THE IMPACT OF AUTOMATED TRADING SYSTEM ON THE BONDS MARKET ACTIVITIES: EVIDENCE FROM THE NAIROBI STOCK EXCHANGE

BY

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DECLARATION

This research project report is my original work and has not been submitted for a degree in any other University.

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This research project report has been submitted with my approval as the university supervisor.

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DEDICATION

I dedicate this work to my wife Monica and children Natasha and Michael.

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ABSTRACT

Many major exchanges have witnessed the implementation of automated systems owing to the large benefits that they convey. Scholars argue that electronic trading systems generally lower the fixed costs of running an exchange, which can translate into lower trading costs for market participants. There has been a controversy over whether the automation of a stock exchange market leads to better market performance or not. The Nairobi Stock Exchange was automated in 2006. Since then, turnover in both the stock and bonds market have risen. Studies to establish the influence of automation have been done on the stocks market at the NSE but not on the bonds market. Thus, the present study sought to establish the impact of automated trading system on the performance of the bonds market on the Nairobi Stock Exchange.

A longitudinal survey design was used in this study. The population of interest was the bond market for the period June 2003 – June 2010. A census of the bond market was therefore performed. Secondary data was collected from the Nairobi Stock Exchange market, Business Daily and stock brokerage firms. The data on bond prices, turnover, and deals were collected. The data was organised using MS Excel and then entered into the SPSS software. The analysis was performed using paired t-test, Pearson correlation, and descriptive analysis.

The study found that bond turnover, prices, and deals were substantially higher for periods after stock market automation than before the automation. The t-tests showed that the observed differences were significant ($p<0.05$). The study concludes that automation of the bond market led to an increase in the bond market turnover, prices, and bond market deals. The study also concludes that bond market automation significantly led to an increase in bond turnover, prices, and deals. The study recommends that there is need for other markets which have not automated their trading systems to take the initiative to do so. Firms wishing to list their bonds on the Nairobi Stock Exchange should do so to take advantage of the improved efficiency that had led to better pricing. Given the increased number of deals due to automation, those wishing to invest in the bond market should do so because the market is able to capture as many deals per day as possible with the automation.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

An automated trading system (ATS) is defined as a computer trading program that automatically submits trades to an exchange (Bessembinder et al., 2009). A bond is a debt security, in which the authorized issuer owes the holders a debt and, depending on the terms of the bond, is obliged to pay interest (the coupon) and/or to repay the principal at a later date, termed maturity. A bond is a formal contract to repay borrowed money with interest at fixed intervals (O'Sullivan and Sheffrin, 2003). A bond market is a market where bonds are sold and bought.

1.1.1 Automated Trading System

Advances in information technology prompt exchanges to consider electronic trading systems as an alternative to open-outcry systems. There are several key differences between floor and electronic screen trading, which may lead to a difference in the provision of liquidity. There are many measures of liquidity (Bessembinder, 2000). Bid - ask spreads are commonly used as a measure of liquidity and are an important indicator of market quality (Kumar and Shastri, 1998) because they represent a cost of trading (Jong et al., 1995).

Instruments (contracts) traded on commodity exchanges include futures, options and other derivatives. Trading in these instruments began with floor trading, also called open outcry systems. In open outcry systems, traders assembled in a pit in the exchange and traded commodities by indicating their bids or offers to others in the pits. Commodity futures markets help with price discovery and provide a way to hedge for producers and buyers of commodities. However, the trading has moved to electronic trading from open outcry systems, following the trend in financial securities trading (Bessembinder et al., 2009).

Most financial markets have moved away from the open outcry system of trading to an automated trading system (ATS) (Mbugua, 2007). ATS is an electronic screen-based system trading all derivative products. The central marketplace is operated by the stock exchange, and instead of crying out in the trading pit, brokers buy and sell on behalf of clients through their ATS terminals. The ATS is designed to automatically match orders in terms of price and time priorities, with transactions being transmitted for registration and settlement after confirmation (Yen and Yeung, 1999). Mbugua (2007) asserted that exchanges automation world over are associated with changes in various market characteristics. These market characteristics include the market returns, volume, volatility, liquidity and bid-ask spread among others. These characteristics of stock trading are linked to expected rate of return on common stock and hence important to an investor.

1.1.2 The Nairobi Stock Exchange Market

Trading of financial securities in Kenya started in the 1920's as a sideline business conducted by accountants, auctioneers, estate agents and lawyers, all of European origin, who met to exchange prices over a cup of tea. The trading system that was employed then was manual, first a call over system and then the open outcry system and in 2004 the CDS was launched, followed by ATS in 2005. The call over and open outcry systems of trading have great limitations in terms of the traded volumes they can handle and the speed at which trade can be executed and hence the need for automation (Mbugua, 2007).

Trading is done through the Electronic Trading System (ETS) which was commissioned in 2006. 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 is now mainly conducted from the brokers' offices through the WAN. However, brokers under certain circumstances can still conduct trading from the floor of the NSE (Wikipedia, 2010).

NSE is categorized into three market segments: Main Investment Market Segment (MIMS); Alternative Investment Market Segment (AIMS); and Fixed Income Market Segment (FIMS). The MIMS is the main quotation market. Companies listed under this segment are further categorized in four sectors that describe the nature of their business, namely: agricultural; industrial and allied; finance and investment; and commercial and services. The AIMS: provides an alternative method of raising capital to small, medium sized and young companies that find it difficult to meet the more stringent listing requirements of the MIMS; is geared towards responding to the changing needs of issuers; facilitates the liquidity of companies with a large shareholder base through ‘introduction’, that is, listing of existing shares for marketability and not for raising capital; and offers investment opportunities to institutional investors and individuals who want to diversify their portfolios and to have access to sectors of the economy that are experiencing growth. The FISMS, on the other hand, provides an independent market for fixed income securities such as treasury bonds, corporate bonds, preference shares and debenture stocks, as well as short-term financial instruments such as treasury bills and commercial papers (NSE Handbook, 2009).

There are several good reasons for developing bond market. The most fundamental reason is to make financial and capital market more complete by generating market interest rates that reflect the opportunity cost of funds at each maturity. This is essential for efficient investment and financing decisions. Moreover the existence of tradable instruments helps risk management. Further the use of financial guarantees and other types of underwriting is becoming increasingly common in corporate debt market as financing deals become more complex. If borrowers have available to them only a narrow range of instruments (e.g. in terms of maturity, currency etc) then they can be exposed to significant mismatches between their assets and their liabilities (Loita, 2010).

The risks entailed by such mismatches have to be managed and the ability to do so will often depend on whether certain exposures can be adequately hedged. Liquid markets help capital market participants to hedge their exposures. If bond market is not well developed for instance firms may have to finance the acquisition of long-term assets by incurring short-term debts. As a result their investment policies may be biased in favour of short-term projects and away from entrepreneurial ventures. The relationship between intermediation through banks and disintermediation through capital markets is controversial. Even in developed economies this two rather distinct systems have grown up one where capital markets are very important and one where banks dominate (Loita, 2010).

1.1.3 Bond Market in Kenya

In most African countries the bond markets are still at rudimentary stage -not well developed -and often crowded by government bonds and a few corporate bonds. However, the ball game is changing and the Bonds market is becoming increasingly active in some African nations- Kenya included. In layman's terms, a corporate bond is a long-term contract in which the bondholders lend money to a company. In return the company (usually) promises to pay the bond owners a series of interest, known as the coupon payments, until the bond matures. At maturity the bondholder receives a specified principal sum called the par value of the bond. The government has also supported this market giving every incentive to promote its growth. In the annual government budget, Finance Minister Uhuru Kenyatta reduced withholding tax in 2009 from 15% to 10% on bonds with at least a 10-year maturity in order to encourage long-term investment. He also announced the reduction of listing fees to encourage more listings (Kihuro, 2009).

The bond market at the Nairobi Stock Exchange (NSE) has proved an attractive avenue to raise medium to long term capital. The NSE First Vice Chairman Lutaf Kassam recently intimated that the turnover for the Fixed Income Securities Market Segment (FISMS) increased by over 127% to Sh65 billion ($851 million) for the first six months year 2009, compared to Sh28 billion ($366 million) in the year 2008. This is however still a far cry in comparison to the African economic giants. Egypt's bond turnover is approximated to be a staggering $4 billion while South Africa's at $2 trillion (Makori, 2009).

Kenya's main electricity generating company KenGen in September 2009 kicked off the sale of a 15 billion shilling ($197 million) infrastructure bond. The 10 year bond is priced at par, 12.5 percent annual coupon and was indeed oversubscribed. The bond was also laced with a sweet coating – the interest earned is tax exempt! This was definitely an incentive to a lot of investors who have always viewed the government's appetite to tax any stream of income unbearable. Funds from the bond would be invested in diverse sources of energy like geothermal in line with the company's strategy of investing at least

40 billion shillings in generation every year to keep up with rising demand (Kihuro, 2009).

Kenya's corporate bond market has attracted other corporate issues this year and arranging banks such as CFC Stanbic Bank have been raking in alot of cash from these transactions. Financial institutions have ventured in this market too; just recently CFC Stanbic Bank floated a Kes.5B fixed and floating rate note and in August Shelter Afrique as well floated a Kshs. 1B corporate bond- which was oversubscribed (Kihuro, 2009).

1.2 Problem Statement

Many major exchanges have witnessed the implementation of automated systems owing to the large benefits that they convey. Theissen (2001) and Grünbichler et al. (1994) argue that electronic trading systems generally lower the fixed costs of running an exchange, which can translate into lower trading costs for market participants. Grünbichler et al. (1994) argue that electronic screen trading reduces the processing and execution time of an order. Pirrong (1996) discusses how miscommunication errors in an open outcry system and the costs associated with these are eliminated on electronic trading systems. According to Gwilym et al. (2003), electronic trading both removes geographical restraints and allows continuous multilateral interaction.

Since the introduction of automated trading system (ATS) at the Nairobi Stock Exchange market to replace the open outcry system, there are several benefits that have come up. For instance, it has been observed that the bonds market has increased its turnover which may indicate improvement in efficiency. The alluring nature of the bonds market saw the first quarter of 2010 realise a turnover of Sh142 billion. The higher aggregate number of bonds currently listed at the NSE and the introduction of automated trading bonds late last year has resulted in the secondary debt market performing considerably well (AllAfrica.com, 2010). Thus, observers attribute this increase in bond capitalization to automation of the market but empirical tests are yet to be done on the same.

There has been a controversy over whether the automation of a stock exchange market leads to better market performance or not. Those in support of this proposition include Biais et al., (1997) and Brailsford et al., (1999), while those with differing findings include Frino et al., (1998) and Pirrong (1996). There are also those that find no impact at all either positive or negative of the introduction of ATS on the market (for example Fung et al., 2003). Thus, the dust on this issue is yet to be settled. There are a few studies that have been done on the impact of NSE automation. For instance, Mbugua (2007) sought to identify the behaviour of volume, volatility and liquidity under three trading systems namely, manual trading, partial trading (CDS) and full automation (ATS) at NSE with a view to determine whether automation had affected the three market characteristics. Another study by Mukumu (2008) sought to establish the effects of market microstructure on performance with a specific focus on automation of Nairobi Stock Exchange. This study failed to capture the effects on the bonds market. A study by Kaberia (2009) sought to assess the perceived benefits and the limitations of automated trading system at the NSE. This study sought views from the MBA students and focused on their perceptions rather than the actual impact on either the stocks or the bonds market. Makori (2009) sought to establish the performance of the NSE before and after the implementation of automated trading system. This study also focused on the stock market and not the bonds market hence the variation from the focus of the present study. Angulu (2007) sought to establish response strategies by stock broking firms to challenges posed by electronic trading system at the NSE. This study took a strategic approach and focused on the stock brokerage firms. This deviates from the present study. Kabaka (2009) did a survey on the need for regulatory framework on electronic trading at the NSE. This study therefore took a regulatory approach to the issue of electronic trading and thus deviates from the focus of the present study. Thus, it can be observed that none of the studies attempted to focus on the bonds market. This is the gap the present study seeks to bridge.

1.3 Objective of the Study

The study sought to establish the impact of automated trading system on the performance of the bonds market at the Nairobi Stock Exchange.

1.4 Importance of the Study

This study is important as it adds on to the growing body knowledge of impact of automated trading systems on financial markets. It will be specifically important to the following stakeholders.

The members of the Nairobi Stock Exchange market will find this study useful as far as determining the impact of reforms and especially ATS on the bonds market is concerned. This will add on to their existing knowledge on the impact of ATS on stock markets by identify the impact on the bonds market, which most other studies have neglected in the past.

Researchers interested in carrying out more research on the effects of automated trading systems will also find this study a useful source of information as regards the same.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The issues associated with the impact of automated trading have been an interesting topic of discussion and continuously examined by many researchers. Over the past decades, automated futures exchanges have been increasing, while other exchanges are gradually replacing their open outcry trading systems to computerized trading systems. In some places, the computerized systems are used to complement the open outcry system (e.g. London International Financial Futures and Options Exchange's (LIFFE) Automated Pit Trading System (APT), New York Mercantile Exchange's (NYSE) Access system, Hong Kong Futures Exchange (HKFE), (Sydney Futures Exchange) SFE), while others like Chicago Board of Trade (CBOT) and Chicago Mercantile Exchange (CME) prefer to conduct trading based on the open outcry system.

2.2 Automated Trading System

Electronic trading systems comprise the means to digitally transmit data between two separate organizations. Essentially, electronic trading systems address two main features of an information transfer system: capacity (bits of data reliably transmitted over a given time period) and response time (period of time after which the channel is available for further data transmissions) (Bakos 1991).

Glosten (1994) provides a theoretical analysis of an idealized electronic open limit order book. The author shows that the electronic open limit order book is competition proof under certain conditions. The main assumptions made are that there is a large population of potential liquidity suppliers, the actual cost of running an exchange are small, and the exchange operates continuously and anonymously. As the author observes, if any of the assumptions are violated, simultaneous trading of equities on a dealer market (like the London Stock Exchange) and an electronic open limit order book (like the Paris Bourse) could co-exist. For example, the trading on the dealer market might not be anonymous.

Seppi (1997) presents a microstructure model of liquidity provision in which a specialist with market power competes against a competitive limit order book. The author shows that a hybrid specialist/limit order market (like the NYSE) provides better liquidity to small retail and institutional trades, but a pure limit order market may offer better liquidity on mid-size orders.

However, Parlour and Seppi (2003) find that neither a pure automated market nor a hybrid market structure is competition-proof. A pure limit order market can always be supported in equilibrium as the dominant market (i.e., where the hybrid limit book is empty), but a hybrid market can also be supported for some market parameterizations, as the dominant market.

Recently, Malinova and Park (2010) investigated the impact of market mechanisms on price efficiency, volume, liquidity, and trade execution costs. They found that integrated markets in which dealer segments coexist with a limit order book provide improved price efficiency and spreads compared to that of a pure dealer market. However, the authors show that a pure limit order market would attract the highest volume which might lead to the transition to fully electronic and automated trading venues in the stock exchange industry. This fact causes the value of human involvement to remain in question.

2.3 Stock Market Theories

The efficient-market hypothesis (EMH) asserts that financial markets are "informationally efficient". That is, one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis, given the information publicly available at the time the investment is made. There are three major versions of the hypothesis: "weak", "semi-strong", and "strong". Weak EMH claims that prices on traded assets (e.g., stocks, bonds, or property) already reflect all past publicly available information. Semi-strong EMH claims both that prices reflect all publicly available information and that prices instantly change to reflect new public information. Strong EMH additionally claims that prices instantly reflect even hidden or "insider" information. There is evidence for and against the weak and semi-strong EMHs, while there is powerful evidence against strong EMH (Nocera, 2009).

Developed by Ralph Elliot in the 1920's, Elliot Wave Theory suggests that the market moves in repetitive patterns called waves. The theory consists of the following: every market action is followed by a reaction. There are 5 waves in the direction of the main trend followed by 3 corrective waves; the cycle is over after the waves of 5 and 3; the 5-3 move becomes 2 subdivisions of the next higher 5-3 wave (Headley, 2006).

Market microstructure is a branch of finance concerned with the details of how exchange occurs in markets. While the theory of market microstructure applies to the exchange of real or financial assets, more evidence is available on the microstructure of financial markets due to the availability of transactions data from them. The major thrust of market microstructure research examines the ways in which the working processes of a market affects determinants of transaction costs, prices, quotes, volume, and trading behaviour

(Harris, 2003). O'Hara (1995) defines market microstructure as the study of the process and outcomes of exchanging assets under a specific set of rules. While much of economics abstracts from the mechanics of trading, microstructure theory focuses on how specific trading mechanisms affect the price formation process.

Chaos theory has been applied to many different things, from predicting weather patterns to the stock market. Simply put, chaos theory is an attempt to see and understand the underlying order of complex systems that may appear to be without order at first glance. Related to financial markets, proponents of chaos theory believe that price is the very last thing to change for a stock, bond, or some other security. Price changes can be determined through stringent mathematical equations predicting the following factors: a trader's own personal motives, needs, desires, hopes, fears and beliefs are complex and nonlinear; volume changes; acceleration of the changes; and momentum behind the changes (Investopedia, 2010).

2.4 Empirical Studies

Numerous papers have investigated the impact of automated trading either within the same exchanges example between two futures markets (Frino, et al., 1998; Pirrong, 1996) or inter market, that is, between futures markets and its underlying spot markets. Shy, et al., (1996) analyze the effect of automated trading between stock and futures markets (Brailsford, et al., 1999 and Fung, et al., 2003). Previous empirical research on the effects of electronic trading can be classified into several main categories; those that investigate the effects of automated trading system on liquidity, market efficiency and volatility (Frino, McInish and Toner, 1998; Pirong, 1996; Sujoto and Kalev, 2003; Theissen, 2002) and those that compare information transmission between those traded on automated systems and open outcry systems (Brailsford, et al., 1999; Fung, et al., 2003). Others further analyze the effects of bid-ask spread and cost transactions under open outcry and screen trading systems (Blennerhasst and Bowman, 1998)

The study by Biais et al., (1997) provides evidence in support of the view that automated trading system leads to lower liquidity. Their findings documented that automation reduce liquidity because it prevents face-to-face negotiation between traders. On the other hand Frino, et al., (1998), Pirrong (1996) differ in their findings. Evidence in their respective studies implies that automated exchanges provide more liquidity than floor traded exchanges. However Frino, et al., (1998) also discovered that relative performance of automated exchanges tend to decline during periods of higher volatility.

Employing trade data over a window of six months, Fung et al., (2003) found no evidence of asymmetric response to good/bad news between Hang Seng Index futures when the market moves to electronic trading. They also observed that information transmission between the futures market and its underlying instrument increases. Beelder and Massey (2002) also documented an increase in information transmission on the Johannesbury Stock Exchange for its index futures contracts after the introduction of electronic trading but the opposite for the gold futures contracts.

Brailsford, et al., (1999) found a significant change in the information transmission processes between Share Price Index futures (SPI) and All Ordinaries Index (AOI) when its underlying market moves to electronic trading. They discovered that such change accelerates the price discovery process between the two markets. These results are consistent with those of Grunbichler, et al., (1994).

Sujoto and Skalev (2003) examine the impact of the introduction of automated trading system at Sydney Futures Exchange. The authors found that both SPI futures' volatility and its persistence to decrease after introducing the screen trading using the GARCH models. However when they estimated the model with Student t-distributed errors, the results indicate no reduction in the volatility persistence of the SPI futures. Studies of Gilbert and Rijken (2002) and Kavussano and Phylaktis (2002) also reported similar results on the level of volatility when they conduct a study on the effect of migrating to the automated trading system.

In contrast, Naidu and Rozeff (1994) find volatility to increase at the Singapore stock market after the introduction of an automated system. On the other hand, Taylor, et al., (2000) suggests volatility level to be almost similar in both systems. Overall there is mixed empirical evidence as to how changes in the market microstructure would have an impact on level of volatility and its persistence, liquidity, transmission of information and volatility asymmetries of the markets studied.

Over the last two decades, the subject of market microstructure has become a major sub-discipline within the field of finance. It is related to the process by which investors' latent demands are ultimately translated into transactions (Madhavan, 2000). Increasing attention is being devoted to market microstructure in today's highly globalised environment, driven by the regulatory changes and rapid structural and technological advances affecting the securities industry world-wide.

Many major exchanges have witnessed the implementation of automated systems owing to the large benefits that they convey. For instance, Theissen (2001) and Grünbichler et al. (1994) argue that electronic trading systems generally lower the fixed costs of running an exchange, which can translate into lower trading costs for market participants. Grünbichler et al. (1994) also argue that electronic screen trading reduces the processing and execution time of an order. Pirrong (1996) discusses how miscommunication errors in an open outcry system and the costs associated with these are eliminated on electronic trading systems. Also, according to Gwilym et al. (2003), electronic trading both removes geographical restraints and allows continuous multilateral interaction.

Moreover, the computerised system offers many advantages for stock brokers and permits a better protection for investors. For example, Benouda and Mezzez (2002) stipulate that the new trading system offers a set of tools and information that facilitate the task of stockbrokers. In addition, investors derive more protection as they can check whether their orders have been executed or not.

Most empirical research on market microstructure has so far been carried out in major industrial countries, particularly the USA. Meanwhile, the development of market microstructure as a subject has coincided with a period of establishment of new stock markets and revitalisation of existing markets in many developing and transitional economies (Green et al., 2003). Hence, more attention has been given to the setting up and revitalisation of stock markets in developing countries. In fact, some of these countries decided to undertake reforms to improve their market microstructure, taking into account international norms and experiences of major stock exchanges. Khambata (2000) argues that these countries were motivated by the need to promote the role of the private sector in stimulating growth in their economies.

Transparency is a commonly cited benefit of electronic trading in that the latter can facilitate the dissemination of real time pre and post trade information market wide. Market transparency is defined (O'Hara, 1995) as the ability of market participants to observe information about the trading process. Information, in this context, can refer to knowledge about prices, quotes, or volumes, the sources of order flow, and the identities of market participants.

Jain (2003) argues that electronic systems are more transparent than trading floors in displaying detailed order flow information, such as quotes, depths, and recent transactions from the limit order book to the market participants in real time. Academic interest in transparency is reflected in a rapidly growing theoretical, experimental, and empirical literature on the relationship between information and security prices. Market transparency arrangements affect the balance of information among participants. Previous theoretical research finds that transparency affects various dimensions of market quality, including liquidity, trading costs, and the speed of price discovery (Madhavan, 2000). Pagano and Röell (1996) suggest that a greater transparency in the trading process improves market liquidity by reducing opportunities for taking advantage of less informed or non-professional participants. Thus, spread, volatility and pricing error are likely to decrease.

In addition, some regulatory responses to transparency questions have been predicated on the belief that greater transparency will increase the efficiency and fairness of securities markets. For example, both the U.S. Securities and Exchange Commission and the U.K. Office of Fair Trading have called for increases in transparency in their respective securities markets as a way of improving market quality.

However, changes to transparency rules tend to benefit one group of participants and their objectives at the expense of another, creating winners and losers. The U.K. Securities Investment Board, for example, opposes increases in transparency; it contends that transparency increases will reduce liquidity, since market-makers positions must be publicly disclosed. Informed traders seek to hide their identity and thus can prefer in certain cases a less transparent system to take advantage of their private information. Harris (1990) supports that highly transparent markets lead to informed investors quitting the market because if they reveal their positions, they run the risk that this information will be used on them. The author further elaborates that transaction costs will increase and liquidity reduced when trades are withdrawn to avoid revealing orders to parasitic traders.

Prominent financial economists have developed a number of concepts that are known to be essential prerequisites for fulfilling the economic roles of stock markets. These concepts include pricing efficiency. Essentially, a stock market is said to be efficient (pricing) if current securities prices reflect all available information (Fama, 1970). This efficiency is an essential prerequisite in stock markets for fulfilling their primary role, which is the allocation of scarce capital resources. Cochran and De Fina (1995) and Lee (1998) note that predictability of stock returns occurs due to the inefficiencies in the pricing of securities. Several studies, such as Domowitz (1999, 2001) and Naidu and Rozeff (1994), have discussed the effects of automation on the pricing efficiency of securities markets. Advocates of automation suggest that the execution process of trades becomes faster and less costly. Such a system is expected to attract more investors, increase trading volume and liquidity and improve the price discovery process.

Bessembinder and Kaufman (1997) characterise a desirable trading system as one with price discovery process that has no excess volatility and provides liquidity at low costs. Amihud et al. (1990) favour a trading system that provides high liquidity and enhances efficient price discovery for emerging stock markets. They argue that efficient price discovery is associated with low volatility, making the market price more informative. It also enhances the role of the market in aggregating and conveying information through price signals.

Moreover, price formation in electronic trading systems is the outcome of precise order execution algorithms, in contrast to the trading floor or phone-based systems where relationships may matter as much as price or size. Electronic processing allows orders to reach the central market faster because of higher processing speeds than with manual processes. Domowitz and Steil (2001) find that most empirical studies show that electronic systems are more efficient than traditional trading venues. However, in some studies the difference is quite marked while in others it is rather small. In this respect, Amihud et al. (1997) find improved efficiency in the value discovery process due to the new continuous trading system. Stock prices were found to adjust faster to market information while noise in stock prices declined. Thus, with the gained efficiency stock prices were made more informative. Similarly, Taylor et al. (2000) and Anderson and Vahid (2001) investigate the impact of electronic trading on the pricing efficiency of the London and Australian stock exchanges and found that these markets have become more efficient under electronic trading.

However, Madhavan (1992) observes that a large enough call auction provides more efficient prices than a continuous market. This is because as more traders participate in auction asymmetric information is reduced and prices tend to reflect the asset value. In the same vein, Chang et al. (1999) using the variance ratios find price discovery to be more efficient in call than in continuous auction.

Maghyereh and Omet (2003) study the shift from the manual trading system to the computerised trading mechanism on the Jordanian Stock Exchange. They examine the efficiency of the market around the date of its automation and find that the move to the electronic trading system has had no impact on the pricing efficiency of the Jordanian capital market. Similar findings were made on the Tunisian Stock Market where the new trading mechanism did not reduce pricing error and thus did not improve market efficiency.

Mbugua (2005) found that automation at NSE was associated with increased volume of trading, increased volatility of quoted stocks and increased liquidity. Greater volumes of trade and volatility were noted when NSE was fully automated compared to manual or partial automated systems. The study also noted that though there was a noted increase in liquidity on introduction of CDS, the liquidity declined on introduction of ATS.

2.5 Summary of Literature Review

The chapter has attempted to exhaustively review literature on automated trading systems and bonds markets. The chapter has also presented a review on the theories of stock markets. From the review, it can be observed that very little research has been done on the bonds market in terms of establishing the impact of automation on the bonds market. The literature on the bonds market in Kenya is very scanty as most empirical studies have focused on the stock market. The next chapter is the methodology and presents the way in which this study will be carried out in order to fulfil the study objectives.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design used in the study, the target population, sample size and sampling method, data collection method and data analysis technique.

3.2 Research Design

This is a quantitative research. A quantitative research is usually designed to provide further insight into the research problem by describing the variables of interest (Mugenda and Mugenda, 2003). According to Bryman and Bell (2007), there are two main types of quantitative research: cross-sectional surveys and longitudinal surveys. The type of descriptive research used here was longitudinal survey. A longitudinal survey seeks investigate a situation by taking repeated measures over time. Since this study sought to take data for the periods before and after the introduction of ATS, a longitudinal survey was best suited.

3.3 Target Population and Sample

The target population is 12 companies on the Fixed Income Security Market Segment (FISMS) of the Nairobi Stock Exchange. This is a segment that mainly trades in the preference shares, bonds and notes. The study will focus on the bonds only. The main players here are the Government through the treasury bonds and infrastructure bonds, EADB, PTA Bank, as well as private sector companies such as CFC Stanbic and Kengen among others. Thus, the target sample was the 12 bonds traded from the period beginning 2003-2005 (pre-automation period) and from 2007-2010 (post automation period). All the listed bonds were studied hence a census of the bonds market.

3.4 Data Collection

The type of data collected in this study is secondary data. Data was collected from the Nairobi Stock Exchange as well as from other sources such as the Business Daily and from the brokerage firms. The specific data collected was on the bonds turnover, prices and deals. These data helped in the quantitative analysis process. Since the data was quantitative, there was no need to test for reliability as the sources were more reliable in themselves.

3.5 Data Analysis

Data collected was presented into spreadsheets using MS Excel. The data was then entered into the statistical package for social sciences (SPSS) analysis package version 17. This software has various statistical tools that can be used to manipulate quantitative data for interpretation. The analysis was done through mean scores and standard deviations. The analysis also involved the use of paired t-tests to determine whether there were any statistical differences in the performance of bonds before and after the automation of the market. The t-tests were done by listing down the performance of bonds before and the performance after in terms of turnover, prices, and deals then the differences observed were tested for significance using the paired t-test. The significance was tested at 5% confidence levels. The results were presented mainly in tables but in some instances charts or graphs were used. The following regression model was used in the analysis to test the effect of automation on bonds.

$$\text{BOND} = \mathbf{a} + \mathbf{b}\,(\text{AUT}) + \mathbf{c}$$

Where a, b and c are constants

BOND	refers to bond performance in terms of turnover, prices, and deals. This is the dependent variable in the model. This was measured using the bond turnover, the average prices of bonds, and the number of deals per day.
AUT	is the dummy variable for automation. The pre-automation period is 0 and 1 otherwise. This was the independent variable in the model.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results of data analysis collected through secondary sources. Data on bond turnover, deals and clean prices were retrieved from excel spreadsheets provided by the Nairobi Stock Exchange for the entire study period. The study covered the period beginning June 2003 to June 2010. The data was divided into pre-automation period (2003-2005) and post-automation period (2007-2010).

The chapter is organised as follows. First, the descriptive results of the variables in the analysis are shown in Section 4.2. Then Section 4.3 shows the results of Pearson correlation analysis with automation as the independent variable and turnover, deals, and prices as the dependent variables. Section 4.4 then shows the results of T-tests to show whether there were any significant differences between the two periods (pre-automation and post-automation period) on the turnover, deals, and bond prices.

4.2 Descriptives on Bond Turnover, Prices, Deals, and Automation

Table 1 shows the results of the descriptive analysis on the data. The statistics used are minimum, maximum, mean, and standard deviation. The minimum and maximum values show the lowest and highest averages for the period on each of the variables. The mean scores show the averages of each of the variables for the period shown. The standard deviations show the extent of variance from the mean scores for each of the variables.

Table 1: Descriptives on Bond Turnover, Prices, Deals, and Automation

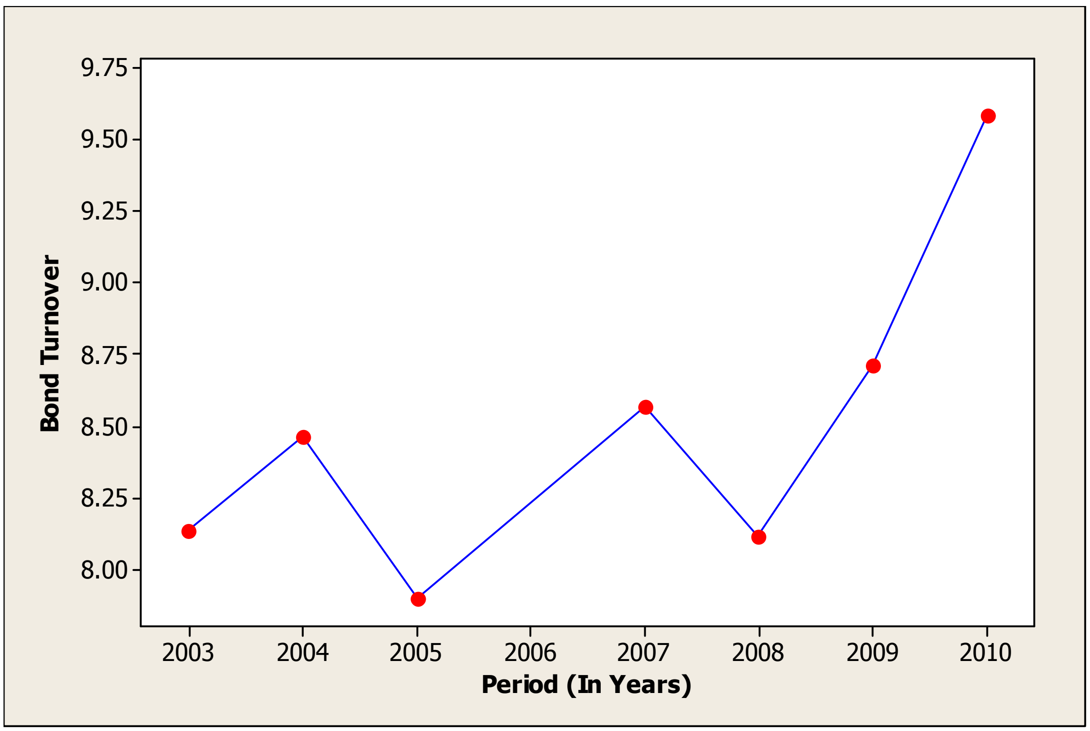
	Minimum	Maximum	Mean	Std. Deviation
Automation	.00	1.00	.5714	.53452
Pre-automation bond turnover	7.22	9.06	8.5593	.44904
Post-automation bond turnover	9.24	9.99	9.7047	.15492
Pre-automation bond prices	94.83	103.51	98.7706	2.86504
Post-automation bond prices	123.41	323.25	282.621	55.63207
Pre-automation total deals	7.00	60.00	20.4706	13.19146
Post-automation total deals	26.00	176.00	77.2857	32.93956

Source: Research Data

The results in Table 1 show that the minimum for automation was 0 while the maximum was 1. This is because any period before automation was coded as 0 in the SPSS while the period after automation was coded 1. The mean score for automation was 0.5714 and the standard deviation was 0.53452. This means that the variance from the mean on automation was moderate.

The results in Table 1 also show that the minimum for pre-automation bond turnover was 7.22 while that of post-automation bond prices was 9.24. It should be noted that the turnover values shown here the natural logarithms of the turnover values and not the absolute figures. Thus, the minimum values show that the post-automation turnover was higher than the pre-automation turnover. The maximum values show that pre-automation turnover was 9.06 while the post-automation turnover was 9.99. Thus, again, it can be observed that the post automation values for turnover were way higher. In fact, a closer look shows that the maximum bond turnover for pre-automation (9.06) was lower than the minimum for the post-automation period (9.24). The mean score for the pre-automation bond turnover was 8.5593 while that of post-automation period was 9.7047. These show that the post-automation bond turnover was higher than that of pre-automation period. The standard deviations reveal that the variances were high in pre-automation turnover than in the post-automation turnover. The results could lead to the conclusion that the bond turnover substantially increased in the periods following bond market automation. These results can also be observed from Chart 1.

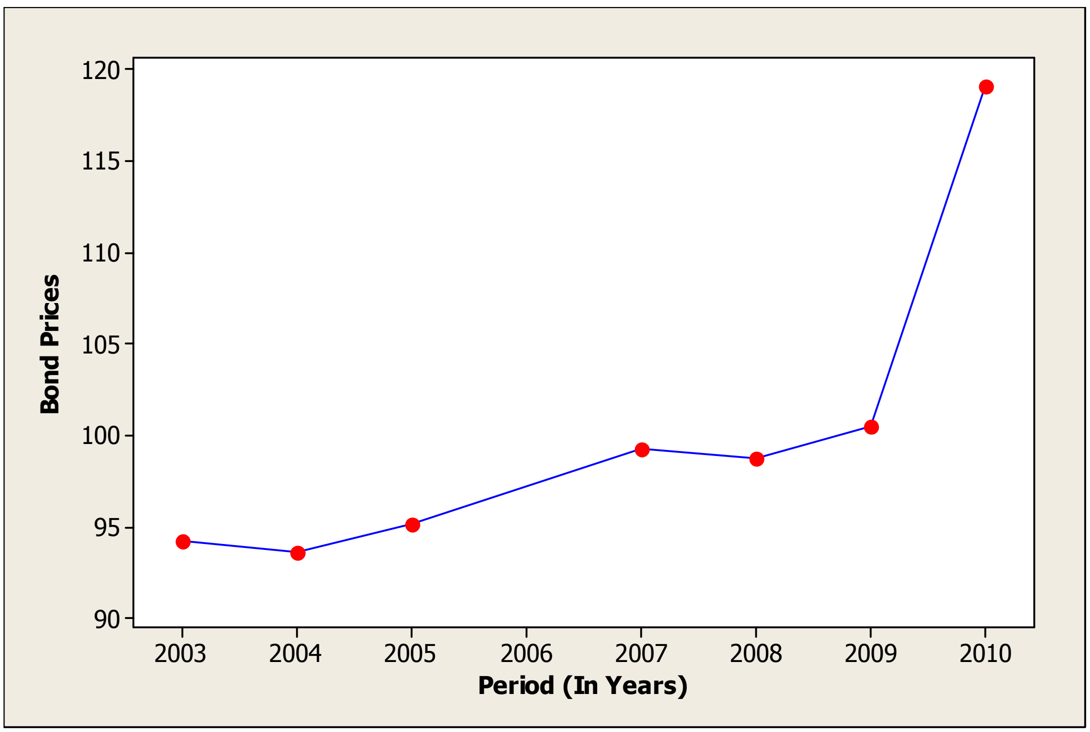
Chart 1: Scatter Graph for Bond Turnover



Source: Research Data

The study also found that the minimum for pre-automation bond prices was 94.83 while for the post-automation period was 123.41. This shows that bond prices were higher after automation. Further, the results show that the maximum pre-automation bond price was 103.51 (a price lower than the minimum for post-automation prices) while that of post-automation period was 323.25. These results confirm that the bond prices were significantly higher after automation of the market. The mean score for bond prices before automation was 98.7706 while it was 282.621 after automation. Thus, again, the mean scores show that post–automation bond prices were substantially higher. The standard deviations show that the post automation prices were more varied. This can lead to the conclusion that the bond prices after automation were more volatile than the periods before market automation. These results are also shown in Chart 2.

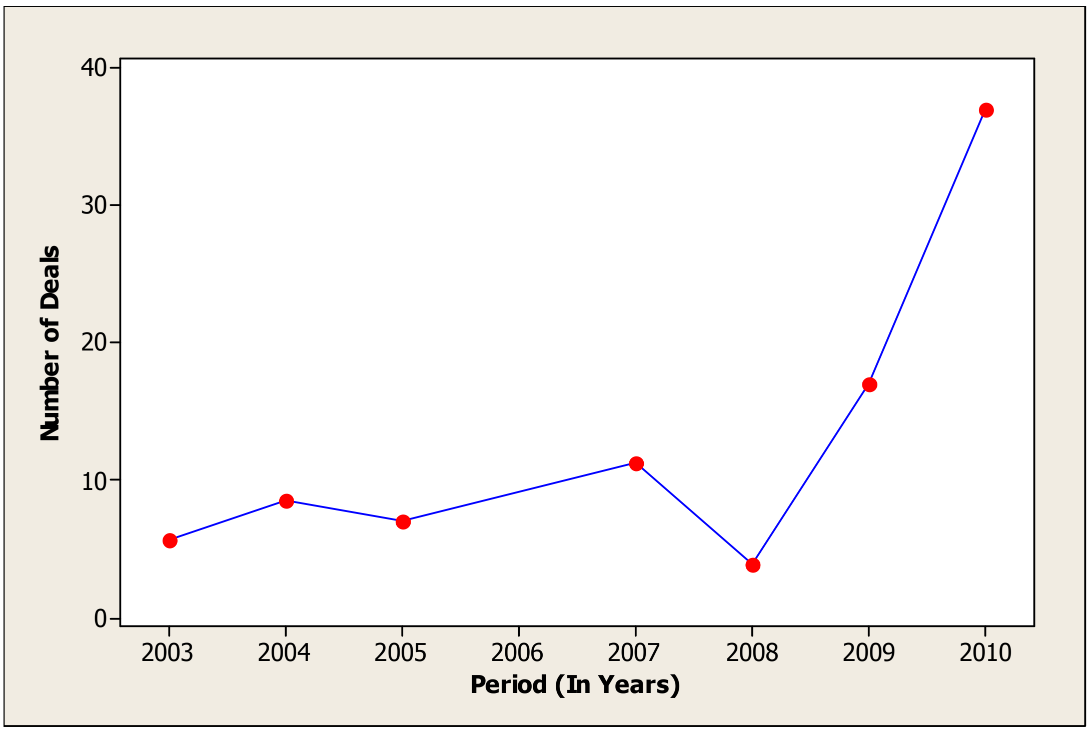
Chart 2: Scatter Graph for Bond Prices



Source: Research Data

On the number of deals, the results in Table 1 show that the minimum deals for the pre-automation period was 7 while that of the post-automation period was 26. This reveals that there were more deals per day in the post-automation period than the pre-automation period. The maximum number of deals for the pre-automation period was 60 while for the automation period was 176. This shows that there were many deals after automation. The mean scores show that the periods before automation had 20.4706 while there were a average of 77.2857 after automation. Thus, it can be noted that there were substantially higher number of deals for the period following automation. The standard deviations show that the variances were high for post-automation period which suggests more activity during the period. These results are also shown in Chart 3.

Chart 3: Scatter Graph for Number of Deals



Source: Research Data

4.3 Effect of Electronic Trading on Bond Market

This section presents the results on the effect of electronic trading on bond market. The Pearson correlation analysis was used to perform this analysis. The results are shown in Table 2.

Table 2: Effect of Automation on Bond Market

		Automation
Pre-automation turnover	Pearson Correlation	-.607
	Sig. (2-tailed)	.149
Post automation turnover	Pearson Correlation	-.112
	Sig. (2-tailed)	.811
Pre-automation price	Pearson Correlation	.045
	Sig. (2-tailed)	.923
Post automation price	Pearson Correlation	-.112
	Sig. (2-tailed)	.811
Pre-automation deals	Pearson Correlation	-.325
	Sig. (2-tailed)	.477
Post automation deals	Pearson Correlation	.296
	Sig. (2-tailed)	.519

Source: Research Data

The study found that automation was negatively correlated with turnover in both pre-automation and post automation periods (R = -0.607 and -0.112 respectively). Both correlations were not statistically significant (p>0.05). The study revealed that pre-automation prices were positively correlated with automation while the post automation prices had a negative correlation with automation (R = 0.045 and -0.0112 respectively). These correlations were however not statistically significant (p>0.005). The study further revealed that automation was negatively correlated with pre-automation deals (R = -0.325) while positively correlated with post automation deals (R = 0.296). These correlations were not statistically significant (p>0.05). These results lead to the conclusion that automation did not have any significant contribution to bond turnover, prices or deals.

4.4 Results on the Paired T-tests

This section presents the results of paired t-tests on pre-automation and post automation bond turnover, prices, and deals. The paired t-tests were performed in order to determine whether there were any statistical differences in the data between the two periods under study. These results are shown in Table 3.

Table 3: Paired Sample Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post automation turnover	9.7262	17	.16087	.03902
	Pre-automation turnover	8.5593	17	.44904	.10891
Pair 2	Post automation price	314.6805	15	5.2769	1.36249
	Pre-automation price	98.7706	15	2.86504	.73975
Pair 3	Post automation deals	82.1765	17	34.31515	8.32265
	Pre-automation deals	20.4706	17	13.19146	3.19940

Source: Research Data

The study found that for pair 1, the mean for post automation turnover (9.7262) was higher than that for pre-automation turnover (8.5593) with a higher standard deviation in pre-automation turnover (0.44904) and also a higher standard error mean in the same period (0.10891). For pair 2, the post-automation price mean (314.6805) was higher than that of pre-automation price (98.7706). The post automation prices also had higher standard deviations (5.2769) and a higher standard error mean (1.36249) than the pre-automation bond prices. The study also noted that the mean (82.1765) for post automation deals in pair 3 was higher than that of pre-automation deals (20.4706) and that the post automation deals had higher standard deviations (34.31515) and higher standard error means (8.32265) than the pre-automation deals. The results in Table 3 lead to the conclusion that the post-automation mean scores were higher for bond turnover, prices, and deals.

The paired sample correlations are shown in Table 4. These results show whether the post automation results are related to the pre-automation ones.

Table 4: Paired Sample Correlations

		N	Correlation	Sig.
Pair 1	Post automation turnover & Pre-automation turnover	17	.110	.675
Pair 2	Post automation prices & Pre-automation prices	15	.627	.012
Pair 3	Post automation deals & Pre-automation deals	17	-.029	.911

Source: Research Data

Table 4 shows that for pair 1, the correlation was 0.110 and p-value was 0.675. In pair 2, the correlations show that the relationship between post automation prices and pre-automation prices was no statistically significant ($R = 0.627$, $p>0.05$). Further, post automation deals and pre-automation deals were not significantly correlated ($R = -0.029$, $p>0.911$). These results lead to the conclusion that there were no significant associations between the variables of interest for the pre-automation and post-automation periods.

In order to establish whether the differences in mean values are statistically significant for the periods before and after automation, Table 5 shows the p-values of paired differences at 95% confidence intervals. The following hypotheses are in place:

H_0: There are no significant differences between the means of the variables.

H_1: There are significant differences between the means of variables.

The results in Table 5 show whether to accept or reject these hypotheses. The mean, standard deviation (SD), standard error mean (SE mean), confidence internals, t-values, degrees of freedom (df) and p-values (Sig.) are shown in the table.

Table 5: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	SD	SE Mean	Lower	Upper			
Pair 1	Post automation turnover Vs. Pre-automation turnover	1.16686	.46006	.11158	.93032	1.40340	10.458	16	.000
Pair 2	Post automation price Vs. Pre-automation price	215.90994	4.13558	1.06780	213.61973	218.20015	202.200	14	.000
Pair 3	Post automation deals Vs. Pre-automation deals	61.70588	37.12439	9.00399	42.61828	80.79348	6.853	16	.000

Source: Research Data

As shown in Table 5, the difference between post automation and pre-automation turnover is 1.16686 with a standard deviation of difference of 0.46006 and a standard error mean difference of 0.11158. The results in Table 5 show that the differences in mean of post automation turnover and pre-automation turnover were statistically significant ($t = 10.458$; $p = 0.000$). Thus, there is a difference between bond turnover for the periods before automation and the period after automation of the market. The automation of the bond market thus led to an increase in the bond market turnover.

Table 5 also shows that the mean difference for post and pre-automation prices was 215.91, the standard deviation was 4.14, and the standard error mean was 1.07. The results show that there were significant differences between mean of prices before and after automation of the bond market ($t = 202.2$; $p = 0.000$). Thus, it can be market automation led to higher bond prices.

The results also showed that the mean difference for post and pre-automation deals was 61.71, the standard deviation was 37.12 and the standard error mean was 9.00. The t value of 6.853 and the significance value of 0.000 show that there were significant statistical differences in the mean of deals before and after automation of the bond market. It can be concluded that bond market automation led to more bond market deals.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of research findings, conclusion of the study, recommendations, limitations of the study, and suggestions for further research.

5.2 Summary of Findings

The study found out that automation was negatively correlated with turnover in both pre-automation and post automation periods ($R = -0.607$ and -0.112 respectively). The study revealed that pre-automation prices were positively correlated with automation while the post automation prices had a negative correlation with automation ($R = 0.045$ and -0.0112 respectively). The study further revealed that automation was negatively correlated with pre-automation deals ($R = -0.325$) while positively correlated with post automation deals ($R = 0.296$). These correlations were not statistically significant ($p>0.05$).

The study further found out that the mean for post automation turnover (9.7262) was higher than that for pre-automation turnover (8.5593). The post-automation price mean (314.6805) was higher than that of pre-automation price (98.7706). The study also noted that the mean (82.1765) for post automation deals was higher than that of pre-automation deals (20.4706).

The study revealed that the difference between post automation and pre-automation turnover was 1.16686. These differences were statistically significant ($t = 10.458$; $p =$

0.000). The mean difference for post and pre-automation prices was 215.91 and the differences were significantly different ($t = 202.2$; $p = 0.000$). The results also showed that the mean difference for post and pre-automation deals was 61.71 and the difference was statistically significant ($t = 6.853$; $p = 0.000$).

5.3 Conclusions

From the correlation analysis, the study concludes that bond market automation did not have any significant contribution to bond turnover, prices or deals. The study also concludes that the post-automation mean scores were higher for bond turnover, prices, and deals.

The descriptive results lead to the conclusion that there were notable differences between bond turnover for the periods before automation and the period after automation of the market. The study also concludes that automation of the bond market led to an increase in the bond market turnover. The automation also led to higher bond prices. The study also concludes that bond market automation led to more bond market deals.

The results of the paired t-tests leads to the conclusion that the differences observed for the periods before and after bond market automation for turnover, prices, and deals were statistically significant. Hence, the automation of bond market at the Nairobi Stock Exchange significantly increased the bond turnover, improved bond prices, and increased the number of deals made per day.

5.4 Recommendations

The study recommends that there is need for other markets which have not automated their trading systems to take the initiative to do so. This is because the present study found evidence to support bond market automation.

The study also recommends that firms wishing to list their bonds on the Nairobi Stock Exchange should do so to take advantage of the improved efficiency that had led to better pricing (due to reduced transaction fees).

The study recommends that given the increased number of deals due to automation, those wishing to invest in the bond market should do so because the market is able to capture as many deals per day as possible with the automation.

5.5 Limitations of the Study

The study faced a number of limitations. First, it took a number of visits to the Nairobi Stock Exchange in order to get the data on bonds for analysis. This made the analysis begin later than the researcher had scheduled.

The study also faced the limitation of time. Given that the time allocated for data collection and analysis was so short, there were logistical problems that may have influenced the outcome of this study. The limitation of time made the researcher work overtime on the project so as to see its completion.

The analysis covered only the bond market. This may limit the applicability of the findings to the entire market as it would have been prudent if both the bond and the stock market were analysed.

Financial resources were another limitation. The research demanded a lot of printing, bindings, typesetting, and data collection. All these activities needed money and this was a challenge to the researcher.

The other limitation of this study stems from the sample period covered. Given that the period covered was three years before automation and four years after automation (total of seven years) may affect the accuracy of the outcome.

5.6 Suggestions for Further Research

The study suggests that future studies should focus on extending the period under study so as to cover longer periods than were covered here. If the data for longer periods can be availed then such a study can be undertaken.

There is also need to replicate these results for the entire market in order to find results for both the stocks and the bonds. A comparative analysis can reveal more on whether the impact of automation was more on the stock market or the bond market.

Future studies also need to carry out studies on the influence of market automation on the volatility of the bond market as this may suggest the volatility effect of stock market automation in Kenya.

Studies should also be performed to investigate if past performance can be used to predict future performance in the bond market in Kenya.

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APPENDICES

Appendix 1: Overall Bond Market Data

Yr	Automation	Turnover	Price	Deals
2010	1	9.5870315	119.1406	37
2009	1	8.714	100.4854	17.05
2008	1	8.11857333	98.77058	3.866667
2007	1	8.56552089	99.257	11.23077
2005	0	7.90125393	95.124	7
2004	0	8.46067237	93.624	9
2003	0	8.1370	94.174	6

Appendix 2: Post Automation Data

2009			2008			2007		2010		
Turnover	**Deals**	**Price**	**Turnover**	**Deals**	**Price**	**Turnover**	**Deals**	**Turnover**	**Deals**	**Price**
1,150,550,000	103	99.2727	51,000,000	2	100.538	497,000,000	10	2,227,650,000	61	112
1,833,000,000	15	101.4957	287,000,000	3	97.9791	711,350,000	7	3,575,100,000	69	114
521,500,000	12	102.3692	1,250,000	2	97.8393	111,750,000	5	3,670,250,000	44	111
789,550,000	6	102.3028	100,000	1	103.1155	4,500,000	5	929,100,000	14	112
1,350,250,000	19	101.5718	29,900,000	1	94.8314	111,750,000	5	8,374,900,000	75	114
500,000	3	97.9435	29,900,000	1	94.8314	598,800,000	47	6,599,350,000	68	111
835,050,000	32	105.9515	480,000,000	5	101.2811	546,850,000	16	4,925,000,000	43	116
786,650,000	7	97.5534	2,000,000	1	99.9653	621,550,000	3	4,581,500,000	44	114
260,000,000	5	106.2468	225,000,000	15	95.541	352,150,000	5	5,947,750,000	56	115
300,000	2	95.087	569,650,000	4	97.8462	1,550,000	9	5,010,300,000	41	116
585,550,000	35	102.0112	5,800,000	1	103.5142	300,000,000	19	5,010,800,000	56	116
805,100,000	11	100.3214	5,850,000	2	101.7292	353,500,000	5	2,970,300,000	29	118
253,000,000	8	96.3466	23,450,000	5	97.8143	569,650,000	10	4,744,900,000	68	119
6,000,000	1	101.9413	60,000,000	13	98.9881			4,395,200,000	43	118
305,600,000	6	100.7734	200,000,000	2	95.7446			4,436,350,000	62	120
300,000	2	100.5521						6,117,050,000	68	122
450,700,000	18	100.0031						5,421,700,000	67	117
109,500,000	12	102.4006						3,863,950,000	37	119
215,300,000	43	99.492						3,303,550,000	36	114
85,000,000	1	96.0711						3,566,900,000	43	121
								5,570,150,000	54	123

Appendix 3: Pre-automation data

2003 Turnover	Deals	2004 Turnover	Deals	2005 Turnover	Deals	Pre-turnover	Pre-deals	PrePrice
250,000	4	1,350,000	2	15,000,000	1	16,600,000	7	100.538
100,550,000	3	2,500,000	2	650,000	2	103,700,000	7	97.9791
190,900,000	7	334,100,000	3	200,000,000	24	725,000,000	34	97.8393
100,450,000	9	146,000,000	8	174,800,000	9	421,250,000	26	103.1155
200,000,000	3	40,100,000	2	205,700,000	5	445,800,000	10	94.8314
1,000,000	1	443,600,000	27	200,000,000	32	644,600,000	60	94.8314
75,100,000	6	498,000,000	6	21,200,000	3	594,300,000	15	101.2811
164,550,000	4	306,650,000	10	3,250,000	3	474,450,000	17	99.9653
78,400,000	7	521,700,000	9	78,850,000	10	678,950,000	26	95.541
170,750,000	7	200,600,000	3	40,000,000	4	411,350,000	14	97.8462
325,000,000	8	101,700,000	7	550,000	4	427,250,000	19	103.5142
350,000	3	988,350,000	14	147,000,000	2	1,135,700,000	19	101.7292
84,450,000	6	305,250,000	27	125,000,000	3	514,700,000	36	97.8143
532,250,000	10	430,150,000	7	22,300,000	2	984,700,000	19	98.9881
72,650,000	9	100,000	1	19,300,000	5	92,050,000	15	95.7446
96,600,000	3	310,500,000	5	21,000,000	4	428,100,000	12	
		279,800,000	12			279,800,000	12	