The Effect of Automation on Stock Market Efficiency: A Case of Nairobi Securities Exchange

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Abstract
The automation of the Nairobi Securities Exchange (NSE) in 2006 was expected as one of its objectives to improve market efficiency. The objective of the study was to determine the effect of automation on market efficiency. This study investigated the effect of the automation on market efficiency of the Nairobi Securities Exchange (NSE) using monthly market returns from the closing NSE 20-Share index and monthly closing equity price list from 2002 to 2012. Two study periods were considered pre-automation period (January 2002 to June 2006) and post-automation period (July 2008 to December 2012). The study adopted a longitudinal research design. The firms considered were listed and had data spanning the study period. The study used secondary data in its analysis. The discussion of the effect of automation on security markets efficiency is very scanty in the literature, particularly in sub-Saharan Africa. The findings from the study will be useful to advancing knowledge in the literature on the effect of automation on security markets efficiency. Descriptive and inferential statistics were used in the study. The results indicate that the introduction of the ATS had no statistically significant effect on market efficiency at the Nairobi Securities Exchange. Overall, the results indicate that automation had not yielded the anticipated benefits in improving efficiency of the Nairobi Securities Exchange.
Keywords: Nairobi security exchange, NSE share index, market automation, market efficiency

1.0 Introduction
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.

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 Automated Trading System (ATS) in 2006.

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).

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 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. The implementation of the Automated Trading System (ATS) 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). The automation of the Nairobi Securities Exchange was premised on the belief that it would as one of its objectives to improve the efficiency (both operational and informational) of the market. Thus after years of implementation of the automation of the exchange, the question that beckons is whether the automation of the exchange has improved the efficiency of the Nairobi Securities exchange. The purpose of this study is thus, to examine the efficiency of Nairobi Securities Exchange taking into consideration the role of automation of the exchange.

The discussion of the effect of automation on security markets efficiency is very scanty in the literature, particularly in sub-Saharan Africa. Evidence emanating from this study is hoped to advance knowledge in the literature on the effect of automation on security markets efficiency.

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.

The study considered secondary data in its analysis. This data used is originally compiled by independent institutions charged primarily with the responsibility of collection and dissemination. There may be errors in compiling and capturing of the data from the source documents. Care was taken while capturing the data from source documents to minimize the chance of the errors significantly affecting the analysis. The researcher endeavored to ensure accuracy was maintained by close supervision of assistants and/or personally undertaking the exercise.

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.

Generally Market efficiency refers to the degree to which share prices reflect all available and relevant information in the securities market. For this study market efficiency referred to the extent to which the new

adoption of automation at the Nairobi Securities Exchange (NSE) was reflected in the security prices.

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 Securities Exchange (NSE) formerly (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. On 17th 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). 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 the Complaints Handling Unit (CHU) was launched 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).

The Nairobi Stock Exchange Limited changed its name to the Nairobi Securities Exchange Limited in 2011. 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. Also 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. The Broker Back Office became operational in the same year. 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 (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 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 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 (African Review, 2013).

Table 1: 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)

2.5 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.

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.

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. However, automation of the Tunisian Stock Exchange (TSE) did not have significant effect on efficiency (Benouda and Mezzez, 2003).

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.

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.

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.

Muli, (2008) examined the relationship between Electronic Trading and Stock Market Efficiency at the Nairobi Securities Exchange and found out that the automated trading system brought about reduction in fraud, increased overall market efficiency and reduction in transaction cost and that the efficiency of the stock/securities market is based on fraud detection, efficiency in price reporting and regulation of market. In overall terms she found significance relationship between electronic trading and stock market efficiency. Previous studies on market efficiency assert that NSE is weak-form efficient (Dickinson and Muragu, 1994 and Asewe, Mule, Ndichu, Aila, Okungu, Michoki, Onchonga and Momanyi, 2013)

3.0 Methodology
3.1 Data Type and Collection
The study adopted a longitudinal research design. This design involves measurements being made at more than one point in time. The target population comprised of all listed companies at the NSE and only included those firms listed at the NSE by 1st January 2002. Only firms with data spanning the study period were considered i.e. firms that had changed names, been taken over, been suspended/delisted/had merged were not included in the study. Therefore only 37 firms were considered, see appendix II.

Secondary data was collected using a data capture sheet. Data on monthly closing index values and monthly closing stock prices were obtained from the daily price list at NSE. The data included monthly returns and closing prices from January 2002 to June 2006 (pre-automation period) and July 2008 to December 2012 (post-automation period). The data is considered reliable since the data was collected by them and are institutions charged with the responsibility.

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 will be 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 this period the NSE was operating under both manual listing and automated listing and coping with the challenges of initial implementation.

3.2 Testing for Market Efficiency
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/firms 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.

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 $\quad \bar{x} = \sum x / N$

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

Where:

$\bar{x}$ = 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 $\quad x^2 = \sum (f_o - f_e)^2 / f_e$

Where:

x^2 = Chi –square

f_o = an observed frequency

f_e = an expected frequency

Σ = 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 2n-2.

4.0 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 security market efficiency. 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 for 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 subsequently.

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 2.

Table 2: Description of Market Performance Indicators

		n	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
Market efficiency	Before	53	-.0733	.1013	.003318	.032627	.061	1.185
	After	53	-.0866	.0720	-.00350	.033316	-.223	.447

4.3 Market Returns Trend

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 1 showed that returns did not provide visual evidence that the situation before automation was systemically better than after automation.
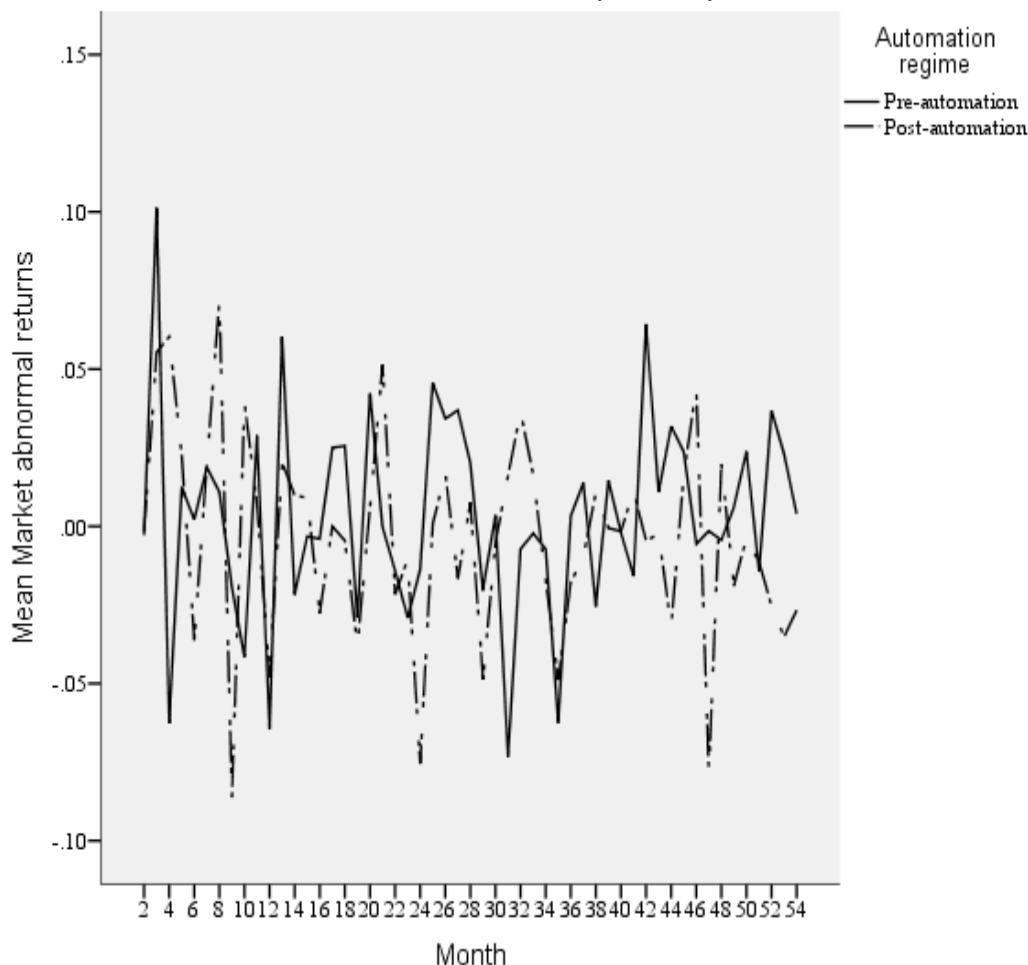

Figure 1: Market Returns Trend

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

4.4 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 at 0.05 level of significance [$t(52)=-1.176$, $p=.245$], 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 3). A crosstabulation of the returns confirmed that the percentages of the firms in various return categories did not remarkably change from the pre-automation era. (See Table 4) The chi-square test of independence provided statistically evidence that indeed there was zero (0) general change in returns at 0.05 level of significance [$\chi^2(2)=.889$, $p=.641$]. See Table 5.

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Table 3: 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: 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 5: 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.

4.5 Discussions

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.

5.0 Summary of Findings, Conclusion and Recommendations
5.1 Summary of the Findings

The study found no significant effect of NSE 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.

5.2 Conclusions

The main objective of the study was to determine the effect of automation on the efficiency of the Nairobi Securities Exchange. The study concludes that the automation of the Nairobi Securities Exchange had no

significant effect on its efficiency.

5.3 Recommendations

The study recommendations 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 without the direction of a 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. Also, all efforts should be done to make information on the security market, such as data easily accessible to the public, specifically to potential investors so as to improve the efficiency of the market. Finally, the study suggests that there is an important role for human intermediation. As the amount of automation in securities markets increases, the NSE need to ask what services human intermediaries 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.

5.4 Suggestion for Further Research

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

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APPENDIX I: 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 II: Listed Equity Firms Considered in the Study

	Agricultural		Construction & Allied
	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 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		

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