Ghana, Mauritius. The system was such that Participants and registrars have online access to the CDS system from their own offices, Participants open and maintain Securities Accounts directly in the CDS system, there is Segregation between Clients' Securities Accounts and Participants' (proprietary) Securities Accounts, it has Real-time interface with automated trading system, it has 3-tier architecture with separation of logic, content and display provides flexibility, security, reliability and scalability, it is a Web-based system (can be deployed over the Internet) and it also has High-Availability configuration and Disaster Recovery Plan (NSE, 2013).

Besides the CDSC being instrumental in clearing and settling trades, it functions as: Central depository for share certificates of companies quoted on the Nairobi Stock Exchange; Sub-registry for all quoted securities (in conjunction with registrars of quoted companies); Issuer of central securities identification numbers to stock holders and the custodian (in conjunction with members) for local and foreign instruments. The system operates a T+3 settlement cycle for transaction on the exchange. The T+3 (transaction plus three days) settlement cycle is facilitated by the immobilization of share certificates in a central location which in turn enables transaction to be processed in an electronic book entry form (NSE, 2013).

The CDSC is beneficial to Investors, Quoted Companies and Stock Broking Firms in Reducing incidence of loss or stolen share certificates, Elimination of late delivery of share certificates, Reduction in the cost of maintaining register of shareholders, Increased liquidity of stock, Increased transparency of market, Increased market turnover, Encourages foreign investments, Ensures prompt inter-broker money and stock settlements, Increased efficiency and profitability of stock broking firms, Reduction of operating costs. The introduction of the CDS in 2004 brought phenomenal growth to the market with the number of shares traded growing from 380 million to 5800 million in 2008. By the end of 2010 4500 million shares had been traded. In 2008 CDS saw the addition of 766,000 new investors in the market through the Safaricom IPO. This could not have been possible without the automation of the delivery and settlement of shares through the CDS (CDSC Chairman's Statement, September 2010).

2.4.2 The Automated Trading System (ATS)

The NSE Automated trading system (NSEATS) was installed on 11th September 2006. NSEATS was developed by the Sri-Lankan based Millennium Information Technology and the staff of the NSE and the CDS. NSEATS is a mainstream computer system designed to match buy and sell orders placed by stock broking companies. Each stockbroker has in his/her office a computer terminal connected with a server located at the NSE. The central system software consists of an

electronic order book which enables members to post their buy and sell orders on behalf of their clients and to have their orders matched automatically. When an order is matched, the broker receives immediately a confirmation of the execution of the trade. The system works in such a way that when a client gives an instruction to his stock broking firm to buy or sell a particular stock, the broker will enter the order on his/her terminal. The order will instantaneously be routed electronically to the Stock Exchange.

The Automated Trading System automatically matches the orders against each other, resulting in trades. The Automated Trading System records the sale price, quantity, buyer and seller and time of the trade. Trades that are executed by the Automated Trading System are known as on-market trades. Orders entered into the Automated Trading System are matched under the supervision of the NSE. The order book maintained by the Automated Trading System for each security is divided into bids and offers and prices are determined and trades effected in accordance with specific rules depending on order parameters set out in the Trading Procedures. The NSEATS was customized and upholds open outcry system i.e. it allows for floor trading of securities alongside the ATS (NSE, 2013).

2.4.3 The Wide Area Network

A Wide Area Network (WAN) platform was implemented in 2007 and this eradicated the need for brokers to send their staff (dealers) to the trading floor to conduct business. Trading was now mainly conducted from the brokers' offices through the WAN. The WAN platform was boosted by the Broker Back Office system which commenced operations in October 2011. The BBO system automated the entire process of transacting in shares with minimal manual intervention and was interfaced with the Automated Trading System (ATS) and Central Depository System (CDS). The system had the capability to facilitate internet trading which improved the integrity of the Exchange trading systems and facilitate greater access to the securities market. However, brokers under certain circumstances can still conduct trading from the floor of the NSE. The automation of the Back Office operations of the Trading Participants of the NSE was a joint

initiative of the Nairobi Securities Exchange (NSE), the Kenya Association of Stock Brokers and Investment Banks (KASIB), the Capital Markets Authority (CMA) and the Central Depository and Settlement Corporation (CDSC). Now, the entire process of trading in securities listed on the NSE is supported by IT, from inputting an order, to processing the order, to making payment and transferring the securities to the new owners (NSE, 2013).

The Broker Back Office is beneficial to Kenya's stock market as Investors would be able to trade through their mobile phones and after additional security features are included and tested, through the internet; Senior management of the Trading Participants and the Clients of the Trading Participant would be able to monitor and audit activities through alert messages and exception reports; it permitted internet access to the system, helping Trading Participants expand their services across all forty seven (47) counties and abroad and It supports Initial Public Offers (IPOs), portfolio management and complaints processing. The Broker Back Office (BBO) was an affirmative step that the Kenya capital markets players and industry as a whole, had taken towards achieving international best practice. The BBO system vendor was Chella Software of India (ASEA Newsletter 2012 and NSE, 2013).

2.4.4 Comparison of open outcry and automated trading

Whether market liquidity is better in automated trading systems or in the open outcry markets in the organized exchanges remains a controversial issue (Frino and Hill, 2001). On the one hand, it is argued that automated trading systems are less liquid than open outcry markets because automated systems cannot handle periods of intense trading as well as floor-traded systems. This is because automated systems have a higher degree of information asymmetry concerning the identity of the traders, and deprive liquidity providers such as locals and market-makers of some of their trading advantages. The delays in cancelling orders on the automated systems discourage the submission of limit orders as traders are forced to offer free options with duration longer than those on the floor

traded systems. This effect could be especially important during periods of intensive trading, a reflection of high information arrival.

Table 2.1 below presented a comparative distinction of characteristics in outcry and automated trading.

Open outcry trading (floor trading)	**Electronic trading**
Trade takes place sequentially (typically in alphabetical order), i.e. one security at a time.	Trading can take place simultaneously in multiple securities at the same time.
Orders can be changed/cancelled faster, and price discovery maintained in markets under stress	Order cancellation procedure may cause delays and discourage limit orders; system may slow down or fail
It is easier to manipulate prices since traders can communicate between themselves and decide on bid and offer prices.	Transparent price discovery, reduced frauds and human errors (less room for informal communications) so prices are swayed by the dynamics of demand and supply
High fixed and operating costs	High development costs but low operating costs
Provide more information about counterparty	Adverse selection in block trades, limiting the growth of order size
Segregated exchanges	24-hour and globally/regionally linked trading possible

Source: Researchers' compilation, 2013.

2.4.5 Automation trends in Africa

Automation of stock exchanges is on the increase in Africa. Since the automation of the Johannesburg stock exchange in mid 1990s and movement of the Egyptian Stock Exchange to an automated order-driven system in 1992 there have been continued efforts towards automation. The Stock exchanges in Sub-Saharan

African stock exchanges have gradually adapted to electronic systems, but many of them still use manual trading systems as well as manual clearing and settlement systems. The most recent stock exchange to automate its trading system is the Botswana Stock Exchange in August 2012 with Uganda, Rwanda and Zimbabwe being in advanced stages of implementing the same (ASEA Newsletter, 2012).

Table 2.2: Infrastructural indicators of African Stock Exchanges

COUNTRY	CSD	TRADING SYSTEM	YEAR OF AUTOMATION
Botswana	Electronic	Electronic	2012
C/d'Ivoire	Electronic	Electronic	1999
Egypt	Electronic	Electronic	1992
Ghana	Electronic	Electronic	2008
Kenya	Electronic	Electronic	2006
Mauritius	Electronic	Electronic	2001
Morocco	Manual	Electronic	1997
Namibia	Manual	Electronic	1998
Nigeria	Electronic	Electronic	1999
S/Africa	Electronic	Electronic	1996
Tanzania	Electronic	Electronic	2006
Tunisia	Electronic	Electronic	1996
Zambia	Electronic	Manual	

Source: Researchers' Compilation from Data on Stock Exchange websites & Jain (2004)

2.4.6 Objectives of Automation

Many stock/security exchanges in Africa are automating and it is on the anticipation of realizable benefits as put forward by several studies; SEM (2004), CMA (June 2010) among others. Some of the realizable benefits objectives of automation put forward include Achieving a reduction in operation costs; Reduction in risks associated with clearing and settlement of transactions; Shortening of the settlement cycle; Achieving improved transparency and market surveillance; Enhanced efficiency of the exchange (both operational and informational) and an Improvement in trading volumes

2.5 Trading Process/procedures

2.5.1 Before Automation

The purpose of any microstructure change is to enhance growth in the stock market, to improve the trading system and to improve on the liquidity of the market (Murinde, 2006).

Figure 2.1 below shows the simulation of the traditional process of trading on NSE trading floor before automation

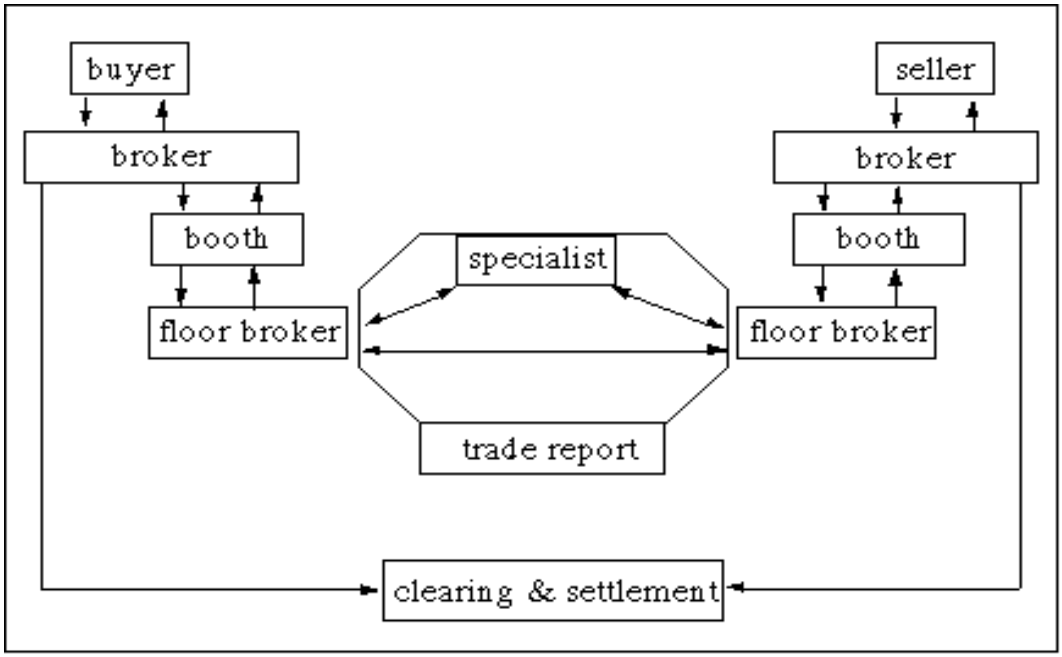

Figure 2.1: The traditional process of trading on a securities exchange trading floor (Before automation)

Source: Adapted from Traditional process of trading at NYSE (Kamel, 2007)

The traditional trading floor steps involved an investors calling a broker and ordering the purchase of shares; on noticing the order, the broker communicates with the relevant trader for order execution. A floor trader receives the order and calls a booth colleague who supplies executable order; the floor trader goes to the pit in the middle of the trading floor where shares are traded and sends the order for execution. An execution is settled when the counterparty is found and both parties record the transaction in their trading book; and simultaneously, the buyer reports the transaction to the trade reporting system and the trader makes a call to the booth to inform the broker to notify the client about the execution This

procedure would typically last about 5-15 minutes depending on the communications network system (telephone, fax etc). Only through the agreement of two corresponding orders can the settlement of the transaction be covered. The transfer of securities is managed by clearing and settlement, in which the alignment of the tickets of both trading parties, takes place (Kamel, 2007).

The automation of the clearing and settlement procedure started in the 1970s, leading to a reduction in paperwork. Today, a physical transfer of securities has largely become obsolete.

2.5.2 After Automation

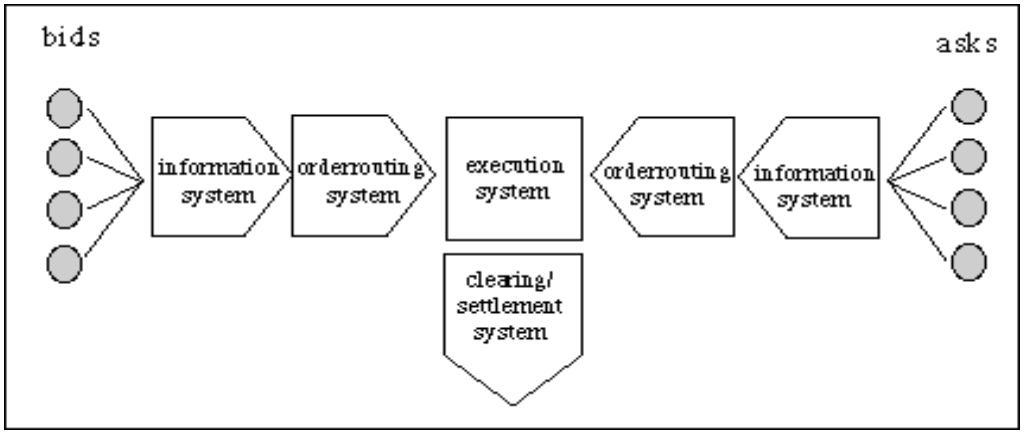

Figure 2.2: Process of Trading after automation

Source: Adapted from American Chamber of Commerce in Egypt, 2001

Automated trading involved an Information System which was mainly electronic (digital) replacing the traditional "pink sheets" system with information available and accessible around the clock; an Order Routing System which enhanced electronic transmission of orders to relevant recipients replacing individuals using hand signals and moving back and forth on the trading platform, currently all transactions are transmitted via electronic networks leading to remarkable increase in the volume of trading; an Execution System which facilitated the process and rendered it more effective and more efficient and Clearing and Settlement Systems which made the Process become easier and faster. Automated securities exchanges are order-driven and prices are determined by the electronic

publication and subsequent matching of orders to buy or sell shares. In such a system as shown in figure 2.2, the role of broker(s) is to act as an intermediaries to facilitate the matching of these buy and sell orders and then to execute the transactions. Under the system, buy and sell orders are matched automatically in the system. The closing price is therefore the last price at which a transaction is executed. Brokerage fee or commission is usually charged for this facility (ACCE, 2001)

2.6 Empirical Review

Advocates of automation suggested that execution of trades was faster and less costly under computerized trading systems. Traders have access to broader information including bid and ask prices, trades sizes and volume, at lower costs, due to the existence of a limit order book than under systems that restrict access to information about standing orders above and below the market. That would attract more investors and improve volume and liquidity and generate better price discovery.

However, critics of automation argue that electronic trading could lead to less efficient prices since judgmental aspects of trade execution are lost with automation, which could be particularly important in times of fast market movements. Further, it can be argued that price efficiency remains unchanged after automation. According to this viewpoint, liquidity and efficiency on a stock market depend on rules on handling and execution of trades. If these rules do not change, then liquidity and efficiency are not expected to change. Market efficiency is an important hallmark of a sophisticated market. A market microstructure (stock market automation) is premised on the belief that it would improve the efficiency (both operational and informational) of the market.

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 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.

Volatility is likely to increase when automation speeds up the dissemination of prices especially when information is hitting the market (Naidu and Rozeff, 1994). In their study they find out reduced autocorrelations of returns, which leads them to conclude that market efficiency improves after automation at the Singapore Stock Exchange. Anderson and Vahid (2001) investigate the impact of electronic trading on price efficiency on the London and Australian stock exchanges, using smooth transition error-correction models. Spot and futures markets become more efficient under electronic trading as transaction costs faced by arbitragers decrease significantly (Anderson and Vahid, 2001). Studies on the efficiency of the Johannesburg Stock Exchange reveal that the exchange is weakly inefficient except studies by Appiah-Kusi and Menyah (2003) and Smith (2008).

Mensah, Pomaa-Berko and Adom (2012) using the Unit Root Random Walk and the GARCH models find that the Ghana Stock Exchange (GSE) was weakly inefficient in both pre and post automation periods, suggesting that the automation of the GSE did not yield the needed impact towards improving the efficiency of the exchange.

Electronic trading systems may increase liquidity and improve efficiency by reducing transaction costs and increasing information availability. These trading systems may also attract new pools of liquidity, by providing affordable remote access to investors.

Several studies also examined the financial effects of automation on stock market liquidity and volatility. Domowitz and Stiel (2001), Muscarella and Piwowar (2001), and Jain (2005) document that stock prices increase and liquidity improves, and cost of equity capital falls all around the world when exchanges increase transparency through computerized trading. Similarly, a number of

studies have also tested the implications of the trading system on market liquidity by analyzing market performance with a different price discovery process; for example, there was liquidity gain and positive liquidity externalities when stocks are traded in a continuous auction session than a call auction system on the Tel Aviv Stock Exchange with the shift from call to continuous trading process (Kalay, Wei and Wohl, 2002). There is evidence that automated trading system accomplishes its mission of increasing volume (market size); however, it fails to reduce the asymmetric information among market participants on the Stock Exchange of Thailand (SET) (Sukcharoensin, Srisopitsawat and Chuenjit, 2004). The transfer to continuous trading enhanced the market liquidity on Paris bourse (Muscarella and Piwowar, 2001). They also noticed that the stock price increased as a result of market quality improvement following the shift. The study considered a sample of 134 listed firms.

Maghyereh (2005) examines the effect of the automation of Amman Stock Exchange (ASE) on the market efficiency using the daily closing price index for a period of 10 years. The sample included those stocks of the largest and most liquid. He found that the shift to electronic trading system increased volatility, and had no significant effect on market's efficiency. Similarly electronic trading significantly influences market liquidity and results in negative abnormal returns on the Amman Stock Exchange (ASE) (Iskandrani and Haddad, 2012). The study used data consisting of closing prices and trading volume for 38 companies for a period of 8 years and conducted an event study for the monthly relative means of 'trading volume' as a proxy for liquidity and stock price behavior was examined through conducting an event study for the stock return. In a separate study there is a reduction in volatility after the adoption of electronic trading and improved liquidity level of Amman Stock Exchange (ASE) (Al-Khouri and Al-Ghazawi, 2008). However, automation of the Tunisian Stock Exchange (TSE) resulted in the improvement in the liquidity of shares, decreased returns but did not have significant effect on volatility or efficiency (Benouda and Mezzez, 2003).

Assaf (2005) examines the effect of automation on volatility of Toronto stock exchange and finds on average, automation had a significant impact on the volatility and hence on the pricing of securities on the exchange. The evidence indicated significant changes in the structure of volatility and the risk-return relationship. The results were consistent with the interpretation that there had been an increase in the quantity of information flowing into the market post-automation. Automated Trading improved liquidity and reduced adverse selection on NYSE and the evidence was strongest for large stocks on (Hendershott et al, 2011). They used the automation of the NYSE quote dissemination as an implicit experiment to measure the causal effect of Automated Trading on liquidity.

Some studies have also focused on the effect of automation with respect to whether or not trading floor is present. Empirically, there is mixed evidence. In comparing the NYSE (which has a trading floor) with Euronext Paris (fully screen based) for a sample of similar stocks (Venkataraman, 2001) finds that spreads are lower on a floor based exchange than on an electronic exchange. Comparing the floor and the screen-based trading system of the Frankfurt Stock Exchange operating in parallel Theissen (2002) finds that an electronic (screen-based) trading system offers low spreads for liquid stocks, while the floor is more competitive for liquid stocks. Jain (2005) investigated 120 stock exchanges worldwide and finds that a change from floor to electronic trading had a number of long run beneficial effects. He found that the equity premium is reduced significantly after the switch to electronic trading and that the cost of capital of listed firms also declined and monthly trading turnover increased and this lowered stock market liquidity. However, a study done by Jarnecic and Snape (2010) using data provided by the London Stock Exchange (LSE) and found that HFT improved liquidity and was unlikely to have increased volatility.

Murinde (2006) conducted a study on micro-structure theory of the African capital markets in 1999 and discovered that with institutional changes market efficiency improved in NSE (Nigerian Stock Exchange), NSE (Nairobi stock exchange), JSE (Johannesburg stock exchange) and market liquidity also

improved, while volatility reduced. There was a highly significant improvement in the performance Nigerian Stock Exchange after the introduction of the ATS in 1999 (Mailafia, 2011). Similarly, Sunday, Omah & Oladimeji (2012) evaluate the effect of the microstructure change (from manual trading system to the automated trading system) on the trading effectiveness in the Nigerian stock market from 1999 to 2011. A similar study revealed that the ATS was an effective trading system and that it had brought about an efficient settlement system and fostered new trading opportunities (Sunday, Omah & Oladimeji, 2012). The study evaluated the effect of the microstructure change (from manual trading system to the automated trading system) on the trading effectiveness in the Nigerian stock market from 1999 to 2011.

Pagano and Roell (1996) compare liquidity and price formation processes in several trading systems with different degrees of transparency. Transparency is defined as the possibility to observe the size and the direction of the order flow. They suggest that greater transparency in the trading process improves market liquidity by reducing opportunities for taking advantage of less informed participants. Then, spread, volatility and pricing error are likely to decrease. Nevertheless, in terms of pre-trade reporting, Madhavan, Porter, and Weaver (2002) finds that too much transparency may be detrimental. They found a decrease in liquidity associated with the display of the limit-order book on the Toronto Stock Exchange (TSE) after controlling for volume, volatility, and price. The study also reveals that complete transparency is not always “beneficial” to the operation of the market it may lead to informed investors to quit the market because if they reveal their positions, they run the risk that this information will be used on their depends. Earlier, Biais et al. (1997) had suggested that automation can lead liquidity to decrease because it doesn't allow a direct negotiation between traders for important transactions and doesn't allow them therefore to preserve a certain control on trading conditions.

An efficient price discovery process is traditionally associated with lower fundamental volatility, which promotes stock market effectiveness in allocating

resources. High volatility can distort resource allocation by making investors more reluctant to hold stocks. Risk-averse investors will demand a high risk premium, which increases the cost of capital and reduces market liquidity (Kim and Singal, 2000). Okumu (2013) examines the impact of microstructure change on market efficiency at the NSE. She finds that introduction of automation at NSE has led to improved market efficiency. The results indicate that mean market returns in the post automation period were higher and more volatile than those in the pre automation period. She advances that the higher market returns could be attributed to improved price discovery process, while the higher volatility may be due to changes in market microstructure through the trading system.

The enthusiasm about stock markets performance in Africa has been talked about as much has been the solutions to the inherent problems. These studies indicate a mix in performance following a shift to automated trading which indicates that automation is not a guarantee for the implied benefits of automation.

The identified papers above tended to focus to on the effect of automation on specific aspects of stock market variables, such as volatility or liquidity in isolation. The study instead assessed the effect of automation on a local domestic market, using five variables of market performance: liquidity, price volatility, market returns, market efficiency and Market Size and establish the relationship among them. In addition, the papers considered only one aspect of stock/securities exchange automation: the Automated Trading System (ATS) or Electronic Trading System (ETS), this is a major limitation as it does not consider automation as a process with several interlinked stages but an as event. This study considered automation wholistically by considering all aspects in automation (CDS, ATS, WAN/BBO) and how 'the automation' affects stock market performance. Furthermore, afew of these papers include all listed firms categories in their analysis. This represents a significant limitation, given the significant participation of all firms in equity markets in resource mobilization and allocation and largely the performance of the market. The study considered all listed companies in all categories in evaluation of performance.

2.7 Conceptual Framework

To measure stock market performance the study considered stock market automation (the CDS, the ATS (NSEATS) and the WAN/BBO as the as key inputs. According to the framework, NSE Automation (ATS, CDS and WAN/BBO) constituted the independent variables whereas stock market performance (liquidity, price volatility, market returns, market efficiency and Market Size) the dependent variables which was the output.

In conceptualizing, NSE automation (CDS, ATS, WAN/BBO) was examined through its effect on stock market performance indicators (stock market size, stock market liquidity, stock market efficiency, stock market returns and price volatility).

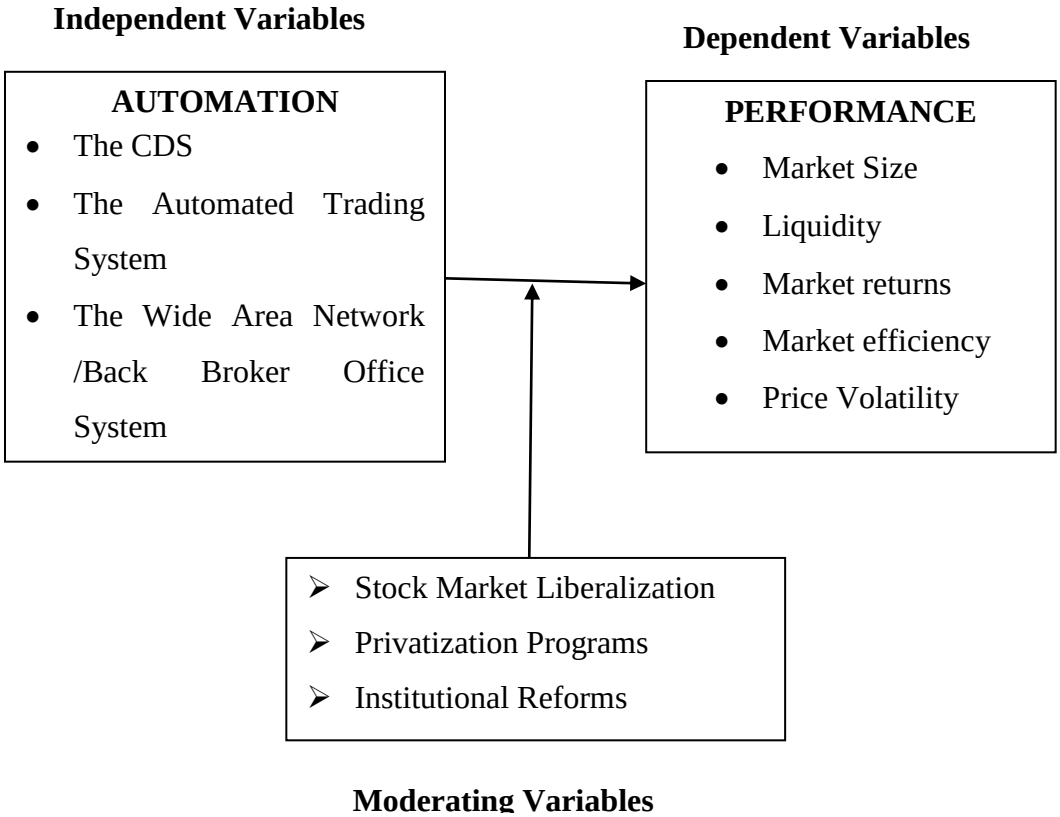

Figure 2.3: Conceptual Framework

Source: Researcher (2013).

De la Torre, Gozzi and Schmukler (2006) find that stock market liberalization, privatization programs via the securities markets and institutional reforms can potentially contribute to stock market performance. In Kenya the implementation dates of the above variables were in the 1990s (Maehle, Teferra and Khachatryan, 2013). There is evidence that the Kenyan market has had an upsurge in activity since 1993 due to economic reform, privatization, and relaxation of restrictions on foreign investors and of exchange controls (Jefferis and Smith, 2005). More recently however, implementation of the economic reform programme has been inconsistent and political problems remain, leading to market volatility, especially in dollar terms, liquidity has remained low throughout. Privatization/divestiture via the stock is an ongoing process. To control for the intervening variable: privatization, the study will only consider data on any securities listed by 1st January 2002. Since the other two variables were implemented way earlier before the study, its effect will be captured in the before automation influencing factors.

CHAPTER THREE
METHODOLOGY

3.1 Research Design

The study adopted a longitudinal research design. This design involves measurements being made at more than one point in time. This design was used because the study involves direct identification of the change from one period to another i.e. it helped measure the changes in the identified market performance variables (stock market size, stock market liquidity, stock market efficiency, stock market returns and price volatility) of the NSE over the identified period of time.

3.2 Target Population

The target population comprised of all listed companies at the NSE between the years 1st January 2002 to 31st December 2012.

3.2 Sampling Procedure and Sample Size

There were 50 listed firms at NSE as at 1st January 2002. Purposive sampling was used and only firms with data spanning the study period were considered i.e. firms that had at any one time changed names, been taken over, been suspended/delisted/had merged were not included in the study. Therefore only 37 firms were considered, see appendix 3. Therefore, a census was carried out covering information on all the 37 listed firms. This constituted the sample.

3.3 Data collection and Instrumentation

Secondary data was collected using a data capture sheet (see appendix 1). Data on market capitalization, market closing index returns, monthly closing prices (prices were adjusted for splits and equity issues) and trading volumes were obtained from the daily price list at NSE, NSE 20 share index and Gross Domestic Product (GDP) was obtained from the Central Bank of Kenya (CBK) monthly and quarterly publications on the Kenyan economy. The data included monthly and daily returns, prices, volumes and monthly/quarterly GDP from January 2002 to June 2006 (pre-automation period) and July 2008 to December 2012 (post-automation period). Depending on the availability of monthly GDP data the study used quarterly GDP data for the study period

To differentiate between the performance in the pre and post automation periods, estimations were done for the pre-automation and post automation periods. Since the automation process took some time before it was finally implemented as a result of some institutional and implementation challenges at the exchange, the periods of implementation was excluded. Therefore the pre-automation period will be taken as the 54 months from 1st January 2002 to 30th June 2006, while the post automation period was taken as the 54 months from 31st July 2006 to 31st December, 2012.

Thus, the period starting from 1st July 2006 to 30th June 2008 was excluded from the analysis since during the period the NSE was operating under both manual listing and automated listing and coping with the challenges of initial implementation. In addition, in this period, there were major reductions by government of its shareholding of companies such sale of 30 percent of the Government shareholding at the Kenya Electricity Generating Company (KenGen), which raised 8 billion Shillings, and was oversubscribed by 330 percent. In view of the the success of the KenGen issue, the Government chose transaction advisors for the offer of 18 percent Government stake in Mumias Sugar Company and 40 percent government stake in Kenya Re-insurance Corporation. The process of restructuring Telkom Kenya was also well underway, with the planned sale of a 26 percent stake to a strategic investor, followed by the sale of a 34 percent stake to the public through the Nairobi Stock Exchange. Safaricom listed in June 2008 and was well oversubscribed. The political turmoil resulting from the 2007 elections were also factored and to avoid breaks in data collected. This would have affected or tilted the outcome. Mensah, Pomaa-Berko and Adom (2012) considered such a break in his analysis of the Ghana Stock Exchange in view of interruption during implementation.

3.4 Reliability and Validity of the Research Instrument

To ensure reliability, the researcher personally recorded data in the data capture sheet. The data provided by NSE, CMA and CBK was reliable since the data was collected by them and are institutions charged with the responsibility.

Additionally the data was checked against NSE market statistical bulletins for consistencies and KNBS for GDP data. To enhance validity of the instrument the researcher sought assistance from research experts, experienced graduates and lecturers to help improve the validity of the instrument.

3.5 Data Presentation and Analysis

The data was coded, organized and checked for any errors that may occur during data collection and keyed into SPSS (Version 20.0) computer software database. The data was grouped in two data sets, pre and post automation and provided a unique opportunity to directly contrast market size, market liquidity, price volatility, stock market efficiency and stock market returns in the sample periods. The data was analyzed using descriptive statistics with the aid of the SPSS computer software. Quantitative data analysis as done by calculating post and pre automation values for the proxy's of the identified performance variables as follows:

For objective 1:

Monthly Market Capitalization Ratio was used to estimate the market size in pre-automation and post-automation periods. Monthly Market Capitalization Ratio was computed as;

$$MCR = \frac{Value\ of\ listed\ shares(Price\ x\ Volume)}{GDP}$$

MCR refers to the value of listed shares divided by Gross Domestic Product (GDP). The size of the stock market depends on the activity of the primary market because it is only when more entities come into the market and raise funds, that more instruments are available in the secondary market. This measure assumed that the overall market size was positively correlated with the ability to mobilize capital and diversify risk on an economy wide basis (Agarwal 2001). Market capitalization was computed using the value of the equity securities only. This

measure has been applied by Yartey (2008) to measure the size of the Johannesburg Securities Exchange. In addition economic performance has a direct influence on investors' participation especially because it affects their earnings and therefore their ability to participate in the market (Ngugi, 2003). A chi-square test and paired t-test were used for the analysis.

For objective 2:

Jousset (1992) in comparing several measures of liquidity concluded that the more adequate and most operational measure was the trading volume. The measure of liquidity used was the trading volume and two empirical tests were conducted;

(i) The relative volume of each stock VR_{it} for each event month t, t ∈ [-54, +54] was calculated. Logarithmic transformations of trading measures were done to improve the normality of series (Mai et Tchemeni, 1995).

$$VR_{it} = \frac{Log(V_{it})}{Log(V_{mt})}$$

Where,

V_{it} is the cumulative stock's volume on the month *t*,

V_{mt} is the cumulative market volume on the month *t*,

Then, the relative volume is averaged across the 37 stocks of the sample, for every month t in pre and post-automation periods.

$$VR_{mt} = \frac{1}{N}\sum_{i=1}^{N} VR_{it}$$

N was the number of securities in the sample.

A chi-square test and paired t-test were used for the analysis

(ii) Second test involved the change in the relative volume for each security *i* which was defined as:

$$\Delta VR_i = VR_{i(a)} - VR_{i(b)}$$

Where;

VR_i was the average monthly relative volume on stock i, and the subscripts indicate before (b) and after the automation (a).

It tested the change in the relative volume of the of the transferred stocks/securities

T-statistic and sign tests were used for the analysis.

For objective 3:

To test market returns, abnormal returns were calculated as follows using an event study model, Market Adjusted Returns model.

Abnormal returns were calculated for each month in the event window:

$$\varepsilon_{it} = R_{it} - R_{mt}$$

Where,

$$R_{it} = In(\frac{P_{it}}{P_{it-1}})$$

R_{it} was the return on stock *i* on month *t*, and P_{it-1} and P_{it} were the closing prices for two successive periods for each stock on month *t*.

Where $R_{mt} = In(\frac{N_{it}}{N_{it-1}})$

R_{mt} was the monthly market return of the NSE 20 share index on month t; N_t was the closing value index on month t and N_{it-1} was the closing value of the index on month $t-1$.

Then the abnormal returns were averaged across the 37 stocks at each event month:

$$\varepsilon_t = \frac{1}{N}\sum_{i=1}^{N} \varepsilon_{it}$$

Sign test and t-test were used to establish the significance

For objective 4:

To test market efficiency the monthly stock returns were calculated as follows;

$$R_{it} = In(\frac{P_{it}}{P_{it-1}})$$

and R_{it} was the return on stock i on month t, and P_{it-1} and pit were the closing prices for two successive periods for each stock on month t.

The monthly market returns were calculated on the basis of the stock market indexes;

$$R_{mt} = In(\frac{N_t}{N_{t-1}})$$

Where R_{mt} was the monthly return of the NSE 20 index on month t; N_t was the closing value index on month t and N_{t-1} was the closing value of the index on month $t-1$

The abnormal return in a given period for security i, ε_{it}, for a security was the difference between its total, actual or ex-post return R_{it} and its expected, normal or ex-ante return $\sum[R_{it}]$: $\varepsilon_{it} = R_{it} - \sum[R_{it}]$. To measure the impact of an event on security returns, one must have a consistent means of measuring normal returns. Brown and Warner [1980], in their classic study of event study methodologies, suggest Market Adjusted Returns model where the normal return for a security at a given point in time equals the market return for that period.

The market return will be defined by the NSE 20 share index. The expected returns for all securities are assumed to be the same during a given period, though they vary over time.

Abnormal returns were calculated for each month in the event window:

$\varepsilon_{it} = R_{it} - R_{mt}$.

This procedure is most commonly used because it avoids errors.

Then the abnormal returns were averaged across the 37 stocks at each event month:

$$\varepsilon_t = \frac{1}{N}\sum_{i=1}^{N} \varepsilon_{it}$$

N was the number of securities in the sample.

A chi-square test was used to test if there is a difference in abnormal returns in pre and post automation and t-test to test if the abnormal returns are significantly different from zero.

For objective 5:

The volatility of securities was defined by fluctuations of stock prices, which was estimated by the variance or the standard deviation of stock returns. Price volatility was measured using one month returns as defined by the natural logarithm of price relative;

$$R_t = In(\frac{P_t}{P_{t-1}})$$

Where P_t denoted the prices observed at one month interval. Transaction prices on/nearest the last day of the month were identified to calculate intra-month returns. For each stock, the one month returns were averaged across the 108 trading months to compute the standard deviation denoted by σ (Goel and Gupta, 2011 and Chang, Hsu, Huang and Rhee, 1998).

The standard deviation of return (r) from a sample of n observations was the square root of the average squared deviation of returns from the average in the sample.

Thus

$$\sigma = [\frac{1}{n}\sum_{t=1}^{n}(r_t - m)^2]^{1/2}$$

Where,

$\sigma =$ standard deviation

$n =$ number of continuous returns

$r_t =$ continuous returns

$m =$ average returns

$r_t = In(\frac{P_t}{P_{t-1}})$ and r_t is the rate of return for the period t, and P_{t-1} and P_t are the prices for two successive periods $(t-1)$ and t,

$$m = \left\{\frac{1}{n}\sum_{t=1}^{n} r_t\right\}/n$$

For this study monthly volatility measures were used which was computed as the 12 month rolling standard deviation estimate that was based on market returns.

Volatility was calculated as the standard deviation of the natural log of returns in indices for the respective period. Goel and Gupta (2011) applied the same in measuring volatility in the Indian stock Indian stock market. An increase in standard deviation would denote an increase in volatility.

Similarly, for each stock, the one month returns were averaged across the 108 trading months to compute the variance denoted by $Var(R_t)$. The volatility of securities as defined by fluctuations of stock prices was estimated by the variance or the standard deviation of stock returns. If the change in trading mechanism had no effect on stock volatility, the variance would be the same for the two return series (before and after the transfer).

Chi-square and t-test s were used to establish the significance

Cross-sectional averages of one month return variances were calculated across the whole sample as well as for two subgroups. Chang, Hsu, Huang and Rhee (1998) use the same approach to measure price volatility on Taiwan stock exchange.

The Chi-square model is shown below:-

Mean: Ungrouped data $\bar{x} = \sum x/N$

Grouped data $\bar{x} = \sum f(x)/\sum f$

Where:

$\bar{\boldsymbol{x}} =$ mean

$\sum f =$ summation of frequency

$N =$ number of scores

$\sum f(x) =$ summation of each value of x multiplied by its corresponding frequency (f)

Chi–square $x^2 = \sum(f_o - f_e)^2/f_e$

Where:

$x^2 =$ Chi –square

f_o= an observed frequency

f_e= an expected frequency

$\Sigma =$ summation

A standard t-test for difference of means was also conducted on the data to establish the significance of the differences between the measures of stock market performance before and after automation. For equal sized samples the t-value was given by:

$$t = \frac{m_1 - m_2}{\sqrt{[(V_1 - V_2)/n]}}$$

Where m_i and V_i are respectively the mean and the variance for the ith period and *n* is the sample size. The degrees of freedom for the test will be given by 2*n*-2.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

The analysis of the data set first sought to examine relevant summary statistics, and a variety of graphical displays using standard summary measures of location and spread of the distribution of the variables such as minimum, maximum, mean, standard deviation, skewness, and kurtosis. The second part of the chapter uses inferential statistics to examine the effects of adaptation to electronic or automated trading by the Nairobi Securities Exchange (NSE) on the five measures of stock market performance. The final part of the chapter discusses the results of the analysis within the context on the existing body of theory and empirical findings.

4.2 Descriptive Statistics

Descriptive statistics were provided for the five items examined as part of market performance. The results showed that the mean market capitalization was lower before automation (M=.890383) as compared to after automation (M=1.734761) of the trading system. Market liquidity data indicated that the situation before automation (M=-1.98045) was better than after automation (M=-2.9024). Firm level liquidity positions also showed the same trend as market liquidity with before automation liquidity (M=-1.98045) being higher than after automation liquidity position (M=-2.90308). Regarding the market returns, the situation after the introduction of the automated trading system slightly worsened to M=-.003497 from M=.003318. The same measures applied to the market efficiency too where the situation again slightly worsened. However, these are indicative descriptive statistics with statistical tests to examine if the changes were indeed significant addressed later in the chapter.

The descriptive statistics also provided minimum, maximum, standard deviation and measures of skewness and kurtosis. The standard deviation provides information about the variability of the data, with higher values indicating lower quality and hence less representativeness of the mean figures. The index of

skewness takes the value zero for a symmetrical distribution. A negative value indicates a negatively skewed distribution, a positive value a positively skewed distribution. The kurtosis index measures the extent to which the peak of a unimodal frequency distribution departs from the shape of normal distribution. A value of zero corresponds to a normal distribution; positive values indicate a distribution that is more pointed than a normal distribution and a negative value a flatter distribution. See Table 4.1.

Table 4.1: Description of Market Performance Indicators

		n	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
MCR	Before	54	.2109	1.658	.89038	.43142	-.161	-1.181
	After	54	1.254	3.156	1.73476	.443951	1.898	3.857
Liquidity i.	Before	54	-2.5711	-1.2929	-1.9805	.299263	-.043	-.569
	After	54	-3.89	-1.55	-2.9024	.29671	.959	9.209
ii.	Before	37	-3.0960	-.7248	-1.9805	.534132	.385	-.102
	After	37	-4.4496	-.6239	-2.9031	.890632	.316	.050
Returns	Before	53	-.0733	.1013	.003318	.032627	.061	1.185
	After	53	-.0866	.0720	-.0035	.033316	-.223	.447
Market efficiency	Before	53	-.0733	.1013	.003318	.032627	.061	1.185
	After	53	-.0866	.0720	-.00350	.033316	-.223	.447
Volatility	Pre-std deviation	37	0.0241	0.4997	0.15259	0.07905	2.54	10.011
	Post-std deviation	37	0	0.374	0.12628	0.07500	1.478	3.41
	Pre-variance	37	0.0006	0.2497	0.02936	0.04132	4.563	23.618
	Post-variance	37	0	0.1399	0.02142	0.02837	3.033	9.97

4.2.1 Market Capitalization Ratio

The first objective of the study was to determine the effect of automation on the market size at the NSE. Time series data indicated increased activities in the stock exchange especially in the immediate period succeeding the automation of the trading system. Figure 4.1 provides graphical display illustrating the time series trend with post-automation market capitalization being generally higher during

the period considered in the study. The market capitalization ratio during pre-automation period is negatively skewed indicating a greater probability of decreases in market liquidity than increase. On the other hand, market capitalization ratio for the post-automation period is positively skewed indicating a higher probability of increases in market capitalization ratio than decreases i.e., the market capitalization ratio in both periods can be described as asymmetric.

However, most recent data indicates that post-automation market capitalization was rising faster.

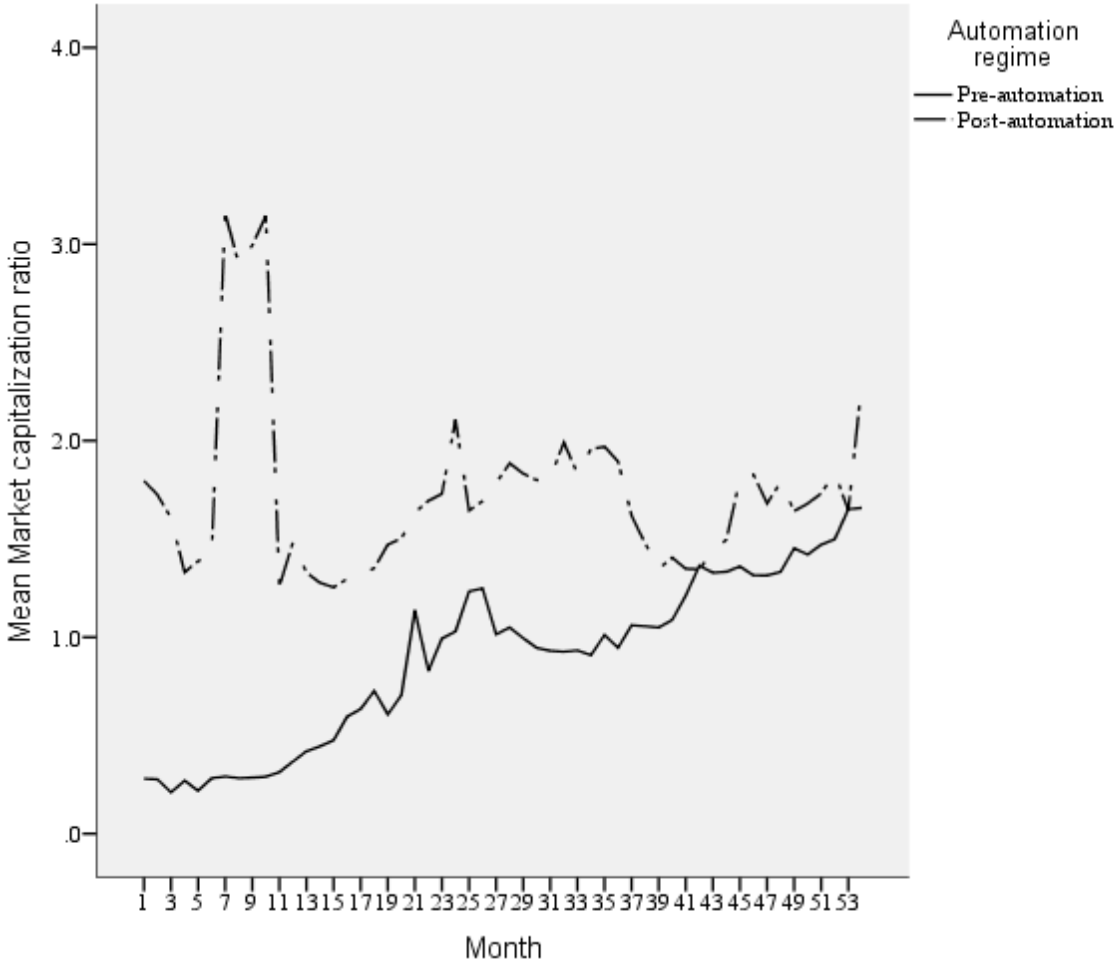

Figure 4.1: Time Series Data Comparing Pre- and Post-automation MCR

4.2.2 Effect of Automation on Market Capitalization

Descriptive statistics showed that market capitalization ratio was higher post-automation than before the trading system was automated. Follow up statistical

tests were performed to confirm this observation. Paired samples t-test and a chi-square test of independence were carried out. As shown in the Table 4.1, the descriptive statistics previously provided were replicated which showed that the market capitalization ratio significantly increased from Pre-automation period (M=.890383, SD=.4314198) to Post-automation period (M=1.734761 SD=.4439508). The p value was substantially smaller than the specified alpha value of .05. Therefore, the results indicated that there was a significant difference in the Market Capitalization Ratios before and after the implementation of the automated trading systems [t(53)= 9.458, p<0.05]. See Table 4.2.

Table 4.2: T-test Analysis for Market Capitalization

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	1.734761	54	.4439508	.0604140
	Before	.890383	54	.4314198	.0587088

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	After & Before	54	-.123	.375

Paired Samples Test

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Pair 1	After - Before	.8443781	.6560423	.0892761	.6653130	1.0234432	9.458	53	.000

A crosstabulation served to summarize the nature of association between market capitalization and type of trading system. There was improvement on all the categories of Market Capitalization. Low market capitalization decreased from

35.2% to 0% after automation, average market capitalization increased from 14.8% to 45.4%, while above average market capitalization increased from pre-automation of 0% to 4.6%. A chi-square test of independence was used to test if these observed differences were statistically significant at 0.05 level of significance. The results presented in table 4.3 provided evidence that automation was significantly associated with increased market capitalization [χ^2 (2) = 59.754, $p<0.05$]

Table 4.3: Cross tabulation Summarizing Relationship Market Capitalization and Trading System

Market capitalization ratio (Binned) * Automation regime Crosstabulation					
			Automation regime		Total
			Before	After	
Market capitalization ratio (Binned)	Low	Count	38	0	38
		% of Total	35.2%	.0%	35.2%
	Average	Count	16	49	65
		% of Total	14.8%	45.4%	60.2%
	Above average	Count	0	5	5
		% of Total	.0%	4.6%	4.6%
Total		Count	54	54	108
		% of Total	50.0%	50.0%	100.0%

Table 4.4: Chi square Test of Association between Trading System and Market Capitalization

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	59.754a	2	.000
Likelihood Ratio	77.171	2	.000
Linear-by-Linear Association	55.652	1	.000
N of Valid Cases	108		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.50.

4.2.3 Stock Market Liquidity

The second objective of the study was to determine the effect of automation on market liquidity at the NSE. Two measures of liquidity were used: the first measure used the pre and post automation cumulative trading volume in relation to the market while the second used the pre and post automation average trading volumes of the firms. Figure 4.2 refer to cumulative trading volume of each stock expressed as of the ratio of the logarithm of cumulative stock volume divided by the logarithm of cumulative market volume. The figure indicates decreased liquidity in the market during the period of post-automation regime as compared to pre-automation period. The mean cumulative trading volume under the post-automation regime was less than the pre-automation regime in all the months except in the 25^{th} month after automation.

The market volatility as measured by standard deviation and variance during pre-automation and post-automation periods is positively skewed indicating a greater probability of increases in market volatility than decreases i.e., the volatility in both periods can be described as symmetric.

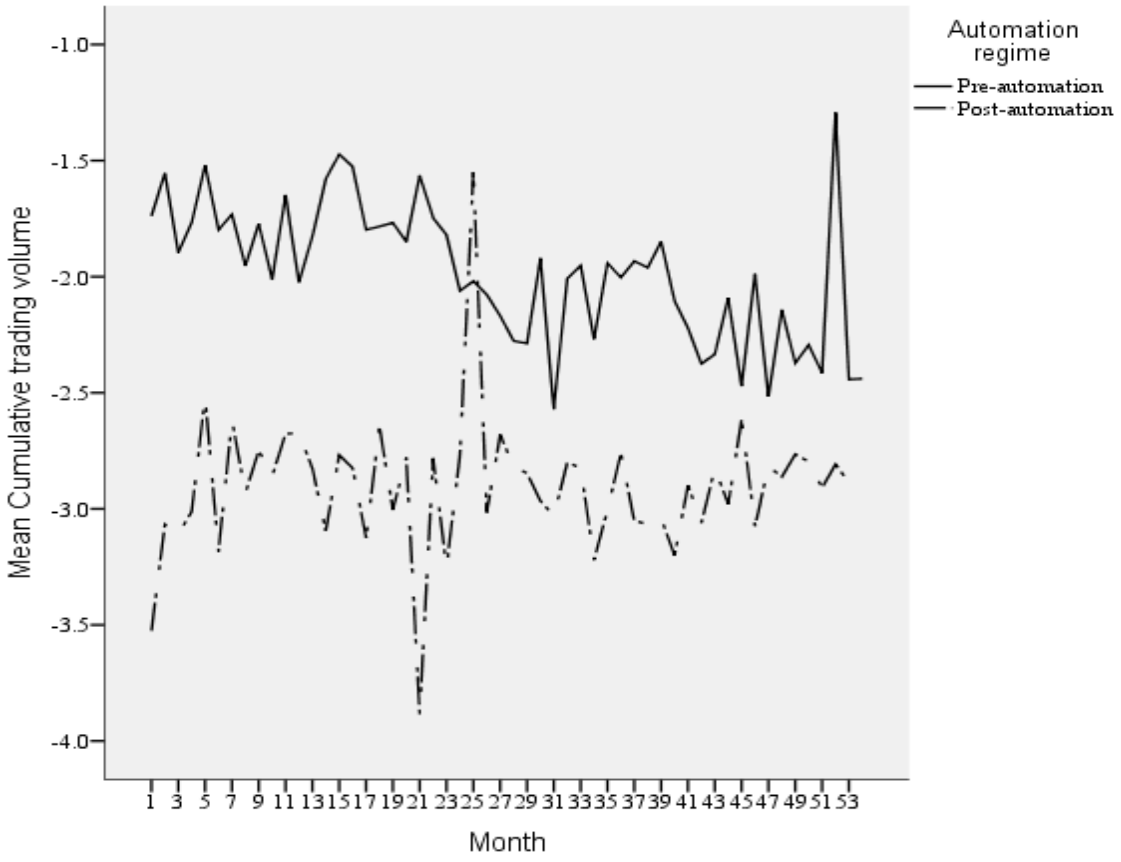

Figure 4.2: Cumulative Trading Volume

The stock market liquidity during pre-automation period is negatively skewed indicating a greater probability of decreases in market liquidity than increase. On the other hand, stock market liquidity for the post-automation period is positively skewed indicating a higher probability of increases in stock market liquidity than decreases i.e., the liquidity in both periods can be described as asymmetric.

The average liquidity per firm during pre-automation and post-automation periods is positively skewed indicating a greater probability of increases in market liquidity than decrease i.e., the liquidity in both periods can be described as symmetric.

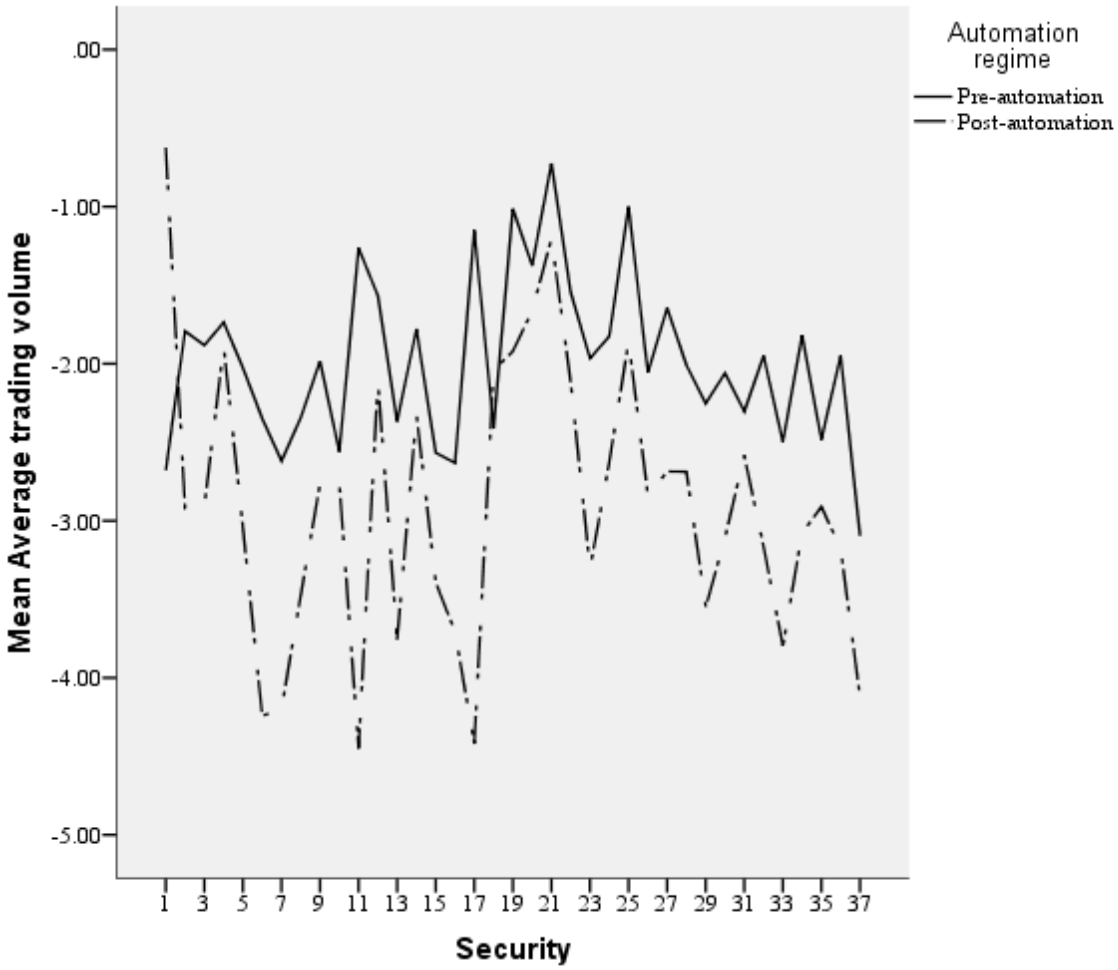

Figure 4.3: Average Trading Volume

Figure 4.3 considers average trading volume against each equity firm (security) in the study. The figure indicates decreased liquidity in the market during the period of post-automation regime as compared to pre-automation period for the firms under the study. The mean average trading volume in the post-automation regime was most of the time less than the pre-automation regime for all the firms except for 2 firms (firm/security 1 and 18).

Possible interpretation of the counterintuitive results is that automation period coincided with increased initial public offers (IPOs), however, most of the post-IPO owners' were mainly long term investors leading to lower IPO aftermarket liquidity (Galariotis and Giouvris, 2009). According Galariotis and Giouvris (2009), liquidity is defined as the ability to trade a particular volume of shares at prices which are close to the price and volume of the previous trade. The liquidity

of each stock has two components: a market wide systematic component and a firm specific idiosyncratic component.

4.2.4 Effect of Automation on Stock Market Liquidity

Two measures of liquidity were used: the first measure used the pre and post automation cumulative trading volume in relation to the market while the second used the pre and post automation average trading volumes of the firms. Thus the first measure was analyzed using t-test and chi-square test while the second measure used t-test and Wilcoxon signed rank test. The results from the t-test suggest that there is a significant difference in liquidity before (M=-1.98045, SD=.2992634) and after (M=-2.9024, SD=.29671) introducing the automated trading system [$t(53) = -15.25$, $p<0.05$]. Thus the findings indicated that the liquidity situation deteriorated with the advent automated trading system. This case can be explained by the proposition that the role of brokers and traders involved in negotiated deals were diminished to the extent that effects affect market liquidity thereby reducing consolidated trading offers that were responsible for significant movement in stocks.

Table 4.5: T-test for the Change in Market Liquidity Position

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	-2.9024	54	.29671	.04038
	Before	-1.98045	54	.2992634	.0407246

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	After & Before	54	-.111	.424

Paired Samples Test

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Pair 1	After - Before	-.92197	.4442059	.0604488	-1.043210	-.800720	-15.25	53	.000

A crosstabulation indicating the changes in the 54 periods before and 54 periods after automation indicated that low liquidity positions in the market increased from .0% to 18.5%, average liquidity positions increased from 23.1% to 30.6%, and above average liquidity positions decreased from 26.9% to .9%. The overall picture is that firms that were in better positions saw their liquidity positions worsen after introduction of the automated trading system with 18.5% of the them moving to lower than market liquidity and another 7.5% performing averagely as the market in terms of their liquidity position. See Table 4.6. A chi-square test of independence confirmed that there was enough evidence statistically to prove that indeed the liquidity position of the market worsened after the introduction of the automated trading system [$\chi^2(2)= 47.237$, $p<0.05$]. See Table 4.7.

Table 4.6: Crosstabulation of Trading Volume and Trading System

Trading volume (Binned) * Automation Regime Crosstabulation					
			Automation Regime		Total
			Before	After	
Trading volume (Binned)	Low	Count	0	20	20
		% of Total	.0%	18.5%	18.5%
	Average	Count	25	33	58
		% of Total	23.1%	30.6%	53.7%
	Above average	Count	29	1	30
		% of Total	26.9%	.9%	27.8%
Total		Count	54	54	108
		% of Total	50.0%	50.0%	100.0%

Table 4.7: Chi-square Test of Market Liquidity Positions

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.237a	2	.000
Likelihood Ratio	61.653	2	.000
Linear-by-Linear Association	46.515	1	.000
N of Valid Cases	108		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.00.

Average liquidity was also considered. This was measured using the change in the relative volume of the transferred stocks/securities for the individual firms in the study. Both the paired t-test and the Wilcoxon signed ranks test were used to find if there were significant differences in before and after automation liquidity as measured by trading volumes. The t-test returned a significant difference between pre-automation (M=-1.98045, SD=.5341317) and Post-automation liquidity (M=-2.90308, SD=.8906319), with t(36)=-6.532 and p=.000. The Wilcoxon signed

ranks test also confirmed the t-test results by returning a significant difference between the two trading system regimes (z=-4.699, p=.000). See Tables 4.8, 4.9 and 4.10.

Table 4.8: T-Test for Firm Liquidity Change

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	-2.90308	37	.8906319	.1464190
	Before	-1.98045	37	.5341317	.0878107

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	After & Before	37	.358	.030

Paired Samples Test

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Pair 1	After - Before	-.922629	.8592317	.1412568	-1.20911	-.6362	-6.532	36	.000

Table 4.9: Wilcoxon Signed Liquidity Ranks

Ranks				
		N	Mean Rank	Sum of Ranks
Before - After	Negative Ranks	2[a]	20.00	40.00
	Positive Ranks	35[b]	18.94	663.00
	Ties	0[c]		
	Total	37		

a. Before < After

b. Before > After

c. Before = After

Table 4.10: Wilcoxon Signed Ranks Test for Liquidity Change

Test Statistics[b]	
	Before - After
Z	-4.699a
Asymp. Sig. (2-tailed)	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

4.2.5 Stock Market Returns

The third objective of the study was to determine the effect of automation on market returns at the NSE. While overall the mean performance of the market returns showed slight deterioration of the returns as shown in the previous section using mean performance, the trend line in Figure 4.4 showed that returns did not provide visual evidence that the situation before automation was systemically better than after automation.

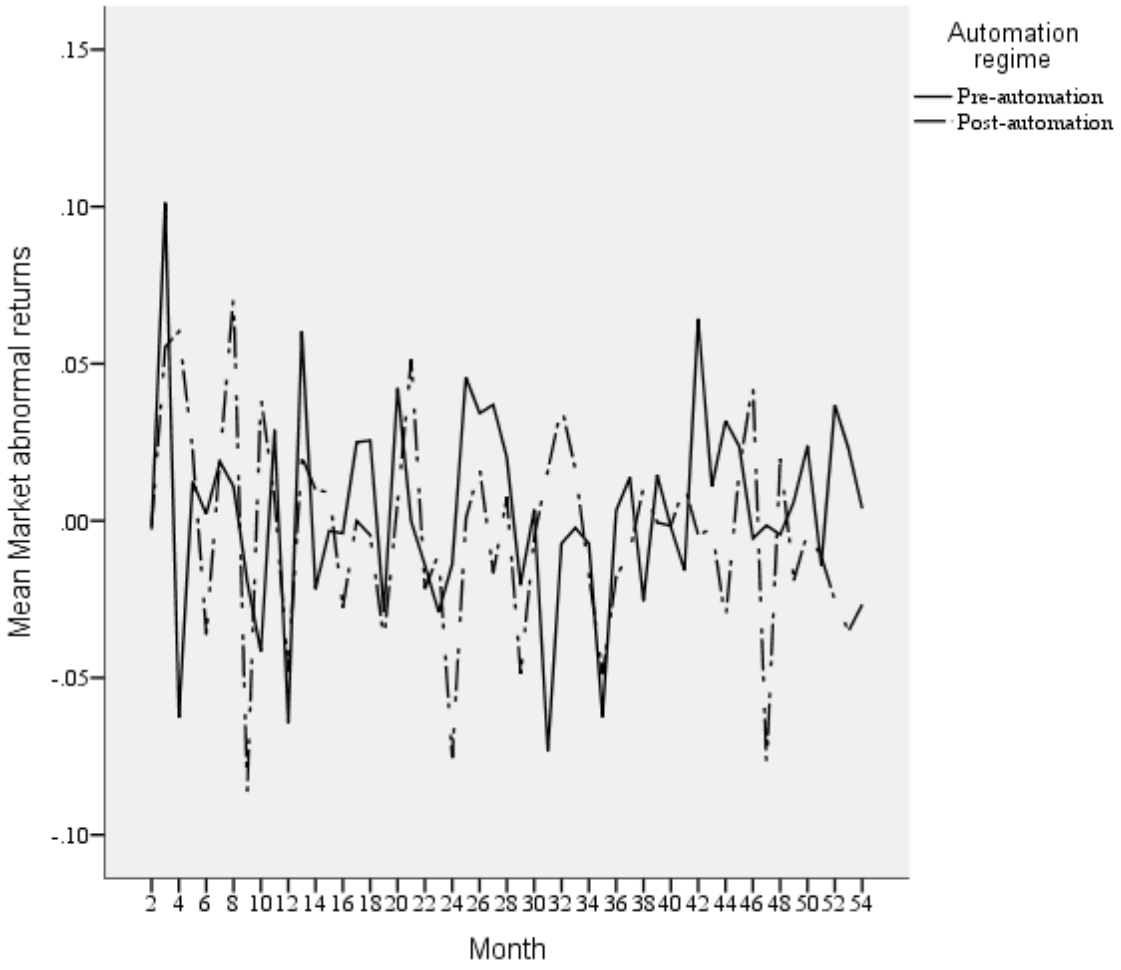

Figure 4.4: Market Returns Trend

The market returns were at one time highest (better) under pre-automation regime and one time lowest (worse) under the post-automation regime.

4.2.6 Effect of Automation on Market Returns

T-test and Wilcoxon signed rank were used to test the hypothesis. The t-test indicated that the advent of automated trading system was associated with reduced market returns (M=-2.9031, SD= .8906319 from M=-1.9805, SD=.5341317), which was significant at 0.05 level of significance [t(36)=-6.53, $p<0.05$]. However, Wilcoxon Signed Ranks Test did not confirm the t-test results as it was not significant (Z=-1.624, p=.104). See Table 4.11, 4.12 and 4.13.

Table 4.11: T-test for the Difference in Market Returns

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	-2.9031	37	.8906319	.1464190
	Before	-1.9805	37	.5341317	.0878107

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	after(a) & before (b)	37	.358	.030

Paired Samples Test

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	after-before	-.92263	.8592317	.1412568	-1.20911	-.63615	-6.53	36	.000

Table 4.12: Wilcoxon Signed Market Returns Ranks

Ranks

		N	Mean Rank	Sum of Ranks
returns before - returns after	Negative Ranks	21a	25.33	532.00
	Positive Ranks	32b	28.09	899.00
	Ties	0c		
	Total	53		

a. returns before < returns after

b. returns before > returns after

c. returns before = returns after

Table 4.13: Wilcoxon Signed Rank Test for Difference in Market Returns

Test Statistics[b]	
	returns before - returns after
Z	-1.624a
Asymp. Sig. (2-tailed)	.104
a. Based on negative ranks.	
b. Wilcoxon Signed Ranks Test	

4.2.7 Stock Market Efficiency

The fourth objective of the study was to determine the effect of automation on market efficiency at the NSE. The overall market efficiency also did not indicate discernible trend whether the situation improved or not under the new trading system as showed in the Figure 4.5.

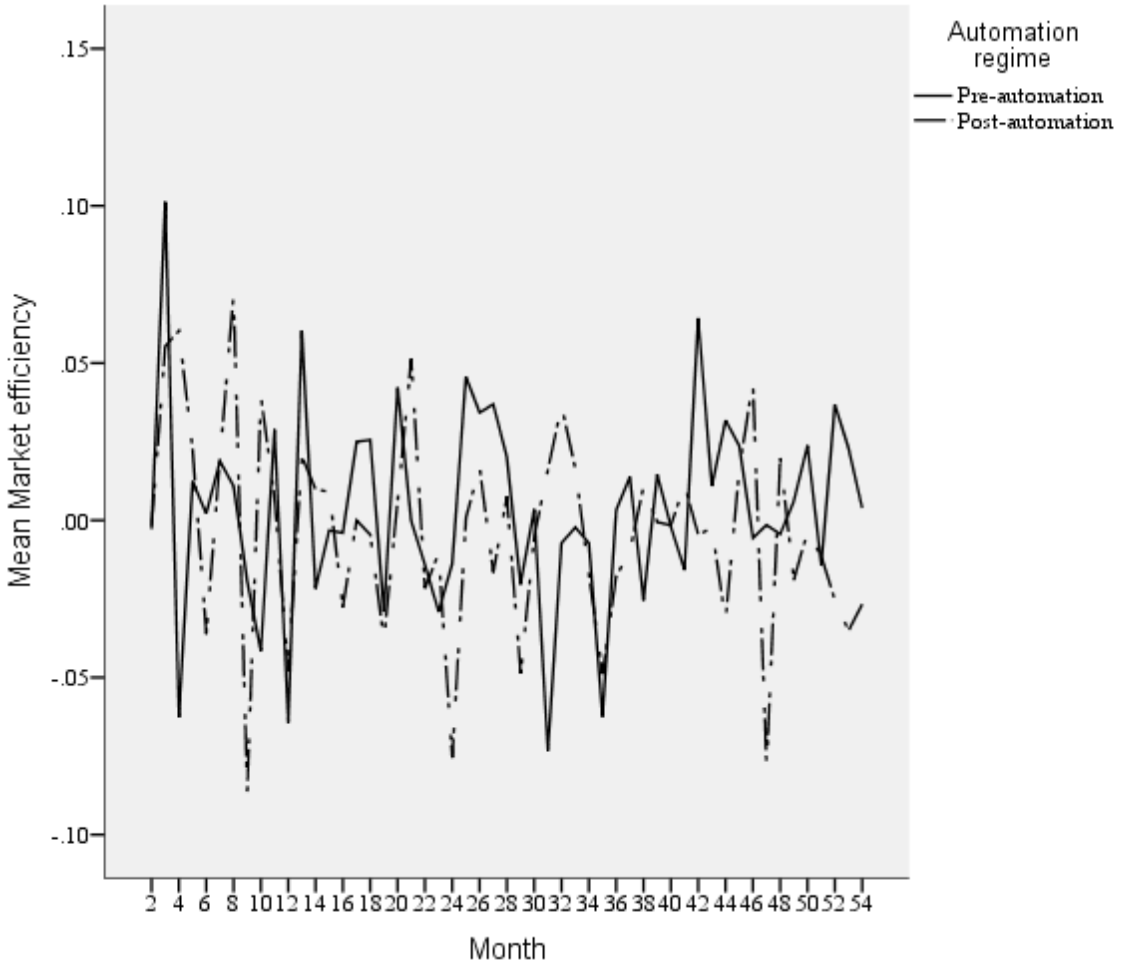

Figure 4.5: Market Efficiency Trend

The market efficiency was at one time highest (better) under pre-automation regime and one time lowest (worse) under the post-automation regime.

4.2.8 Effect of Automation on Market Efficiency

To test for market efficiency, the study sought to find out if there was evidence of anomalous return behavior. A t-test found no difference between in returns that could be attributed to the operation of the automated trading system [t(52)=-1.176, p=.245], with the abnormal returns after automation (M=-.0034, SD=.0333163) as compared to situation before automation (M=.0033, SD=.0326270) being almost non-existent. See Table 4.14. A crosstabulation of the returns as shown in the Table 4.15 confirmed that the percentages of the firms in various return categories did not remarkably change from the pre-automation era. The chi-square test of independence provided statistically evidence that indeed there was zero (0) general change in returns [$\chi^2(2)=.889$, p=.641]. See Table 4.16.

Table 4.14: T-Test for Difference in Market Efficiency

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	-.0034	53	.0333163	.0045763
	Before	.0033	53	.0326270	.0044817

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	After & Before	53	.181	.195

Paired Samples Test

		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Pair 1	After - Before	-.0068	.0422035	.005797	-.01845	.00482	-1.176	52	.245

Table 4.15: Market Efficiency and Automation Regime Crosstabulation

Efficiency (Binned) * Automation regime Crosstabulation					
			Automation regime		Total
			Before	After	
Efficiency (Binned)	Low	Count	10	14	24
		% of Total	9.4%	13.2%	22.6%
	Average	Count	38	34	72
		% of Total	35.8%	32.1%	67.9%
	High	Count	5	5	10
		% of Total	4.7%	4.7%	9.4%
Total		Count	53	53	106
		% of Total	50.0%	50.0%	100.0%

Table 4.16: Market Efficiency and Automation Chi-square Test

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.889a	2	.641
Likelihood Ratio	.892	2	.640
Linear-by-Linear Association	.493	1	.483
N of Valid Cases	106		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.00.

4.2.9 Market Volatility

The final objective of the study was to determine the effect of automation on price volatility at the NSE. Presented in form of a time series trend line chart, the two measures used to represent volatility provided overall same picture indicating that there were mixed movements in market volatility that could not be discerned to be systemic showing a change in the market situation. Both standard deviation chart and variance chart are used in figures 4.6 and 4.7 respectively.

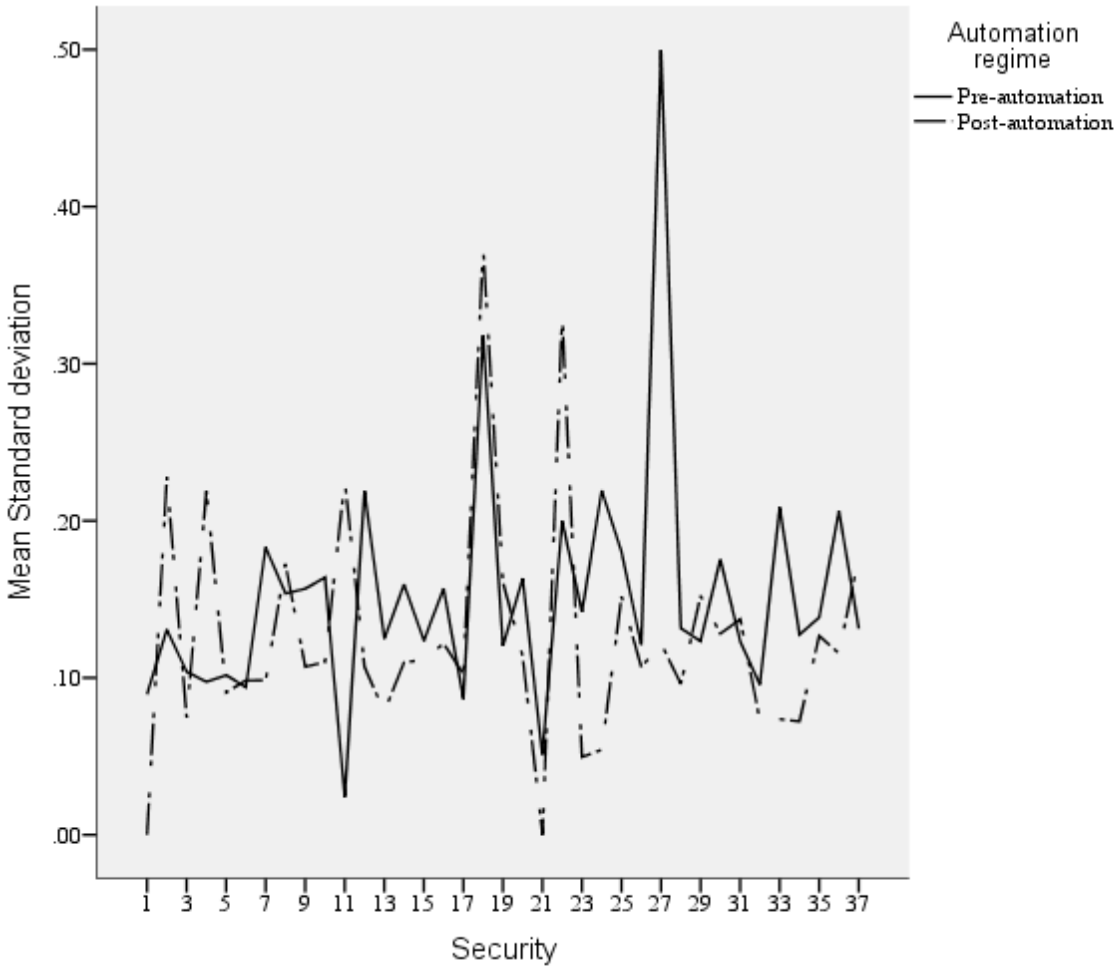

Figure 4.6: Standard Deviation Trend

The mean standard deviation of stock returns was at one time highest (worse) under pre-automation regime and one time lowest (better) under the post-automation regime.

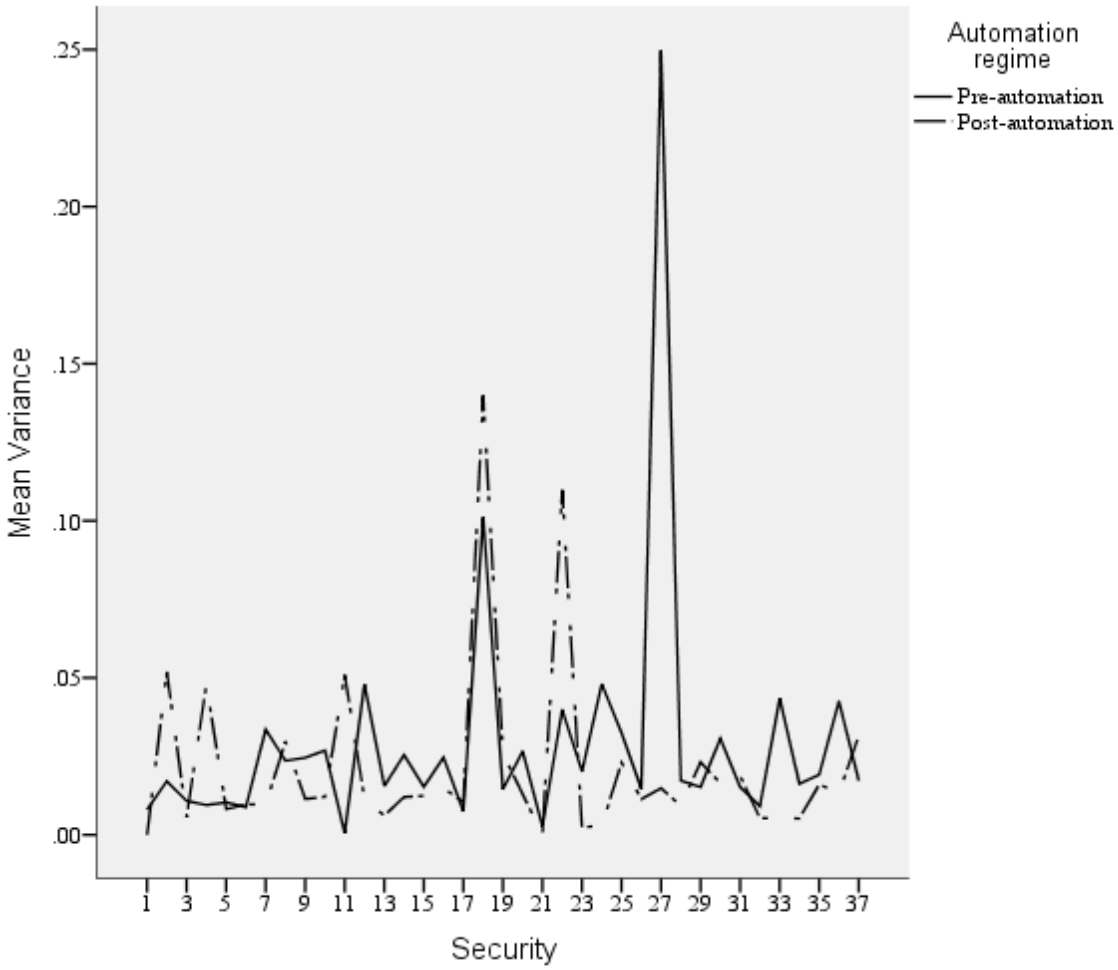

Figure 4.7: Variance Trend

The mean variance of stock returns was at one time highest (worse) under pre-automation regime and one time lowest (better) under the post-automation regime.

4.2.3.0 Effect of Automation on Stock Market Volatility

Volatility referred to the variability in market returns as measured by standard deviation as well as variance of the stock prices. While descriptive statistics indicated a downward trend in the amount of standard deviation (before M=.152590, SD=.0790504, after M=.126275, SD=.0750011), there was no significant evidence that this was actually the case [t(36)=-1.689, p=0.100]. See Table 4.17.

Table 4.17: T-Test for Standard Deviation Differences

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	.126275	37	.0750011	.0123301
	Before	.152590	37	.0790504	.0129958

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	After & Before	37	.244	.145

Paired Samples Test									
		Paired Differences					t	df	p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Pair 1	After - Before	-.026315	.0947628	.0155789	-.05791	.00528	-1.689	36	.100

A crosstabulation of the changes in the market volatility as measured by the standard deviation of the returns returned a mixed change that could not systemically point toward a certain direction as in Table 4.18.

Table 4.18: Standard Deviation and Automation Regime Crosstabulation

Standard deviation (Binned) * Automation regime Crosstabulation					
			Automation regime		Total
			After	Before	
Standard deviation (Binned)	Low	Count	7	13	20
		% of Total	9.5%	17.6%	27.0%
	Average	Count	28	22	50
		% of Total	37.8%	29.7%	67.6%
	High	Count	2	2	4
		% of Total	2.7%	2.7%	5.4%
Total		Count	37	37	74
		% of Total	50.0%	50.0%	100.0%

When subjected to a chi-square test, it was found out that there was no significant change in the volatility in the market [$\chi^2(2)= 2.520$, p=.284]. Therefore, the results from chi-square test provided further evidence in support of the t-test results.

Table 4.19: Chi-square Test for Independence between Automation Regime and Standard Deviation

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.520a	2	.284
Likelihood Ratio	2.550	2	.279
Linear-by-Linear Association	1.729	1	.189
N of Valid Cases	74		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.00.

Variance of the market returns was also used to measure the volatility in the market. A t-test showed a slight decrease in the volatility (from M=.029364, SD=.0413208 to M=.021418, SD=.0283700). The differences were not significant at 0.05 level of significance [t(36)= -1.073, p=.290]. See Table 4.20.

Table 4.20: T-test for the Difference in Variance

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	After	.021418	37	.0283700	.0046640
	Before	.029364	37	.0413208	.0067931

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	After & Before	37	.207	.220

Paired Samples Test							
	Paired Differences				t	df	p
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			

					Lower	Upper			
Pair 1	After - Before	-.00795	.0450346	.0074036	-.022960	.007069	-1.073	36	.290

A crosstabulation of the changes in variance in respect to the type of the trading system indicated were consistent across all the volatility categories signaling no significant changes. See Table 4.21.

Table 4.21: Crosstabulation of Variance and Automation Regime

Variance (Binned) * Automation regime Crosstabulation					
			Automation regime		Total
			Before	After	
Variance (Binned)	Low	Count	35	35	70
		% of Total	47.3%	47.3%	94.6%
	Average	Count	1	2	3
		% of Total	1.4%	2.7%	4.1%
	High	Count	1	0	1
		% of Total	1.4%	.0%	1.4%
Total		Count	37	37	74
		% of Total	50.0%	50.0%	100.0%

A chi-square test of independence confirmed that indeed there were no significant change in the volatility of the market returns [$\chi 2(2)=1.333$, $p=0.513$]

Table 4.22: A Chi-Square Test for the Difference in Variances

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.333a	2	.513
Likelihood Ratio	1.726	2	.422
Linear-by-Linear Association	.148	1	.700
N of Valid Cases	74		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .50.

4.3 Discussions

The study finding that the market capitalization ratio significantly increased from Pre-automation period which may be due to large amounts trades at any given price occasioned by lower transaction costs (Song, Tan and Wu, 2005). The lower transaction costs may also lead to several small trades hence increased trade frequency in the securities market. Further, lower transaction costs may be attributed to increased activity in primary market thereby further increasing the overall market size.

Regarding liquidity, automation may be important for market liquidity because it increases the ability of equity traders to effectively execute stock trades when needed and at reasonable costs. Electronic exchanges may be more expensive than floor-based exchanges to open, but over the longer term operating costs of an electronic exchange are much lower. The conventional wisdom is that electronic exchanges offer lower trading costs than floor-based exchanges (Song, Tan and Wu, 2005).

The present study found significant difference between liquidity position before and after automation of the exchange, since liquidity in overall decreased. According to Maxfield (2009), an important attribute distinguishing exchange trading systems is the extent to which trading is automatic, based on orders or quotes, or whether is it negotiated. The central dilemma is that transparency and surveillance capability rises with the extent of automatic trading. But negotiated trading can stimulate volume and liquidity-important measures of stock market success. Dealers, traders who operate for themselves and possibly as brokers to clients also, are the key protagonists in negotiated trading. They play a market-making function that can be very important in young stock exchanges by taking risks that other market participants are not willing to bear.

While company and economy wide fundamentals are usually taken to be the key determinants of a company's performance, this study found no systematic change in the market performance. However, this finding is not unique since Tan and Floros (2012) also finds that other factors account for returns in the market that

may confound the effect of automation of the trading system if those factors have much bigger effect on the company performance, for instance, the great recession of 2007-2009.

The decrease in liquidity may also be due to decreased human involvement at the securities exchange. Existing theory suggests that human intermediaries play at least two vital functions. First, an intermediary's knowledge of the market and its participants may uncover hidden liquidity that facilitates quicker and more efficient matching of client orders (Grossman, 1992). The value of this matching function is greater when trading volume is low and matches are difficult to find. Secondly, when information asymmetry is high, the repeated interaction between an intermediary and its clients allows the intermediary to protect itsSelf against informed trades and offer better prices to its customers (Seppi, 1990). The results are not in isolation as Bodie *et al*. (2002) also suggests that automation decreases liquidity because for important transactions traders cannot negotiate directly and so have no control on trading conditions.

The study found no significant effects of automation on market efficiency. This in contrast to Jarrett and Kyper (2005) finding that market returns are not random and can be used to predict future returns with a degree of accuracy, this study found no effects of the automation on the market efficiency. Market inefficiencies could have arisen if there were identifiable systematic and permanent variations in stock returns, in which case, those nonrandom variations were expected to decrease with increased trading activities occasioned by the automated trading system whereby new participants and instrument would be available.

The study found that volatility of the returns series seemed to be same both before and after automation of the trading system. It would be expected that major episodes in the market history such as the use of automated platforms may worsen volatility due to increased intensity of trading activities (Uppal, 1998). Conversely, automation could increase the portfolio flows thereby raising liquidity resulting in reduced volatility. However, this study found no such evidence.

CHAPTER FIVE
SUMMARRY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of the Findings

The study found that the Market Capitalization Ratio (MCR) significantly increased from Pre-automation period. This can be attributed to increased portfolio flows as a result of lower transaction costs. Lower transaction costs also have the effect of attracting participants to the primary market thereby increasing trading volumes. A crosstabulation summary on the nature of association between market capitalization and type of trading system revealed an improvement on all the categories of Market Capitalization.

The study found significant difference between liquidity position before and after automation of the exchange. The exchange records lower liquidity after its automation. A crosstabulation summary revealed only an improvement in average liquidity position after automation. This could be attributed to the fact that most large volume trades did not rely on orders or quotes but were negotiated, which occurred more intensely before automation than after automation. Thus in pre-automation era, negotiated trading stimulated higher volumes than after automation.

The study also found no significant effect of automation on market efficiency. This suggests that the automation of the exchange has not improved the efficiency levels of the exchange. Market inefficiencies can be exhibited by the market where it can be shown that there were patterns of returns that could be used to predict future returns. This study found no differences in the patterns of returns from pre-and post automation era.

The study finally found that volatility of the returns series seemed the same both before and after automation of the trading system. Whereas major economic or political episodes may affect volatility, no significant differences were found in the study to indicate that volatility was affected by the automation process. It

would have been expected for volatility to either increase or decrease as the automation process was likely to signal either increased efficiency or lead to increased portfolio flows.

5.2 Conclusions

The main objective of the study was to determine the effect of automation on the performance of the Nairobi Securities Exchange. The study concludes that automation process at the Nairobi Securities Exchange had the following effects on the performance of the exchange:

i. That the market size actually increased after the introduction of the automated trading system.
ii. The major deviation from expectation was that liquidity seemed to significantly decrease after the introduction of the automated trading system.
iii. The market returns, market efficiency as well as volatility were significantly unaffected by the introduction of the automated trading system.

5.3 Recommendations

From the study, the following recommendations could be made

1. Finding that automation has not improved efficiency levels at the NSE the study recommends that on-line discount trading services must be enhanced in the evolution of automated trading on the exchange, this is more appropriate for individuals who require fast execution, lowest commissions and have the expertise to make their own trading decisions independent of a certified stock broker. In addition, information on the security market, such as data should be made easily accessible to the public, especially, potential investors so as to improve the efficiency of the market.
2. To further gain the confidence of the public in the operations of NSE, besides the automation that makes the process more transparent and faster, the securities exchange need to further deepen the demutualization process

so that the general investor community can have a say in how it is organized and run.

3. Finding that liquidity levels worsened at the NSE the study recommends that the NSE needs to determine what services human intermediaries initially provided that are difficult or impossible to replicate in a fully automated trading system. Theory and past research suggest that human intermediation is most valuable when trading is thin and when information asymmetry is high. These two factors are highly correlated. The NSE should make information flow even.

5.4 Suggestion for further research

The study suggests that future research may be carried to confirm and assess the determinants of reduced liquidity positions in the market after introduction of the automated trading system. Further research could also be conducted into the post-automation efficiency/volatility/liquidity level of the NSE by adopting different estimation techniques as well as extending the sample size and scope so as to ascertain the exact effect of the automation on exchange.

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APPENDICES

APPENDIX I: Data Capture Sheet

	MONTHS	Market Capitalization (Kshs)	AVG. SHARE CLOSING PRICE	GDP (Kshs)	Traded Volume	NSE 20 Share Index
PRE AUTOMATION	1					
	2					
	3					
	4					
	5					
	6					
	7					
	.					
	.					
	.					
	54					
POSTAUTOMATION	1					
	2					
	3					
	4					
	5					
	6					
	7					
	.					
	.					
	.					
	54					

APPENDIX II: Key Market Performance Indicators of NSE between 2002 And 2011

Market Indicator	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	% Δ 2002-2011
Market Capitalization (kshs-bn)	112.3	317	306	464	823	853.1	746.6	831.8	1166.7	879.6	683.26
No. Listed Companies	51	48	48	48	52	54	56	55	55	58	13.7
Market Capitalization of Listed Cos. (% of GDP): MCR	11.02	27.8	23.96	31.6	69.4	53.18	31.81	36.58	48.29	34.48	
Total Volume Traded (mn)	140	380	630	870	1450	1940	5860	3160	7550	5720	3985.71
Turnover (Kshs bn)	2.88	15.2	22.2	37	95.2	89.01	85.68	37.91	110.38	78.26	2617.36
Turnover as a % of GDP	0.28	1.33	1.74	2.53	5.8	5.15	3.65	1.7	4.67	3.07	996.43
Turnover ratio	2.56	4.8	7.29	7.9	11.5	10.41	11.42	4.59	9.45	8.87	
IPO	0	0	0	0	3	2	2	0	0	1	
Rights Issues	0	1	1	2	1	3	2	0	3	0	
Bond Turnover (kshs Bn)	33.21	42	34.11	13.6	48.58	85.07	95.3	110.65	483.15	450.76	1257.3
NSE 20 Share Index	1,363	2,737	2,946	3,973	5,646	5,445	3,521	3,247	4,433	3,205	135.14

Sources: Author's Computation from NSE, CMA Annual Reports & Kenya National Bureau of Statistics.

APPENDIX III: Listed Equity Firms Considered in the Study

	Agricultural		**Construction & Allied**
1	Eaagads Ltd Ord 1.25 AIM	22	Athi River Mining Ord 5.00
2	Kakuzi Ord.5.00	23	Bamburi Cement Ltd Ord 5.00
3	Kapchorua Tea Co. Ltd Ord Ord 5.00 AIM	24	Crown Berger Ltd Ord 5.00
4	Limuru Tea Co. Ltd Ord 20.00 AIM	25	E.A.Cables Ltd Ord 0.50
5	Rea Vipingo Plantations Ltd Ord 5.00		
6	Sasini Ltd Ord 1.00		**Energy & Petroleum**
7	Williamson Tea Kenya Ltd Ord 5.00 AIM	26	KenolKobil Ltd Ord 0.05
		27	Kenya Power & Lighting Co Ltd Ord 2.50
	Automobiles & Accessories	28	Total Kenya Ltd Ord 5.00
8	Car & General (K) Ltd Ord 5.00		
9	Marshalls (E.A.) Ltd Ord 5.00		**Insurance**
		29	Jubilee Holdings Ltd Ord 5.00
	Banking	30	Pan Africa Insurance Holdings Ltd Ord 5.00
10	Barclays Bank Ltd Ord 0.50		
11	Diamond Trust Bank Kenya Ltd Ord 4.00		**Investment**
12	Housing Finance Co Ltd Ord 5.00	31	City Trust Ltd Ord 5.00 AIM
13	Kenya Commercial Bank Ltd Ord 1.00		
14	National Bank of Kenya Ltd Ord 5.00		**Manufacturing & Allied**
15	NIC Bank Ltd Ord 5.00	32	A.Baumann & Co Ltd Ord 5.00 AIM
16	Standard Chartered Bank Ltd Ord 5.00	33	British American Tobacco Kenya Ltd Ord 10.00
		34	East African Breweries Ltd Ord 2.00
	Commercial & Services	35	Kenya Orchards Ltd Ord 5.00 AIM
17	Express Ltd Ord 5.00 AIM	36	Mumias Sugar Co. Ltd Ord 2.00
18	Kenya Airways Ltd Ord 5.00	37	Unga Group Ltd Ord 5.00
19	Nation Media Group Ord. 2.50		
20	Standard Group Ltd Ord 5.00		
21	TPS Eastern Africa (Serena) Ltd Ord 1.00		