IMPACT OF STOCK EXCHANGE AUTOMATION ON VOLUME, VOLATILITY AND LIQUIDITY OF STOCKS AT NAIROBI STOCK EXCHANGE (NSE)

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DECLARATION

This MBA project is my original work and has not been submitted for presentation at the University of Nairobi or any other institution of higher learning.

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DEDICATION

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ABSTRACT

Exchanges automation world over are associated with changes in various market characteristics. These market characteristics include the market returns, volume, volatility, liquidity, 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.

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 out cry system and in 2004 the CDS was launched, followed by ATS in 2005. The call over and open out cry systems of trading have great limitations in terms of the traded volumes they can handle and the speed at which trade can be executed and hence the need for automation.

The objective of the study was to identify the behavior 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 has affected the three market characteristics.

The findings of the study revealed that automation at NSE is 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 full automated compared to manual or partial automated systems. However though there was a noted increase in liquidity on introduction of CDS, the liquidity declined on introduction of ATS.

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

NSE	-	Nairobi Stock Exchange
DSE	-	Dar-es-Salaam Stock Exchange
USE	-	Uganda Securities Exchange
CDS	-	Central Depository System
CDSC	-	Central Depository System Corporation
ATS	-	Automated Trading System
AKS	-	Association of Kenya Stockbrokers
NYSE	-	New York Stock Exchange
TSE	-	Tunisian Stock Exchange
LSE	-	London Stock Exchange
INSE	-	India National Stock Exchange
BSE	-	Bombay Stock Exchange
CMA	-	Capital Market Authority
CDAs	-	Central Depository Agents
SSE	-	Singapore Stock Exchange
ECNs	-	Electronic Communication Networks
MSE	-	Mumbai Stock Exchange
IFC	-	International Finance Corporation
WAN	-	Wide Area Network
NASDAQ	-	National Association of Securities Dealers' Automated Quotation
MIT	-	Millennium Information Technologies
MIMS	-	Main Investment Market Segment
AIMS	-	Alternative Investment Market Segment
FISMS	-	Fixed Income Securities Market Segment

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background

Securities markets exist in order to bring together buyers and sellers of securities in order to facilitate trading. Sharpe, Alexander and Bailey, (2004) distinguish securities market in a number of ways. The market can be either a primary market or secondary market depending on whether the securities are being offered for sale by the issuer. Securities market can also be money markets or capital markets. Money markets typically involve financial assets that expire in one year or less where as capital markets involve financial securities with life span of greater than one year.

Securities markets can also be call or continuous market. Madhavan, (1992) defines a call market, as a market where trading takes place at specified time intervals whereas continuous market trading takes place continuously. In a continuous market an investor's order is executed immediately upon submission. A continuous trading is characterized by a sequence of bilateral transactions at different prices. In a periodic system, however, investors' orders are accumulated for simultaneous execution at a pre-determined time. The periodic system, commonly referred to as a call auction or batch market, is characterized by a set of multilateral transactions at one price.

A stock exchange performs numerous essential functions. These include bringing together buyers and sellers of securities, ensuring that there is fair play between the players, determining the price at which the securities will be traded among others. Clemons and Weber, (1997), identify two most critical functions of the stock exchanges. These are facilitation of price discovery and price dissemination by determining the price at which securities' should trade, based on the best assessment of their value by the broadest collection of market participants, and making this information available to the broadest collection of potential traders. It also facilitates trades execution by bringing buyers and sellers together for exchange of shares, with the lowest possible trading costs. It is claimed that information technology can facilitate both and indeed all major exchanges have made significant investments in information technology to improve price discovery and execution.

A trading mechanism is defined by the distinctive set of rules that govern the trading process. The rules dictate when and how orders can be submitted, who may see or handle the orders, how orders are processed and how prices are set. The rules of trading affect the profitability of various trading strategies and hence affect traders' behaviour, price formation, and trading costs (Venkataraman, 2001). Graves, Hedge and Miller, (1994), observe that trading systems have a significant effect on the price discovery process.

1.2 Evolution of NSE Trading Systems

Trading of financial securities in Kenya first 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. In 1954, after the London stock exchange (LSE) agreed to recognize the NSE as an overseas stock exchange, the NSE was constituted as a voluntary association of stockbrokers registered under the societies Act; trading moved to the "Call Over" system, where bids and offers were exchanged over the telephone (Mbaru, 2006).

In 1991, the exchange was registered under companies Act and adopted the more open and transparent floor based "Open Cry" system, whereby stockbrokers shouted out their bids and offers on an open trading floor (Mbaru, 2006).

Planning for NSE automation started in 1995 when the government opened the market to foreign investors. The market turnover began rising rather faster in the same year and it attained the highest index in the history of the exchange. That was when the limitations of the manual trading system became apparent. The call over system which was started in 1954 had become obsolete and the open-outcry which replaced it in 1992 was showing tensions and limitations hence the decision to automate the stock exchange (Kibaki, 2006).

In November 2004, the market implemented the CDS, automating the settlement of equity trades executed on the NSE. This is a computer system that facilitates holding of securities in electronic accounts and facilitate faster and easier processing of transactions for securities, shares and bonds (CMA, 2005).

Akapa, (1999) defines CDS is an electronic transfer of securities, with settlement and registration linked for immobilized securities. The immobilized securities are those shares whose owners have surrendered their certificates to the central custodian and become a registered depositor, as in the case of banks. Once registered at the CDS, the right to withdraw immobilized securities is discouraged

The central depository system, procured from Millennium Information Technologies Limited of Colombo, Sri Lanka, was commissioned as ready for use on 10th November 2004. The commissioning meant that investors who hold or intend to hold shares listed on the NSE can now open electronic shares accounts through their stockbrokers or their custodian banks, and will henceforth trade through those accounts rather than in paper certificate form, as was previously the norm (CMA, 2005).

The second phase show the automation of execution of trades, the process that occurs before settlement. This was achieved by implementation of ATS which is designed to electronically match buy and sell orders in a transparent process that involves members firms of the NSE placing bid and ask prices in a centrally accessible electronic order book. ATS was implemented in October 2006, which was followed by installation of Wide Area Network (WAN), to facilitate trading from NSE members' offices. This has also facilitated members to establish branches across the entire country to better serve the investors' needs (Mbaru, 2006).

ATS was commissioned at the NSE on October 25, 2006. The ATS was sourced from Millennium Information Technologies (MIT) of Colombo, Sri Lanka. MIT is also the suppliers of Central Depository System (CDS) (Daily Nation, October 25, 2006). The ATS solution has been customized in order to automate the current trading environment as much as possible holding the spirit of open outcry trading rules to ensure no significant departures from the overall trading principles in the market, other than those necessitated by the automation process (Mwebesa, 2006). Ongwae (2006) observes that the launching of ATS ranks NSE among leading capital markets in Africa to be automated. This is further expected to attract more domestic and foreign investors.

ATS implementation is expected to improve trading by ensuring more trading hours. Mwebesa, (2006) observes that with ATS, the trading hours have been increased from two to three hours in a day, removed the block trades board and incorporated the functionality for the trading of rights in the same manner as equities. The ATS also allow electronic monitoring of trades during the trading process as the system has an in built market surveillance capability. The system also permits almost real time transfer of trading information relating to index movement and price and volume movements of traded stocks. According to Kang'aru (2006) the new automated trading system will significantly cut the time taken to conclude every share sale, by automatically matching the sell and buy orders, unlike in the past when this was done by marking on a chalk board.

The ATS is designed to match buy and sell orders placed by broker firms. Bid and ask prices are entered into a central electronic order book. During trading hours, orders are matched according to fixed rules and execution prices are set (NSE, 2006). The NSE, which is the largest market in East and Central Africa, has seen its market capitalization soar over 550 percent to approximately Kshs 727.56 billion on Friday 13, October 2006, from Kshs 112.05 billion in December 2002. In the same period, the NSE 20-share index has increased by over 260 percent to 4,906.49 points (Mbaru, 2006). Kang'aru (2006) observes that the NSE 20 share index, the market indicator of share price movements, which stands at 4,600 level is expected to pass the 5,000 mark due to increased activity and additional listing.

1.3 Problem Statement

Various researches carried out on different stock exchanges, to establish the impact of automation on trading variables like volume, volatility, variability of returns, liquidity of trading, serial correlation in returns and bid-ask spreads have arrived at differing and sometimes contradicting conclusions.

Naidu and Roseff (1994), observed that automation of Singapore Stock Exchange (SSE) is associated with substantial increases in volume traded for all stocks, substantial increases in volatility for all stocks, substantial increases in liquidity ratios and a slight increase in bid-ask spreads.

Sioud and Hmaied (2000), observed that following automation of Tunisian stock exchange (TSE), there was a significant abnormal return for all securities, an increase in the volume after transfer of stocks to the new system, no significant impact was detected on volatility and that the new trading mechanism does not reduce pricing error and thus does not improve market efficiency.

As observed above, while these two studies have agreed on observed results on volume and liquidity, they have arrived at differing results as far as volatility is concerned. Naidu and Roseff (1994) in their study of Singapore stock exchange concluded that there was a substantial increase in volatility following the automation while Sioud and Hmaied (2000) concluded that following automation at the Tunisian stock exchange there was no significant impact detected on volatility. This leaves a question as to what causes this differing results and what would be the probable result if such a study was carried out at the NSE.

Madhavan, (2000), argues that automation has reduced information gap between institutional and retail investors. Simultaneously, automation and regulatory initiatives have increased transparency and lowered trading costs. These factors contribute to the growth of online trading. Online traders respond to information flow in similar ways. In effect, the internet serves as a coordination device amplifying their impact on prices. The net effect is diminished liquidity and sharply higher inter-day price volatility.

Mwebesa, (2006), claimed that the launch of NSE automation will result to stakeholders realizing gains from a more liquid market in which there is less share price volatility, investors' confidence is enhanced and issuers of capital are more comfortably able to raise larger amounts of long term capital. There is need to verify whether NSE expectation as raised by Mwebesa have been achieved. This means that a study on the behaviour of these market characteristics following automation at NSE will help confirm or reject this claim. Green et al, (2003), find evidence of increased liquidity and efficiency but more ambiguous result for volatility on the introduction of screen based trading at Mumbai Stock Exchange (MSE).

Naidu and Roseff, (1994), argues that there is not complete assurance that measurements of the variables before and after the automation event reflect the influence of automation since other variables may intervene to affect volume, return variability, and other variables. Stoll and Whaley, (1989), studied the effect of stock market structure on the short-run volatility of stock prices. They observed that it is difficult to separate the volatility of stock prices induced by demand-side factors from the volatility induced by the way stocks are opened. Nevertheless, documented behaviours such as greater volatility around the open, the effect of trading volume on volatility and greater returns to suppliers of immediacy at the open make it desirable to investigate improvements in the structure of trading.

There is good reason to focus on volume, volatility and liquidity. Naidu and Roseff, (1994) explains that these characteristics of stock trading are linked to expected rate of return on common stock. Illiquid markets tend to be more volatile. In illiquid markets, investors face higher trading costs and have reduced incentives to develop information about companies. Investors demand higher returns to compensate for these undesirable features and firms end up with higher cost of capital. On the other hand, liquid markets tend to keep capital costs down

Since CDS and ATS were introduced at NSE in November 2004 and October 2006 respectively, no known study has been undertaken on the effects of NSE automation on the market characteristics, raising an interest to undertake this study.

1.4 Objectives of the Study

This study seeks to achieve three objectives:

1. To identify the behaviour of volume before and after automation of NSE
2. To identify the behaviour of volatility before and after automation of NSE
3. To identify the behaviour of liquidity before and after automation of NSE

1.5 Importance of the Study

The study will be useful to various parties as explained below.

1.5.1 Investors

Investors will benefit from the study by learning how the automated system operates and the many benefits that it offers. ATS Market Viewer and Ticker provides a window for the investors and other interested parties to view the market such as current trade prices, highs and lows, volume traded as well as price changes of the security, the market turnover and volume, foreign purchases and sales as well as the 20 share and all share index values on a real time basis. Investors should be able to take full advantage of the automated system.

1.5.2 Stock Brokers

With NSE automation, trade execution procedures are changing to reflect automation. All orders are immediately recorded on the system and brokers can see the prevailing price quotes in the order so clients can demand that information is shared with them and accordingly modify their orders. Brokers will benefit from the study by learning these changes and their effects and adapting their trading to maximize the benefits of automation.

1.5.3 Regulator

The regulator should understand and enforce the trading rules within which the markets operate. CMA should continuously carry out research on the changes taking place in the market and change the rules accordingly. The surveillance team, Exchange and CMA staff, can be able to detect abnormal price fluctuations or occurrences, dispatch announcements to the market, set limits as well as suspend a security or purge orders. This study will send light on some of these issues.

1.5.4 Academicians

The study will be important for academicians and researchers who want to carry further studies on the impact of NSE trading automation on various market characteristics.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Stock Market Reforms

An abundant theoretical and empirical literature has been interested in stock market microstructure and particularly in the change of the trading mechanism. Sioud and Hmaied, (2000) observes that the literature advances the reasons why this change could influence aspects of trading such as liquidity, stock behaviour, volatility and market efficiency.

The development of economies of developing countries was for a long time delayed by insufficiency of financing. The countries for a long time relied on their banking sectors to drive the growth of their economies. Sioud and Hmaied (2000) argue that these financial systems essentially based on the banking sector, did not permit any more to fill the need of firms that had to face more and more menacing international competition with the liberalization policy adopted by most of these countries.

Due to this limitation there is need to enhance the growth of the developing countries financial markets. This will encourage companies to raise the required capital hence facilitating the growth of the economies. Sioud and Hmaied, (2000) observes that to stimulate their financial markets and to favour the creation of new sources of financing, some of these countries decided to undertake reforms to improve their market microstructure, taking into account international norms and experiences of major stock exchanges. Several exchanges decided to automate their trading systems in order to take advantage of existing technology. This wave of reforms concerned also emerging markets such as markets of Israel in 1987, Singapore in 1989 and Morocco in 1998 which introduced change in their trading systems in order to attract order flows and increase liquidity through improved market transparency and enhanced quality of execution

In the past two decades technological innovation has become a major force shaping financial service delivery and that appears likely to accelerate over the next few years. As a result of technological advances, the infrastructure supporting the processing, communication and storage of financial information are all undergoing substantial and irreversible changes.

Technology is making it easier to access markets and products both domestically and internationally. It has also made it easier to analyze and monitor risk more effectively, to disaggregate it on a broad scale, to price it more accurately and to redistribute it more efficiently. This meant that the NSE must embrace the new technology (Mbaru, 2006).

Technological innovations that enable high speed, low cost electronic trading systems are dramatically changing the structure of financial markets. Exchanges and markets around the world are merging or forming alliances to improve liquidity and reduce costs in the face of increased competition from each other and from these computerized trading systems. Trading volume on electronic communications networks (ECNs) has grown rapidly over the past several years. ECNs are now involved in more than a third of NASDAQ trading volume and are attempting to increase their market share in NYSE-listed issues as well. ECNs offer the promise of greater operational efficiency, lower trading costs, improved limit order exposure, trader anonymity and faster executions (Barclays, Hendershott and McCormick, 2003).

There are various trading rules that determine how trading will be carried out in an exchange. These rules also ensure fairness to all market participants. Amihud and Mendelson, (1987) observes that recent developments in securities markets induce policy makers to critically evaluate existing trading procedures. The plans to establish a national market system, the increases in trading volumes, the fierce competition between exchanges and over-the-counter markets and the expansion of electronic trading, all made the security industry ready for a change. All major U.S exchanges are continuously evaluating new (mostly automated) trading procedures and European capital markets are already allowing forms of continuous trading together with their ordinary call market procedures

Many major exchanges, including the London Stock Exchange (LSE) and NASDAQ, rely on their member firms to act as dealer intermediaries and to provide continuous two-way quotes. These dealers risk their own capital to trade as principals with investors' customers. Competition among exchanges and technology-enabled non-exchange trading venues will fundamentally alter exchange-mandated liquidity provision by dealers. Either exchanges' will develop more sophisticated trading systems that enable dealers to provide risk-based

pricing for their dealing services, or off-exchange will fragment the central market and capture significant trading volume (Clemons and Weber, 1997).

2.2 Manual Trading

Until the mid nineties almost all stock exchanges functioned as Open Out-cry systems. Mukherji (2005) defines open out cry system as a process where a broker received customer orders, directly from customers or routed via their back offices, by phone. He would usually then make a note of the order in a little notebook, make some strange finger movements, and call out the name of the stock to indicate that he wanted to sell it. Alternatively he could look around for somebody doing a different finger movement and crying out the name of the same stock, indicating he wanted to buy. Once the buying and selling brokers met, they decided whether they could make a deal at the price offered (for the sale) and desired (for the buy) and if the deal come through, it would be inputted at the end of the day into the exchange's system, which was traditionally paper-based.

Though there was price discovery through the movements in prices that various brokers offered and desired for the stock, price dissemination was imperfect. The result was that individual brokers could get their clients (mostly retail clients) very different prices, depending on their skill and, sometimes depending on their integrity, brokers would hoodwink gullible clients by giving them the worst price of the day, keeping the rest for themselves (Mukherji , 2005).

Historically, securities markets were organized as auctions featuring physical trading floors. This meant that brokers had to physically meet at the trading floors to exchange the securities. According to Madhavan, (2000) these markets, which prevailed largely until the advent of electronic markets in the late 20th century, had to limit entry because of physical space constraints, typically operating in a mutualized governance structure. The result could be categorized as a two-tier information structure, with substantial differences in the availability and quality of information between exchange participants and the outside investors. In absence of information linkages, securities markets were fragmented, offering isolated pools of liquidity.

2.3 Automated Trading

When volumes of trades increase in an exchange, it becomes difficult trading in a manual system. This is due to the fact that the manual system cannot handle the volumes and thus necessitate automation. It also causes delays in trades' execution. Mukherji, (2005) notes that an electronic trade matching system does the same thing the brokers did in a manual system, getting buyers and sellers together so that they can deal at a price acceptable to both of them and publish these prices in real-time. At the centre of this system is an electronic order book which stores the buy and sells orders that have been received for various listed stocks.

When the computer coordinates trading, there is no trading floor, no stage for players to meet and act upon, no crowds or groups to analyze. Advocates of computerized trading systems claim that the trading is faster and simpler. Opponents fear that the computers reduce liquidity and cannot intervene when markets are moving rapidly or in other special circumstances involving for example, information release (Naidu and Rozeff, 1994).

Essentially, an order book has to match the buy and sell orders for each stock so that the buyer gets the best price offered from his point of view (the lowest price to sell) and the seller also gets the best price (highest price to buy). The basic rule of priority for matching trades is first price and then time (Mukherji, 2005). Tunisian stock market uses a centralized computer limit order book system. Every broker has a terminal to enter orders in the order book and a telephone to communicate with the headquarters and possibly receive other order flows. The highest limit price of all buy orders for a particular stock is the best bid price for the stock, and the lowest limit price of all sell orders for a particular stock is the best ask price for the stock (Sioud and Hmaied, 2000).

Unlike traditional markets, trading in an automated auction is through an electronic limit book without the need for a physical exchange floor or intermediaries such as market markers. But in absence of intermediaries, an automated auction is dependent on public limit order for liquidity. If the limit order book is thin, even small trades can induce large price movements, increasing trading costs and volatility (Coppejans, Domowitz and Madhavan, 2001). Kalay, Wei and Wohl (2002) concede that continuous trading increases the frequency

of trading, thereby enabling immediate execution during the entire business day. This is unlike the manual system which does not allow the continuous trading.

Madhavan, (2000) argues that the internet has had a profound and permanent impact on the trading environment, a change nothing short of revolutionary. This revolution is far from over, and if anything, has been accelerated by an unusual confluence of factors in the securities industry including globalization, regulatory reforms, and technological change.

Though electronic trading has been used in some markets for well over a decade, its penetration has been very uneven across different sectors. Take-up has been affected by the form of existing market structures, regulatory and competitive factors, and the varied needs of traders. Typically, deep, liquid markets, with broadly standard asset classes and straightforward trade types ar e 'easiest' to migrate to electronic trading. The spread of electronic trading depends also on what is achievable with current trading technology; further innovation will enable further waves of change to market arrangements (Allen and Hawkins, 2002).

The biggest advantage of electronic matching is precise price discovery and fair trading. All orders are immediately recorded on the system and brokers can see the prevailing price quotes in the order so clients can demand that information is shared with them and accordingly modify their orders. There is also immediate execution of market orders and limit orders, which have an existing matching price on the system. Also, in an automated exchange a broker's customer can actually track his order on the trading system so there is absolute transparency. India's National stock exchange (INSE) and Bombay stock exchange (BSE) do not allow orders to be bunched so that the brokers cannot cheat customers on the price. The system also maintains an automatic audit trail thus surveillance becomes easier (Mukherji, 2005). Coppejans, Domowitz and Madhavan (2001) identify various advantages of automation that has allowed a rapid adoption of automation to trades equities, bonds, foreign exchanges and derivatives in securities markets. These include speed, simplicity, and low cost.

The input of all prices into electronic systems has also enabled trade through rule, the national best bid offer, a concept in the US whereby the investor or broker has an option to buy or sell at whatever exchange they get the best price. The reduced role of the broker and the automatic execution of trades have reduced both time and cost execution. This has led to the growth of program and algorithmic trading, which has pushed down costs (Mukherji, 2005).

Automated exchanges offer the opportunity to match orders based on consistent rules where trades of the same price and size are selected on priority basis. Buhr and Rose, (2001) identify the three priorities, namely price priority, where the highest bid and lowest ask have priority, time priority, where orders submitted earlier at an equivalent price have priority or order priority, where markets order that can be executed immediately have priority over limit orders that can only be executed at a price.

2.3.1 NSE Central Depository System (CDS)

NSE automation started with the introduction of the CDS. CMA, (2005) defines CDS as a computer system that facilitates holding of securities in electronic accounts and facilitate faster and easier processing of transactions for NSE securities, shares and bonds. Akapa, (1999) defines CDS is an electronic transfer of securities, with settlement and registration linked for immobilized securities. The immobilized securities are those shares whose owners have surrendered their certificates to the central custodian and become a registered depositor, as in the case of banks. Once registered at the CDS, the right to withdraw immobilized securities is discouraged

Central depository and settlement systems manage the after–trade activities that take place in organized and over- the counter markets. The operations, polices and procedures of these organizations are vital to the success of the financial markets they serve. A CDS is responsible for the clearing of securities, such that the net position of each market investor is identified. CDS's are nearly always responsible for the settlement of securities, that is to say, the payment and physical or virtual delivery of purchased financial products and the accounting for those product transactions. Following the transfer of payments, CDS's are

engaged in the business of managing financial products for investors and issuers. These services include the management of share ownership functions and identification of shareholders for companies (CMA, 2005).

The core activities of the Central Depository and Settlement System are, Trade Capture or verification, trade confirmation, netting (determining of settlement obligations), payment, and central depository or registry. Nearly all CDSs worldwide strive towards some variant of Delivery versus Payment (DvP) mechanism. This is the notion that when the trade is settled the seller provides the security to be exchanged at the same time the cash is received. There is an immediate two-way transfer and finality of the transaction with no possibility of reversing the trade. Effective DvP is essential to eliminating counter-party risk, as the faster a trade is completed without error, the less chance of default (CMA, 2005).

CMA, (2005) idenfies three types of risks that CDS's work to counter. Principal risk, where either a security or cash has been presented but the other side of the trade has not been completed, replacement cost risk, where trades fail to settle and market actions must re-do the trade and liquidity risk, which is any cost that comes from the delay of payment

Significant increases in volumes and liquidity could result in an increase in systemic risks within the existing paper-based settlement system to levels that would be unacceptably high. The NSE, in liaison with stakeholders in the market, took a critical look at the manual system and decided to implement a robust and modern clearing, settlement and depository environment. This will allow investors to transfer listed securities without the need for certificates or transfer forms. Securities shall be represented by ledger accounts and will be transferred automatically by book entry movement in CDS accounts (CMA, 2005).

Shares immobilization was undertaken in four phases starting in November 2004 and ending in February 2005. From 28th February it became compulsory that any person trading in shares must first open a CDS account into which any shares bought would be credited and any shares previously held in certificate form would be deposited prior to sale (Waiyaki, 2005).

CDSC, which operates the CDS is a limited liability company incorporated under the companies Act and authorized, as well as regulated, by the CMA to provide central depository services in Kenya. It is an associate of the Nairobi Stock Exchange, with the NSE owning 20% of the issued equity, and the stockbrokers, through AKS, who constitute the membership of the NSE owning 18% of the equity. The balance of 62% is spread between the Capital Markets Challenge Fund limited, a consortium of 9 listed and unlisted companies holding 50%, Capital Authority Investor Compensation Fund holding 7% and between the stock exchanges in Uganda (USE) and Tanzania (TSE) holding 5% (Ogalo, 2005).

One of the benefits of CDS is that it avoids the paper crunch. The world over is moving to a paperless society where information can be stored, retrieved or processed in a digital form. Moreover the paper crunch could take the form of unsettled trades, lost certificates, lost dividends and cheques (Akapa, 1999). CDS assures a faster, safer and easier trading in securities. An investor do not have to wait for the issue of certificates before he or she can trade again as shares are credited to an investor's account 5 days after the date of trade.

CDS has significantly reduced financial risks by facilitating faster and more efficient deliveries and settlement process. The longer the delay between the transfer of shares and payment, the greater is the risk. Before introduction of CDS the settlement period used to be t+7 days which greatly hampered market operations and liquidity (Akapa, 1999). Other benefits of CDS include, lowering settlement cost by breaking the chain of intermediaries, increased efficiency by reducing settlement cost while offering faster transactions, lowered risk of fraud by eliminating every day risk of settlement as the certificate passes through fewer hands limiting the chances of fraudulent activities, improved transparency and promotes market development.

2.3.2 NSE Automated Trading System (ATS)

ATS was commissioned at the NSE on 25thOctober, 2006 and expected to enhance the exchange's efficiency and capacity in trade execution, thereby boosting liquidity in the capital market. It is also expected to simplify trading and enable the market regulator to monitor trade electronically. The system is linked to the economical and time saving CDS

system (Ongwae, 2006). This system ranks NSE among the leading capital markets in Africa to be automated and also represents the company's stride towards becoming a world-class securities exchange to attract more domestic and foreign investors. Automation of trade at NSE is a step in right direction in East African bourses move towards cross-listing. Most of the stock exchanges in Africa still operate the open out-cry trading system where the stockbroker call out their offers and bids and the information, including details of the concluded transactions are written on a board.

The ATS solution has been customized in order to automate the current trading environment as much as possible holding the spirit of open outcry trading rules to ensure no significant departures from the overall trading principles in the market, other than those necessitated by the automation process. It will increase trading hours from two to three, remove block trades, incorporate the trading of rights, enable electronic market surveillance and permits almost real time transfer of trading information relating to index movement and price and volume movements of traded stocks (Mwebesa, 2006).

The system is designed to match buy and sell orders placed by broker firms. Bid and ask prices are entered into a central electronic order book. During trading hours, orders are matched according to fixed rules and execution prices are set. Trading is subdivided into two differing market types, based on the type of securities traded. Equity market constitutes trading of all equity securities. The equity market is subdivided into three market boards, Normal, prompt and the odd lot board. Fixed income market constitutes trading of government issued bills and bonds traded on price terms (MIT, 2006).

ATS is a system, a collection of different components that work together to fulfill a common objective and in this case trading. It is a computer system designed to electronically match orders based on configured trading rules. The system is made up of different functional based modules namely, offline trading, the equity trader, market surveillance, market administration, trading rules and the database, the CDS. CDS and ATS systems were commissioned in Nov 2004 and Oct 2006 respectively and they are tightly coupled. ATS is to

Trade execution while the CDS is to Trade settlement. The two systems operate on a T+3 trading cycle (NSE, 2006).

Offline Trader allows traders to place orders when the Market is closed and then submit them on the next trading Session. It can also be used to convert order files from the comma delimited format to a format that is compatible with the equity trader (NSE, 2006).

Equity Trader is the online or real-time trading interface for the ATS. It has all the functionality that the ATS Operator needs to be able to trade. It allows traders to view market data, place and manage orders and to view executions that have happened, create alerts, view exchange announcements and graphing instrument for prices and index levels (NSE, 2006). CDS Database provides client account details and stores securities details such as the holdings for each client.

Market surveillance is an important aspect of trading so as to ensure orderly conduct and getting hold of attempts to circumvent the trading rules during and after trading. The surveillance team, Exchange and CMA staff, can be able to detect abnormal price fluctuations or occurrences, dispatch announcements to the market, set limits as well as suspend a security or purge orders (NSE, 2006).

Market Administration is the ATS Market Manager interface that is used for opening the market as well as guiding the market through the various sessions as well as closing the market. It has an interface to manage the different participants and administer users, Exchange Manager, as well as one to check on the overall health of the system, Sysguard (NSE, 2006).

The ATS has interface where the trading rules can be modified and also the structure of the entire market defined. This module is referred to as the Exchange Manager (NSE, 2006).

Market Viewer and Ticker provides a window for the investors and other interested parties to view the market such as current trade prices, highs and lows, volume traded as well as price

changes of the security, the market turnover and volume, foreign purchases and sales as well as the 20 share and all share index values on a real time basis (NSE, 2006).

Orders are placed for a client, not a member firm. The system first verifies the holdings when selling. After a transaction, clients are allocated shares hence their CDS accounts are updated. The system matches orders using limit order matching as opposed to the dealing spreads. This is automatic and instantaneous based on the trading rules (NSE, 2006).
The market is divided into two, equity and fixed income markets. Equity market constitutes equity securities (ET). This market is further divided into Normal Board, Odd Board, and Prompt Board (NSE, 2006).

The normal board constitutes the main market segment and trading is for any quantity greater than or equal to the instrument lot size which is 100 securities. Normal trading cycle is subdivided into pre-open operating between 10:00a.m and 10.30a.m, open-auction between 10:30a.m and 10.31a.m, regular trading between 10:31 a.m. and 1.00 pm and close between 1.00 p.m. and 5.00 p.m. During pre-open the system accepts orders, in which period orders may be amended or cancelled. During pre-auction, the system temporarily closes the order book and starts matching the orders. It establishes the opening price and determines the orders to be executed according to the rules. During regular trading new orders are continually matched against existing orders in the order book. If an order cannot be executed it is stored in the order book (MIT, 2006).

Trading on odd lot board concentrates on orders of equity market listed securities with order quantities less than the normal board lot size which is less than 100 securities. The board passes through a single continuous trading cycle and will not update market statistics or indices (MIT, 2006).

Prompt board trading criteria rules are identical to that of the normal board. However, the CDS will tag all prompt board executed orders for a T+1 settlement (MIT, 2006).

Fixed Income Market constitutes debt securities, government issued bills and bonds and Corporate Bonds and are traded on price terms. Currently this market segment is not activated and continues trading manually (NSE, 2006).

Electronic trading is being adopted more slowly in fixed-income markets than in equity markets. At NSE, while equity trading has been fully automated, fixed income trading continues to trade manually. Allen and Hawkins, (2002) explain that fixed-income products are far less homogenous, with many individually less liquid issues, varying in coupon, maturity, frequency of interest payments, etc. Relative to equity markets there are also fewer but larger trades. These factors all make it technically more difficult and more expensive to introduce automation. Moreover, the decentralized telephone dealer markets typical of fixed-income products were probably less conducive to a rapid, widespread introduction of automation than were the centralized exchanges in equity markets

2.3.3 Key Features of ATS

The ATS has a higher performance. It accepts 10 orders per second or 200 Trades a minutes. Thus it can handle 12,000 Trades an hour or 36,000 Trades a day. The trading system is robust. It is able to recover from database failures due to connectivity or System Software issues. It has the familiar windows environment, allows for customization of the screens, allows one to save their working profiles and has effective use of colour. This makes it user friendly. The system can import data from order placement systems and also have its output exported to other applications such as MS Excel (NSE, 2006).

The system has diverse order types. It can accept different types of orders such as Market orders, limit orders, Day orders, Good till Cancel, Immediate orders, has minimum fills for odd lot orders. It also has other Market features. It allows one to view various market statistics, set alerts, view announcements, view trades, price as well as index graphs and set trader limits (NSE, 2006).

The benefits of ATS include greater transparency in the placement of bids and offers, improve market surveillance and transmit almost in real time, trading information relating to

index movements and price and volume movements of traded securities. More current information will become readily available to a wider constituency of stakeholders, facilitating the decision making process and lowering the risk of participating in the markets. Trading at the prompt board is now done on T+0, meaning that buyers and sellers are matched instantaneously. As a result the turnover has hit the Kenya shillings one billion per day mark (Mbaru, 2006).

The electronic system offers many advantages for stockbrokers and permits a better protection for investors. In fact the order book is observed by all stockbrokers at the same time, the new system is managed by software offering stockbrokers a set of tools and information that facilitate their tasks, offers more protection for investors, trade reporting is automated and real time publication is technically feasible (Sioud and Hmaied, 2000).

The benefits of electronic trading mechanism offer many advantages over the floor. Venkataraman, (2001) identifies various benefits associated with electronic trading. First, the benefit of any trading system increases with the number of locations from which the system can be accessed. While the Paris Bourse can easily offer remote cross-border membership and direct electronic access for institutional investors the inherent limitations of trading floor space require access limitations at the NYSE. Second, the heavy trading volume and the growing number of new listings raise concern about the capacity limits of trading floor. Thirdly, the development and maintenance cost of an automated market is considerably lower than that of floor trading, thus providing significant cost reductions. Fourthly floor-based exchanges are typically organized as mutual associations, while automated exchanges have typically separated the ownership of the exchange from owner. For these reasons, a floor based mechanism may have higher execution costs than an automated trading mechanism.

2.4 Impact of Automation on Volume of Traded Shares

One measure of the impact of automation upon trading is the units of volume traded before and after automation. There are several reasons to expect greater trading volume from an automated system as compared with non-automated system. Naidu and Roseff, (1994)

explains that since the exchange earns profits by providing a market to trade shares, profit maximizing behaviour by the exchanges suggests that exchange institutes a new and costly trading system only if it expects to increase profits either by cutting average costs on existing and future expected trade volume or by increasing trading volume or both. Volume arises from liquidity trading, noise trading and information trading. All this are stimulated by automated trading due to broadened access and improved efficiency

Electronic trading is transforming financial markets. It can reduce costs, extend participation and remove many physical limitations on trading arrangements. It allows much greater volumes of trades to be handled, and permits customisation of processes that until recently would have been technically impossible or prohibitively expensive. It is a major force for changes in 'market architecture', the key features of market structure such as participation arrangements, venues and trading protocols (Allen and Hawkins, 2002).

Evidence from the move of Israel stocks from call auction trading to continuous trading shows that investors have preference for stocks that trade continuously. When large stocks move from call auction to continuous trading, the small stocks that still trade by call auction experience a significant loss in volume relative to the overall market volume. As small stocks move to continuous trading, they experience an increase in volume and positive abnormal returns because of the associated increase in liquidity (Kalay, Wei and Wohl, 2002).

Different measures undertaken from 1989 to 1994 stimulated the development of Tunisian Stock Market and led to an important increase of the investor demand. Indeed, the volume of exchange increased from 68 million dinars in 1990 to 626 million dinars in 1996. However this demand had not been accompanied by an equivalent increase in stock offers. This ensured an ascending movement of stock prices. So, the Tunis stock market displayed during five successive years a rise in its index from 199 in 1992 to 634 at the end of 1995 (Sioud and Hmaied, 2000). At the NSE various measures have been put in place since 1995 to automate the exchange. This according to Mbaru, (2006) has seen its market capitalization soar over 550 percent to approximately Kshs 727.56 billion on October 2006, from Kshs

112.05 billion in December 2002 and the NSE 20-share index has increased by over 260 percent to 4,906.49 points.

Derrabi (1998) studied the change of the Moroccan market microstructure following automation. He noted that the automated trading system produces a significant and permanent increase of prices. The fixing system permits also efficiency improvement and lower volatility but no significant impact has been noted for stocks traded in continuous trading system (Sioud and Hmaied, 2000).

2.5 Impact of Automation on Volatility of Traded Stocks

The volatility of security prices is defined as the movement of actual prices from fair or equilibrium prices. Price fluctuations create the price volatility risk in which rational and risk-averse investors will combine the risk to their required rate of return for discounting their securities value. In other words, the volatility risk enlarges the capital costs. Although the price change reflecting the news or information about changes in fundamental value can be accepted by long-term investors, the noise or uninformed trading creates substantial price fluctuations and the volatility risk (Nittayagasetwat and Withisuphakorn, 1997).

Naidu and Rozeff, (1994) observed that automation has the potential to alter both volatility of the stocks returns and the trading volume. If automation speeds up the dissemination of bids, asks, sizes, prices and volumes, traders' responses to the information being transmitted by prices are to speed up. If prices move more quickly to the equilibrium levels, volatility is likely to increase, especially when the information is hitting the market

Increasing the number of participants in the auction increases the price precision. In fact, a large number of participants take part in the determination of the equilibrium price, which lowers volatility and pricing error (Sioud and Hmaied, 2000). It will be interesting to study whether the automation at the NSE has actually resulted to increase or decrease in the volatility of the quoted stocks. Volatility of stocks traded on NYSE, is higher at the opening (call auction) than in the closing transaction (continuous trading). The higher volatility at the opening of the trading session is not related to the trading method. In fact, this can be

explained by the non availability of all the order book and the impossibility for investors to adjust their positions before the opening becomes effective. The higher volatility at the opening is also due to the particular practices of the NYSE (Amihud and Mendelson, 1987). Amihud et al, (1990) studied the impact of stock market microstructure on return volatility and on the value discovery process in the Milan stock market. The trading mechanism employed at the market is a call market, which is usually preceded and followed by trading in a continuous market. They found that the opening transaction in the continuous market has the highest volatility, and that opening the market with the call transaction seems to produce relatively lower volatility. In the closing transaction, investors correct perceived errors or noise in the prices set at the call (Sioud and Hmaied, 2000).

It is generally assumed that increased market liquidity is associated with lower volatility, and vice versa. Such prediction also follows naturally from the theories relating to discretionary timing of trades. However there is little direct empirical evidence on this, rather trading volume and the absolute value of price changes are commonly found to be positively correlated and there is some evidence that the volatility or volume correlation extends to common factors in prices and volumes (Coppejans, Domowitz and Madhavan, 2001).

2.6 Impact of Automation on Liquidity of Traded Shares

Teall, Gargalas and Wu, (2005) defines a liquid market as a market when prospective purchasers and sellers can transact on a timely basis with little cost or adverse price impact. One might argue that the exchange mandated responsibility of the specialist to provide liquidity in one-sided markets confers a liquidity advantage to the exchange while less costly access might swing the advantage to the electronic market and its institutional participants. Bid-ask spreads are generally considered to be good indicators of liquidity, with narrow spreads indicating the price impacts of trading will not be severe

Theoretically, the trading volume of a given security is an increasing function of its liquidity, other things being equal. Thus, an increase in trading volume of a stock after its transfer to the new trading system reflects an increase in its liquidity. Temporal consolidation of orders and better transparency ensued better liquidity. However, the automated trading system and

absence of direct negotiations between participants could reduce market liquidity (Sioud and Hmaied, 2000). Liquidity and transparency are desirable because they reduce the required return by investors and therefore increase security values. Increased liquidity improves the ability of stock markets to perform their information processing and signaling functions (Green et al, 2003).

In literature, whether market liquidity is better in automated trading systems or in the open outcry markets in the organized exchanges remains a controversial issue. On the one hand, it is argued that automated trading systems are less liquid than open outcry markets because automated systems cannot handle periods of intense trading as well as floor-traded systems. Jiang, Tang and Law, (2001) observes that automated systems have a higher degree of information asymmetry concerning the identity of the traders, and deprive liquidity providers such as locals and market-makers of some of their trading advantages. The delays in canceling orders on the automated systems discourage the submission of limit orders as traders are forced to offer free options with duration longer than those on the floor-traded systems. This effect could be especially important during periods of intensive trading, a reflection of high information arrival. Automated systems can reduce the human errors observed in floor trading, but have experienced delays or system failure when faced with unusually large trading volume.

Electronic trading is a global trend in the international financial markets. Early evidence based on the relative performance of exchange-based electronic trading systems and floor trading has shown that the impact of electronic trading on market functioning is likely to be positive. In particular, it is likely to improve transparency and liquidity of the markets. However, the performance of electronic trading systems deteriorates during times of market pressure with high price volatility or large trading volumes, but electronic trading will under-perform floor-based trading only during extreme market conditions (Jiang, Tang and Law, 2001). Mwebesa, (2006) claimed that the automation of NSE would result to lower volatility and improved volumes of trades. It is necessary to study how automation has affected the various market characteristics at NSE.

2.7 Market Efficiency.

Freud and Pagano, (2000) define market efficiency as operational and informational. Operational efficiency pertains to a market's ability to provide liquidity, rapid execution, and low trading costs. One way to examine this type of efficiency is a study bids and offers, or the spread between them and adjust for the trading characteristics of specific stocks issues. Informational efficiency can be defined as a market's ability to determine the true fair value of a security. Fama (1970) bases the efficient market hypothesis on this definition

Information- based trading determines the informational efficiency of markets. New private information is impounded into prices when investors' trade on private and the speed at which this price discovery process operates separates efficient from inefficient markets. The private information transmission process is promoted when informed traders are able to recoup the costs of information gathering by trading. Therefore an important decision in design of an exchange system is the extent to which traders should be allowed to exploit their private information (Heidle and Huang, 2002).

Information systems can serve as intermediaries between buyers and the sellers in a vertical market, thus creating an electronic market-place. A major impact of these electronic market systems is that they typically reduce the search cost buyers must pay to obtain information about the prices and product offering in the market. Economic theory suggests that this reduction in search costs plays a major role in determining the implications of these systems for market efficiency and competitive behaviour (Bakos, 1991).

The obligation of the NYSE specialist requires the exchange to maintain meaningful spreads at all times, maintain price continuity, and trade in stabilizing manner. Institutional investors prefer to use the floor broker to "work" large and difficult orders. The floor broker can react quickly to changing market conditions and execute sophisticated trading strategies, thus reducing market impact and execution costs. On the other hand, anecdotal evidence around the world suggests that markets are moving away from floor based trading system. Proponents of the automated system argue that trading floors are inefficient, are overrun with

people and paper, have less transparency, and should be replaced with technologically superior electronic systems (Venkataraman, 2001).

As electronic trading changes market structure, it influences significantly the performance of these markets. Most obviously, substantial falls in trading costs can be attributed directly to the effects of electronic trading. The impacts on other aspects of market quality are more varied and may be unclear or controversial. Two such areas relate to the transparency of trading information and the degree of market fragmentation (Allen and Hawkins, 2002). Kang'aru (2006) notes that ATS is expected to cut settlement of each share trade from the T+5 days to T+3. The system will also allow delivery and payment on the same day.

Electronic trading creates the potential for a high degree of transparency across the whole trading process. In principle, systems can disseminate real-time pre and post-trade information market-wide. For example, electronic order books can facilitate greater transparency by showing a list of trading opportunities. Conversely, other systems can operate with minimal information leakage, for example eliminating any information about pending orders, enabling users to avoid giving away valuable, potentially market-moving information to competitors (Allen and Hawkins, 2002).

Electronic trading can exert both fragmenting and consolidating influences. For example, in fixed-income and foreign exchange markets, new systems consolidate areas that formerly relied on fragmented, bilateral telephone communication. By contrast, in equity markets, typically dominated by centralized exchanges, alternative trading venues can increase apparent fragmentation. Yet equity markets' numerous mergers, alliances and linkages can also be associated with electronic systems' ability to consolidate sources of liquidity and harness efficiencies (Allen and Hawkins, 2002).

Freud and Pagano, (2000) found out that the Toronto stock exchange has not seen deterioration in market efficiency following the introduction of automated trading and/or routing systems. However the need to proceed slowly and with care is suggested. They argue that fully electronic options markets can be less liquid than physical markets. This is due to

the risk that a fully computerized trading system could discourage some institutional block trading. Steil, (2001), observed that automation of trading systems, led by the continental European exchanges and the US electronic communication networks (ECN's) has resulted in significant declines in trading costs, massive increases in turnover, internalization of trading and settlement system operations and major reforms in exchanges governance.

This literature review is important in understanding the development of the trading systems in different stock exchanges around the world and how they have evolved over time. It will further send light on the effects of stock exchanges' automation on different market characteristics thereby offering a benchmark in undertaking this study on the effects of automation at NSE. This literature review will further help to identify various factors that contribute to different behaviour of the market characteristics following automation of various exchanges.

3.0 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

The research design is an empirical study that evaluates the impact of automation of trading at NSE on the market characteristics. Three aspects of market characteristics, that is, volume, volatility and liquidity were analyzed. Market data on daily high, low and closing prices, the units of volume traded for each stock was obtained from NSE for the period 9th December 2003 to 30th March 2007 using data collection form in **Appendix 1**.

3.2 Population

The population of the study consisted of all the stocks that were listed and traded at the NSE for the period 9th December, 2003 to 30th March, 2007.

The overall time period was divided into sub periods as follows:

Period A

Before introduction of CDS (Manual Trading) — 9th December 2003 to 10th November 2004

Period B

After introduction of CDS but before ATS. — 11th November 2004 to 25th October, 2005

Period C

After introduction of ATS — 26th October 2005 to 30th March 2007

The three sub periods contain 238, 241 and 361 trading days respectively **(Appendix 25).**

3.3 Model Specification

The variables associated with trading are defined as follows:

3.3.1 Volume

VOLjt is the daily volume of trading, that is, the number of shares traded in stock j on day t, Since the scale of volume differs from stock to stock, the log volume, L, relative for each stock is computed:

Thus:

$$LVOL_j = \log (BVOL_j / AVOL_j), \text{ and}$$

$$LVOL_j = \log (CVOL_j / BVOL_j), \text{ where}$$

$$AVOL_j = \frac{1}{Ta} \sum (VOL_{jt}),$$

$$BVOL_j = \frac{1}{Tb} \sum (VOL_{jt}), \text{ and}$$

$$CVOL_j = \frac{1}{Tc} \sum (VOL_{jt}),$$

Where, Ta, Tb and Tc are the numbers of trading days in Period A, B and C respectively.

3.3.2 Volatility

$STDEV_{jt}$ is the volatility of daily return, measured by estimates of standard deviation of return. Standard deviation of stock j on day t is measured by a modified range estimator (Garman and Klass, 1980).

$$STDEV_{jt} = \frac{H_{jt} - L_{jt}}{0.5 (H_{jt} + L_{jt})}$$

Where: $STDEV_{jt}$ denotes the volatility of daily return, j on day t

H_{jt} denotes the daily high price of stock, j on day t and

L_{jt} denotes the daily low price of stock, j on day t

3.3.3 Liquidity

$TURN_{jt}$ is the value of shares traded or turnover, defined as $P_{jt}VOL_{jt}$, where P_{jt} is the closing price of stock j on day t.

The study employs two measures of liquidity, LR1 and LR2. LR1 is the liquidity as measured by the ratio of stocks daily traded volume divided by its daily standard deviation.

Thus:

$$LR1 = \frac{VOL_{jt}}{STDEV_{jt},}$$

LR2 is liquidity as measured by the ratio of the stock's daily turnover divided by its daily volatility,

Thus:

$$LR1 = \frac{TURN_{j}}{STDEV_{jt}.}$$

For every stock, the arithmetic mean of daily data is calculated. The averages in each sub period are distinguished with the prefixes A, B and C for before introduction of CDS, after introduction of CDS and after introduction of ATS respectively.

3.4 Data Analysis

Daily data on volume, volatility and liquidity is summarized for each stock for the three periods using data summarization form in **Appendix 2** to facilitate data analysis. The stocks included in the analysis are those that were listed and traded during the whole period under consideration. Statistical analyses are employed using Ms Excel. These include averages, comparison of the characteristics before and after automation, regression analysis and Z-statistics.

Mean daily volumes for each stock in each of the three periods, manual trading, trading under CDS and full automation trading, are calculated. This is achieved by taking the total volume of each stock in each period and dividing by the total number of trading days for the stock in each period.

Thus:

$$\bar{VOL}jA = \frac{\sum VOL_{jt}}{NjA}$$

$$\bar{VOL}jB = \frac{\sum VOL_{jt}}{NjB}$$

$$\bar{VOL}jC = \frac{\sum VOLjt}{NjC}$$

Where

$\bar{VOL}jA$ denotes the mean daily volume for stock *j* in period A

$\bar{VOL}jA$ denotes the mean daily volume for stock *j* in period B

$\bar{VOL}jA$ denotes the mean daily volume for stock *j* in period C

and NjA, NjB, and NjC denote the number of trading days in period A, B and C respectively.

Mean daily volatility is calculated as the total volatility for each stock in each period divided by the number of trading days in each period for the stock.

Thus:

$$\bar{STDEV}jA = \frac{\sum STDEVjt}{NjA}$$

$$\bar{STDEV}jB = \frac{\sum STDEVjt}{NjB}$$

$$\bar{STDEV}jC = \frac{\sum STDEVjt}{NjB}$$

Where: $\bar{STDEV}jA$, $\bar{STDEV}jB$ and $\bar{STDEV}jC$ denotes the mean volatility of stock *j* in each period and NjA, NjB and NjB denotes the trading days in each period.

Mean daily liquidity is calculated as the total liquidity for each stock in each period divided by the number of trading days in each period for the stock

Thus:

$$\bar{LR1}jA = \frac{\sum LR1jt}{NjA,} \quad \text{and} \quad \bar{LR2}jA = \frac{\sum LR2jt}{NjA}$$

$$\bar{LR1}jB = \frac{\sum LR1jt}{NjB,} \quad \text{and} \quad \bar{LR2}jB = \frac{\sum LR2jt}{NjB}$$

$$\bar{LR1}jC = \frac{\sum LR1jt}{NjC,} \quad \text{and} \quad \bar{LR2}jC = \frac{\sum LR2jt}{NjC}$$

Where LR1 and LR2 represents the two liquidity measures, and N*j*A, N*j*B and N*j*C represents number of trading days in each of the periods.

Regression analysis is used to evaluate the manner in which the volume, volatility and liquidity increases or decreases are spread across the individual quoted stocks. To evaluate if traded volume, liquidity or volatility tend to increase or decrease proportionately across all stocks regardless of their initial data, regressions of each market characteristic are carried out between period A and B, and periods B and C.

The cross sectional Z-values are calculated using the distributions of mean data for volume, volatility and liquidity to carry out significance tests whether there was change on automation of NSE or not.

4.0 CHAPTER FOUR: DATA ANALYSIS, FINDINGS AND DISCUSSION

4.1 Data Organisation

NSE provided the daily data on 48 stocks that were quoted and traded within the period 9th December 2003 to 30th March 2007. The data are the daily high, low and closing prices and the units of the volume traded for each security. **Appendix 25** shows the number of actual trading days in each period. The percentage trading days to the total trading days in the period is also shown. Although all the stocks are quoted at NSE, they show a wide dispersion in the market characteristics across firms. Mean prices during the manual trading ranged from Kshs 3.80 to Kshs 470.05, while after introduction of CDS Kshs 4.57 to Kshs 375.31 and Kshs 5.00 to 363.06 on full automation. Mean volume during manual trading ranged from 867 units to 1,156,550 units while on introduction of CDS, the range is 383 units to 1,118,879 units. On full automation the range is 1,050 units and 780,616 units (**Appendix 9).** The total period examined is one of generally rising prices (**Appendix 10).** The mean returns, where return is defined as the log price relative of ending price over beginning price and excludes dividends is 0.16 with standard deviation of 0.417 with CDS trading and 0.39 with standard deviation of 0.356 with both CDS and ATS trading systems **(Appendix 11).**

The NSE is categorized into three segments. These are the Main Investment Market segment (MIMS), Alternative Investment Market Segment (AIMS) and Fixed Income Securities Market Segment (FISMS). MIMS and AIMS trades in ordinary stocks while FISMS trades in preference shares and Bonds. MIMS is further divided into Agricultural, Commercial and Services, Finance and Investment and Industrial and Allied Sectors

4.2 Firms Considered for the Study

Appendix 3 lists the names of the quoted stocks at the NSE as at 30th March 2007. From the table, 48 stocks were quoted as at that time. Quoted companies are classified according to the segments in which their securities are traded. At NSE majority of the stocks are quoted under MIMS. Out of the 48 quoted stocks, 44 stocks are considered for the study. These are stocks that were quoted and traded for the whole period of the study.

Table 1 below lists the names of the stocks not examined and the date of their first trading. Four stocks newly added to the NSE, Scan Group, Equity Bank, Eveready East Africa Limited and Kengen Limited are excluded since they did not trade the whole period of the study and hence lack of trading data for the period prior to listing. The following are the date the four stocks started trading at NSE.

Table 1: Stocks that Did not Trade for the Whole Period

Security	**First date of trading**
Kengen Ltd	17th May 2006
Equity Bank Ltd	7th August 2006
ScanGroup Ltd	29th August 2006
Eveready Ltd	18th December 2006

Source: NSE Publications

44 stocks were considered for the study which represents 92% of the total number of quoted stocks as shown in Appendix 4. Of these stocks 36 securities were quoted on the MIMS, 4 under Agricultural sector, 7 under Commercial and Services sector, 11 under Finance and Investment sector and 14 under Industrial and Allied sector, while 8 securities were quoted under AIMS.

4.3 Volume

To examine the behaviour of volume within the three periods, Manual, partial automation on implementation of CDS and full automation on implementation of both CDS and ATS, the log volume relative to each stock is computed since the scale of volume differ drastically from stock to stock.

Table 2: Mean Log Volumes and Standard Deviations

Period	Mean Log	Standard Deviation
Manual Trading	-	-
Between Manual and CDS	0.023	0.466
After ATS	1.004	3.160

Source: Research Data

Appendix 5 shows in details the mean volume for each stock in each of the three periods. The Mean log volume, LVOLj, across the 44 stocks is 0.023 with standard deviation of 1.004 between partial automation period and manual trading period, and 0.466 with standard deviation of 3.160 between full automation period and partial automated period of trading, indicating volume increases between the two periods and large dispersions in the magnitudes of the volume increases across individual stocks. However there was a larger increase in volume and dispersion when ATS (period C) was introduced compared to period following introduction of the CDS (Period B). Similarly the results show a higher dispersion across individual stocks between period of full automation and partial automation than partial automation period and manual trading period **(Appendix 12).**

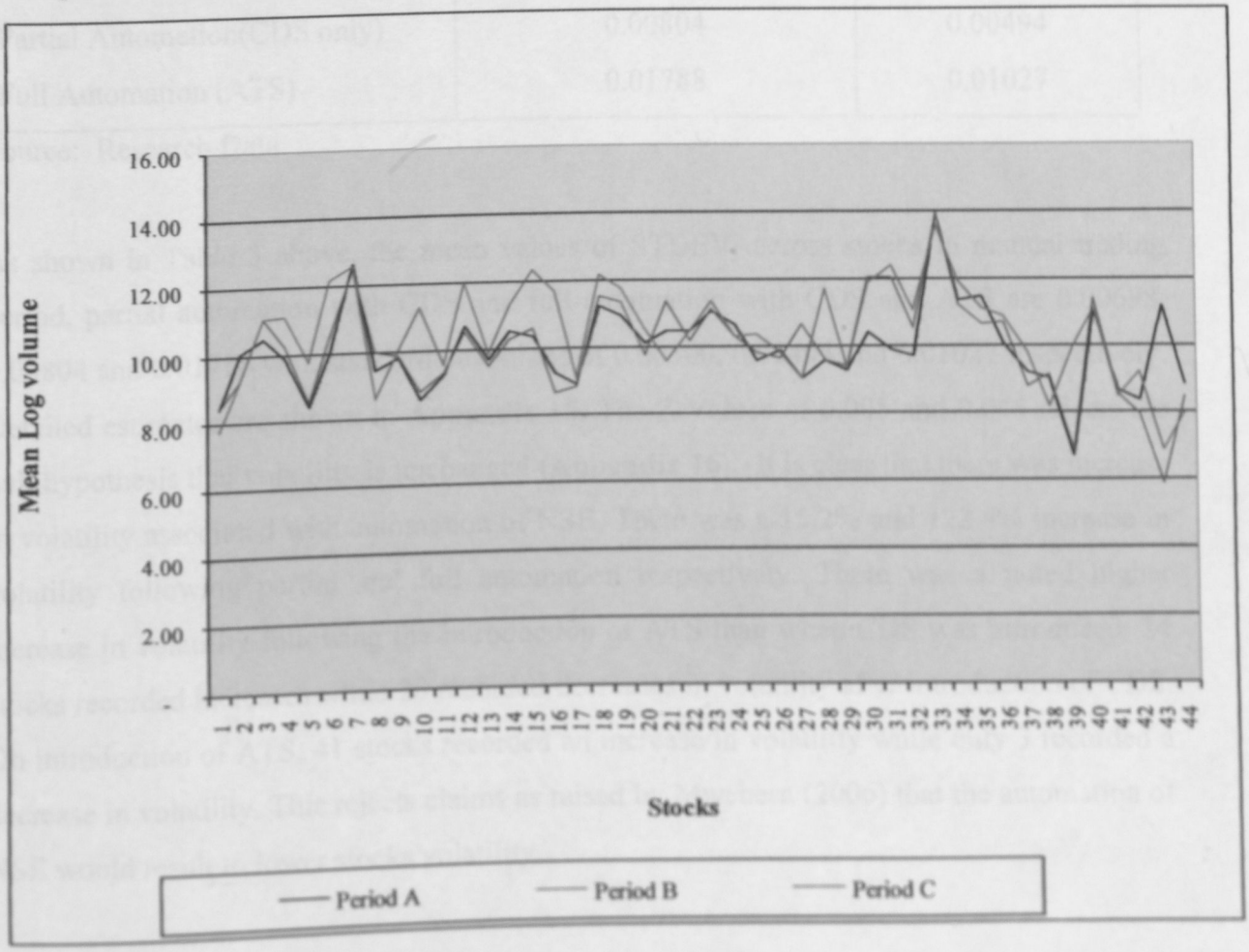
Following conversion of the trading system from manual system to partial automation (CDS), 24 stocks experienced volume increases while 20 stocks experienced decreases in volume. An increase in volume for most stocks is observed following full automation. Between full automation and partial automation periods, 32 stocks experienced volume increases while 12 stocks recorded volume decreases.

The cross-sectional z-values using the distributions of LBVOLj and LAVOLj and LCVOLj and LBVOLj or logs of mean volumes in each period are calculated to test the significance increase in the volume. The parametric Z= 0.11 between partial automation and manual

trading periods and 2.2 between full automation and partial automation periods, hence the findings that the shift to automation is associated with increase in trading volume for individual stocks traded on NSE. This confirms higher increases in volumes in full automated period than in partial automation period **(Appendix 13).**

It is also necessary to find out the manner in which the trading volume increases are spread across individual firms. To find out if trading volume tends to increase proportionately across all stocks regardless of their initial trading volumes, LAVOLj is regressed against LBVOLj and also LBVOLj against LCVOLj. The adjusted R^2 of the regressions is 0.52 and 0.55 for partial automation period and full automation respectively, indicating that the before automation trading volume in each period is influencing the after automation trading volume, a high influence being recorded after introduction of ATS **(Appendix 14).**

Graph 1: Mean Log Volumes for Each of the 44 Stocks Analyzed.



From the graph above, it is clear that stocks with lower volume before automation recorded higher increases in volumes following automation than those that had higher volumes before automation. Stocks under MIMS recorded higher volumes in all the periods as compared with those that are listed under the AIMS.

4.4 Volatility

Appendix 6 shows the average daily volatility for the 44 stocks analysed in the three periods. The volatility measure is the daily trading range scaled by the mean daily price.

Table 3: Volatility Measure

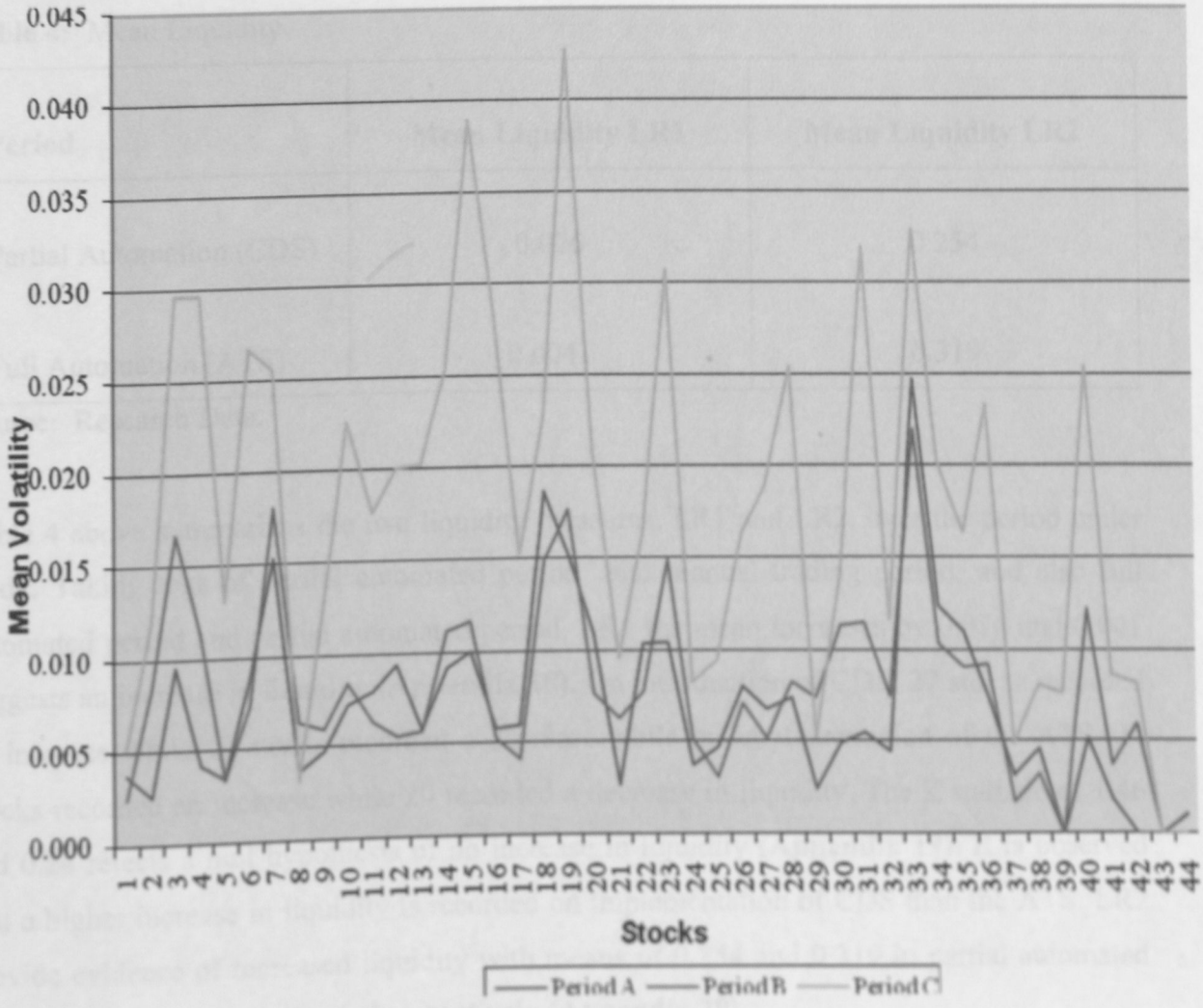
Period	Mean Values of STDVj	Standard Deviations
Manual Trading	0.00698	0.00500
Partial Automation(CDS only)	0.00804	0.00494
Full Automation (ATS)	0.01788	0.01027

Source: Research Data

As shown in Table 3 above, the mean values of STDEVj across stocks in manual trading period, partial automation with CDS and full automation with CDS and ATS are 0.00698, 0.00804 and 0.01788 with standard deviations of 0.00500, 0.00494 and 0.01027 respectively. Detailed estimates are shown in **Appendix 15.** The Z-Values of 0.005 and 0.046 rejects the null hypothesis that volatility is unchanged **(Appendix 16).** It is clear that there was increase in volatility associated with automation of NSE. There was a 15.2% and 122.4% increase in volatility following partial and full automation respectively. There was a noted higher increase in volatility following the introduction of ATS than when CDS was introduced. 24 stocks recorded increases while 20 recorded decreases in volatility after introduction of CDS. On introduction of ATS, 41 stocks recorded an increase in volatility while only 3 recorded a decrease in volatility. This rejects claims as raised by Mwebesa (2006) that the automation of NSE would result to lower stocks volatility.

As with volume it is necessary to find out the manner in which volatility changes occur throughout the stocks. The logs of the standard deviations for each period are regressed against the preceding period, that is, Manual period against partial automated period and partial automated period against full automated period. On introduction of CDS a higher adjusted R^2 of 0.59 indicates that the main factor explaining volatility after CDS is volatility in manual system. However when ATS was introduced the adjusted R^2 is only 0.071, meaning that the volatility before ATS does not explain the volatility after ATS **(Appendix 17).**

Graph 2: Mean volatility for the 44 stocks in the three periods.



The graph above indicates an increased volatility following automation. There was minimal increase in volatility after implementation of CDS. However when ATS was introduced, volatility greatly increased for almost all the stocks analyzed with higher magnitude compared to CDS period. Stocks with lower volatility before automation recorded lower increases in volatility following the automation.

4.5 Liquidity

Appendix 7 and 8 shows the mean liquidity as measured by LR1 and LR2 respectively for each stock for the three periods.

Liquidity is affected by both volume and volatility. Since both volume and volatility increased, the behaviour of the liquidity ratio depends upon which increased more.

Table 4: Mean Liquidity

Period	Mean Liquidity LR1	Mean Liquidity LR2
Partial Automation (CDS)	0.076	0.254
Full Automation (ATS)	0.0041	0.319

Source: Research Data.

Table 4 above summarizes the two liquidity measures, LR1 and LR2, over the period under study. Taking logs of partial automated period and manual trading period, and also full automated period and partial automated period, LR1 the mean increases by 0.076 and 0.041 suggests an increase in liquidity **(Appendix 18).** On introduction of CDS, 27 stocks recorded an increase while 17 stocks recorded a decrease while on implementation of the ATS, 24 stocks recorded an increase while 20 recorded a decrease in liquidity. The Z statistic of 1.46 and 0.24 rejects a null hypothesis of no increase in liquidity **(Appendix 19).** It is observed that a higher increase in liquidity is recorded on implementation of CDS than the ATS. LR2 provide evidence of increased liquidity with means of 0.254 and 0.319 in partial automated period and full automated period respectively **(Appendix 20).**

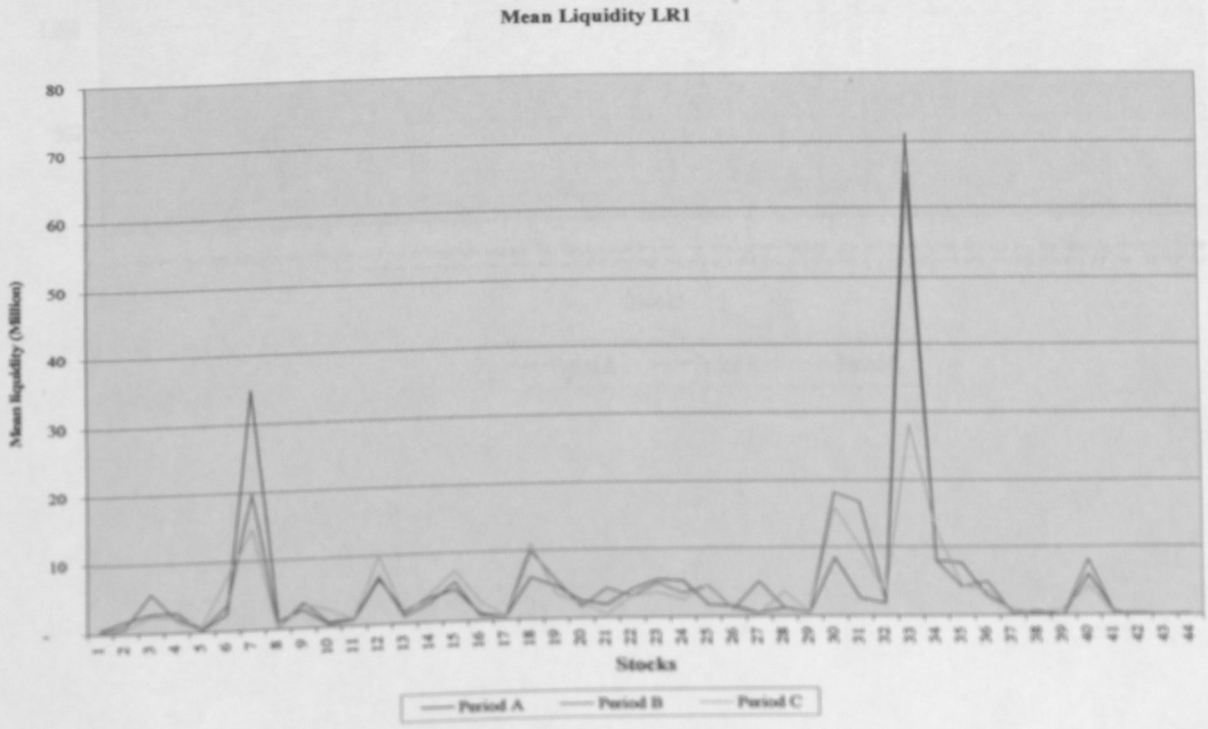
Table 5: R- Squared for LR1 and LR2

Period	R^2 for LR1	R^2 for LR2
Manual Trading / Partial Automation	0.80	0.75
During CDS / ATS	0.40	0.33

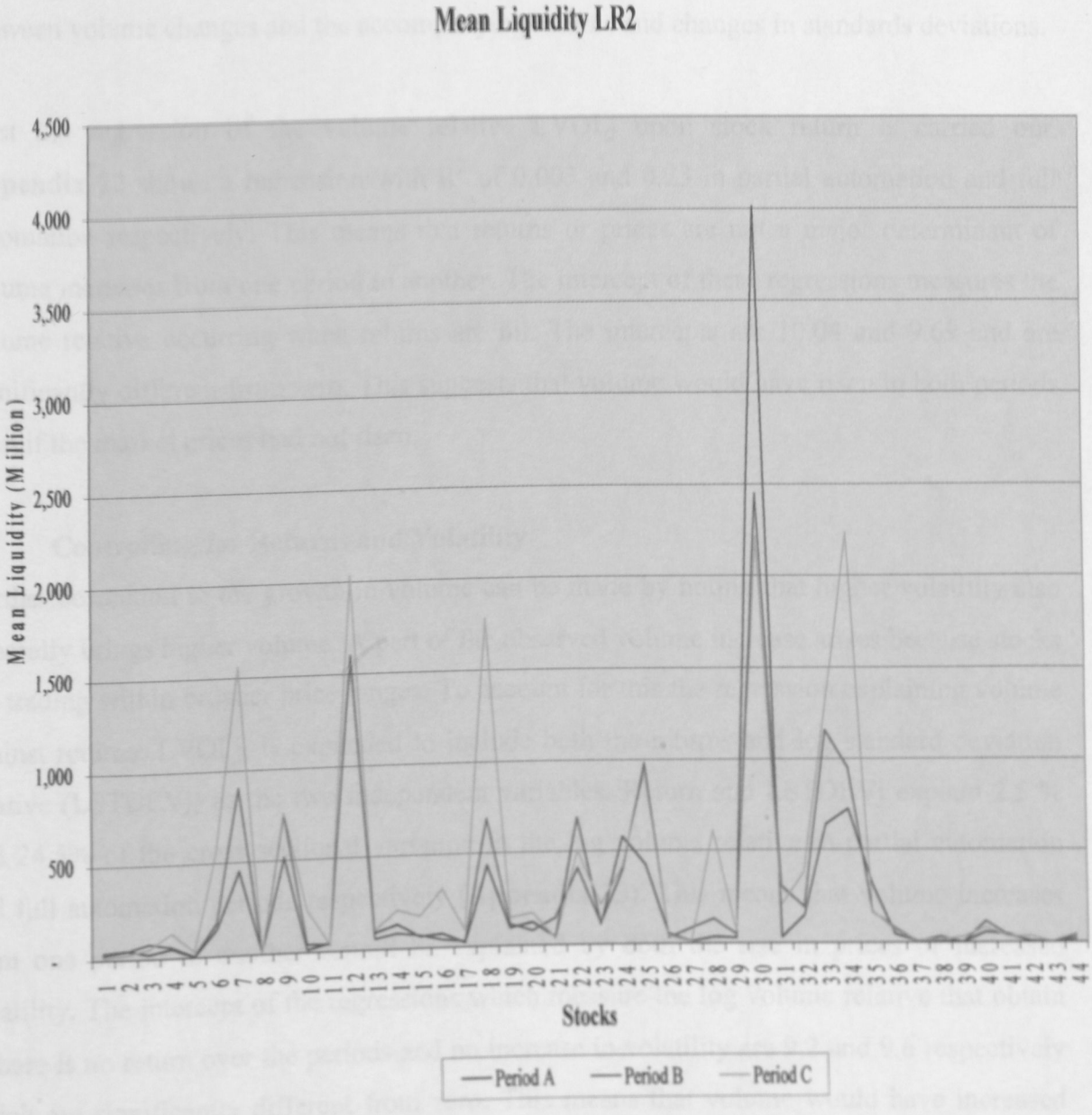
Source: Research Data.

A cross sectional relation by regressing liquidity in the three periods as summarized in Table 5, reveals that liquidity during manual trading determines liquidity on implementation of CDS as shown by a higher R^2 for LR1 of 0.80. However a lower R^2 of 0.40 suggests that the liquidity during CDS period is not a major determinant of liquidity on implementation of ATS. The results are confirmed by LR2 where partial automated and full automated periods recorded an R^2 of 0.75 and 0.33 respectively. **(Appendix 21)**

Graph 3: Mean Liquidity, LR1 for the 44 Stocks.



Graph 4: Mean Liquidity, LR2 for the 44 Stocks



4.6 Controlling for Returns

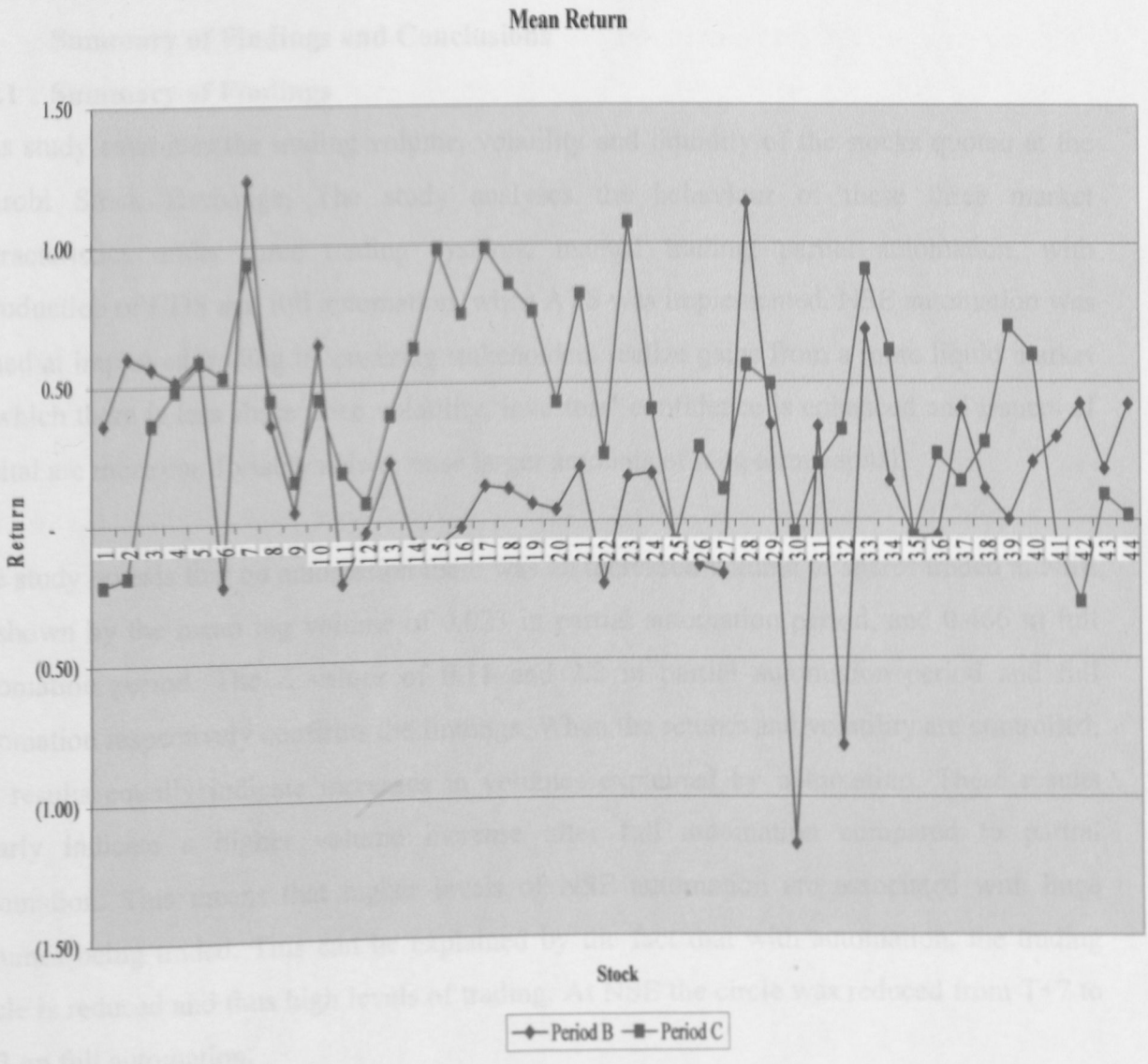
Generally volume tends to increase with prices and the NSE experienced a price rise with automation. However there is a need to be cautious in concluding that automation caused the observed volume increases. This is achieved by examination of the cross sectional relation between volume changes and the accompanying returns and changes in standards deviations.

First the regression of the volume relative LVOLj upon stock return is carried out. **Appendix 22** shows a regression with R^2 of 0.003 and 0.23 in partial automation and full automation respectively. This means that returns or prices are not a major determinant of volume increases from one period to another. The intercept of these regressions measures the volume relative occurring when returns are nil. The intercepts are 10.04 and 9.69 and are significantly different from zero. This suggests that volume would have risen in both periods even if the market prices had not risen.

4.7 Controlling for Returns and Volatility

Further correction to the growth in volume can be made by noting that higher volatility also generally brings higher volume. A part of the observed volume increase arises because stocks are trading within broader price ranges. To account for this the regression explaining volume against returns, LVOLj, is expanded to include both the returns and log standard deviation relative (LSTDEVj) as the two independent variables. Return and LSTDEVj explain 2.5 % and 24.5% of the cross sectional variation in the log volume relative in partial automation and full automation periods respectively **(Appendix 23).** This means that volume increases from one period to another cannot be explained by both the rise in prices or increased volatility. The intercept of the regressions which measure the log volume relative that obtain if there is no return over the periods and no increase in volatility are 9.2 and 9.6 respectively which are significantly different from zero. This means that volume would have increased even if the returns had remained nil and volatility unchanged. Thus automation is associated with a significant rise in trading volume.

Graph 5: Mean Returns for Each Stock under CDS and ATS Trading Periods



From the graph it is clear that full automation period recorded high returns than partial automation period. Generally, most of the stocks recorded positive returns in both periods. The highest positive returns were recorded in partial automated period by Kenya Airways and Crown Berger stocks. The highest negative returns are recorded by E.A Cables stock in the same period. Stocks quoted under AIMS recorded lower returns compared to those that traded under MIMS.

5.0 CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings and Conclusions

5.1.1 Summary of Findings

This study examines the trading volume, volatility and liquidity of the stocks quoted at the Nairobi Stock Exchange. The study analyses the behaviour of these three market characteristics under three trading systems, manual trading, partial automation, with introduction of CDS and full automation, when ATS was implemented. NSE automation was aimed at improved trading by ensuring stakeholders realize gains from a more liquid market in which there is less share price volatility, investors' confidence is enhanced and issuers of capital are more comfortably able to raise larger amounts of long term capital.

The study reveals that on automation there was an increased volume of shares traded at NSE as shown by the mean log volume of 0.023 in partial automation period, and 0.466 in full automation period. The Z values of 0.11 and 2.2 in partial automation period and full automation respectively confirms the findings. When the returns and volatility are controlled, the results equally indicate increases in volumes explained by automation. These results clearly indicate a higher volume increase after full automation compared to partial automation. This means that higher levels of NSE automation are associated with huge volumes being traded. This can be explained by the fact that with automation, the trading circle is reduced and thus high levels of trading. At NSE the circle was reduced from T+7 to T+3 on full automation.

Similarly, there was an increased volatility in both periods, partial and full automation. This is indicated by increasing mean volatility of 0.00698, 0.00804 and .01788 in the three periods respectively. This shows a 15% and 124% increases. The Z values of 0.005 and 0.046 confirm these findings. Like volume the exchange recorded a higher increase in volatility on introduction of ATS than CDS.

NSE recorded an increase in Liquidity on automation as shown by mean increases of 0.076 and 0.041 on introduction of CDS and both CDS and ATS respectively. However, unlike

volume and volatility, the exchange recorded reduced liquidity in full automation period compared to partial automation. The Z values of 1.46 and 0.24 confirm this.

It is worth noting that many variables are involved in determining trading volumes, volatility and liquidity. Each exchange involves a cluster of market related variables, institutional regulatory and competitive features that makes exchanges unique thus generalizing the finding might not be possible.

5.1.2 Conclusions

From the study the following conclusions have be arrived at:

Automation at NSE is associated with increased volume of shares traded. Higher increases in volume are noted when the exchange was fully automated. Price increases during the automation period and increased volatility do not influence volume increases.

Volatility of traded stocks also increased with the automation. Higher stocks' volatility is recorded when the exchange was full automated with implementation of ATS than after CDS.

Similarly there was increased liquidity of the NSE following the automation. However there was a noted decline in liquidity when the exchange achieved full automation. Higher liquidity was noted following the implementation of CDS than ATS.

5.2 Limitations of the Study

This study had the following as the limiting factors:

First, the study considered the effects of automation on three market characteristics. However there are many other market variables like return variability, bid-ask spread and other variables that are affected by automation and need to be considered.

Secondly, this study looks at the effects of automation on three market characteristics. However it is worth noting that there are other factors that affect these market characteristics.

The study has considered the effects of returns and volatility on the increase of volumes. However control over many other factors that affects the market characteristics need consideration.

5.3 Recommendations

This study has shown improved trading at the NSE following the automation. This means that being a fairly new project, the management of NSE need to ensure that there is enough controls in place to ensure that the system is fully operational. For example, there was a recent complain by investors that brokers are misusing the ATS to enrich themselves.

At the planning stage of NSE automation, Mr. Mwebesa (2006) of NSE claimed that the automation project was to result to reduced price volatility. However the results of the study show an increased volatility. The study would recommend an investigation as to why this claim or objective was not achieved.

Automation being a new phenomenon in the Kenyan Capital market, there is need for NSE to carry out investors' education country wide. This will enable the investors to carry out trading at the various branches opened up by the stock brokers around the country. This will further enhance the volume and liquidity of traded stocks.

NSE is in the process of finalizing on its wide area network (WAN) to facilitate stock Brokers to open various branches around the country. This will enhance investors' participation in trading with stocks. It is recommended that NSE speed up the process and open up all major towns in the country.

Currently there is little in terms of international trading at NSE. The authorities concerned should open up trading at international level. This will further improve the volume of trade and liquidity.

5.4 Suggestions for Further Research

This study considered only three aspects of market characteristics and how they were affected by automation. Other variables are also affected by automation and need to be studied.

There is also need to look into the basis on which NSE management had considered that the automation project was to result into reduced volatility and the reasons as to why automation actually result to increased volatility.

Following the introduction of CDS and ATS, it is now possible to trade from anywhere in the country provided there is a stock broker who is connected to NSE via the Wide Area Network (WAN). It would be interesting to study the effects of opening of the branch networks by stock brokers on the various market characteristics.

This study has revealed that following the automation, both volume and volatility increased with CDS and ATS. However liquidity increased with CDS but dropped when ATS was introduced. There is need to carry out a further study as to this behavior on liquidity.

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7.0 APPENDICES

APPENDIX 1 - DATA COLLECTION FORM

DATE				
SECURITY	DAILY HIGH PRICE	DAILY LOW PRICE	CLOSING PRICE	VOLUME TRADED

APPENDIX 2 - DATA SUMMARISATION FORM

SECURITY				
PERIOD				
DATE	DAILY HIGH PRICE	DAILY LOW PRICE	CLOSING PRICE	VOLUME TRADED

APPENDIX 3: QUOTED FIRMS AT NSE AS AT 30TH MARCH 2007.

STOCK NUMBER	NAME OF STOCK	SECURITY
	MAIN INVESTMENT MARKET SEGMENT	
	AGRICULTURAL	
1	Unilever Tea Kenya Ltd	Ordinary KShs. 10.00
2	Kakuzi ltd	Ordinary KShs. 5.00
3	Rea Vipingo Plantations Ltd	Ordinary KShs. 5.00
4	Sasini Tea & Coffee Ltd	Ordinary KShs. 5.00
	COMMERCIAL AND SERVICES	
5	Car & General (K) Ltd	Ordinary KShs. 5.00
6	CMC Holdings Ltd	Ordinary KShs.5.00
7	Kenya Airways Ltd	Ordinary KShs. 5.00
8	Marshalls (E.A.) Ltd	Ordinary KShs. 5.00
9	Nation Media Group	Ordinary KShs. 5.00
10	TPS Ltd (Serena)	Ordinary KShs. 5.00
11	Scan Group	Ordinary KShs. 1.00
12	Standard Group Ltd	Ordinary KShs. 5.00
	FINANCE AND INVESTMENT	
13	Barclays Bank Ltd	Ordinary KShs. 10.00
14	C.F.C Bank Ltd	Ordinary KShs. 5.00
15	Diamond Trust Bank Kenya	Ordinary KShs. 4.00
16	Housing Finance Co Ltd	Ordinary KShs. 5.00
17	I.C.D.C Investments Co Ltd	Ordinary KShs. 5.00
18	Jubilee Insurance Co. Ltd	Ordinary KShs. 5.00
19	Kenya Commercial Bank Ltd	Ordinary KShs. 10.00
20	National Bank of Kenya Ltd	Ordinary KShs. 5.00
21	NIC Bank Ltd	Ordinary KShs. 5.00
22	Pan Africa Insurance Holdings Ltd	Ordinary KShs. 5.00
23	Standard Chartered Bank Ltd	Ordinary KShs. 5.00
24	Equity Bank	Ordinary KShs. 5.00
	INDUSTRIAL AND ALLIED	
25	Athi River Mining	Ordinary KShs. 5.00
26	Bamburi Cement Ltd	Ordinary KShs. 5.00

27	British American Tobacco Kenya Ltd	Ordinary KShs. 10.00
28	Crown Berger Ltd	Ordinary KShs. 5.00
29	Olympia Capital Holdings ltd	Ordinary KShs. 5.00
30	E.A.Cables Ltd	Ordinary KShs. 5.00
31	E.A.Portland Cement Ltd	Ordinary KShs. 5.00
32	East African Breweries Ltd	Ordinary KShs. 2.00
33	Sameer Africa Ltd	Ordinary KShs. 5.00
34	Kenya Oil Co Ltd	Ordinary KShs. 0.50
35	Mumias Sugar Co. Ltd	Ordinary KShs. 2.00
36	Kenya Power & Lighting Ltd	Ordinary KShs. 20.00
37	Total Kenya Ltd	Ordinary KShs. 5.00
38	Unga Group Ltd	Ordinary KShs. 5.00
39	Eveready East Africa Ltd	Ordinary KShs. 1.00
40	KenGen Ltd.	Ordinary KShs. 2.50
	ALTERNATIVE INVESTMENT MARKET SEGMENT	
41	A.Baumann & Co.Ltd	Ordinary KShs. 5.00
42	City Trust Ltd	Ordinary KShs. 5.00
43	Eaagads Ltd Ord	Ordinary KShs. 1.25
44	Express Ltd	Ordinary KShs. 5.00
45	Williamson Tea Kenya Ltd	Ordinary KShs. 5.00
46	Kapchorua Tea Co. Ltd	Ordinary KShs. 5.00
47	Kenya Orchards	Ordinary KShs. 5.00
48	Limuru Tea Co. Ltd	Ordinary KShs. 20.00

APPENDIX 4: FIRMS CONSIDERED FOR THE STUDY

STOCK NUMBER	NAME OF STOCK	SECURITY
	MAIN INVESTMENT MARKET SEGMENT	
	AGRICULTURAL	
1	Unilever Tea Kenya Ltd	Ordinary KShs. 10.00
2	Kakuzi	Ordinary KShs. 5.00
3	Rea Vipingo Plantations Ltd	Ordinary KShs. 5.00
4	Sasini Tea & Coffee Ltd	Ordinary KShs. 5.00
	COMMERCIAL AND SERVICES	
5	Car & General (K) Ltd	Ordinary KShs. 5.00
6	CMC Holdings Ltd	Ordinary KShs.5.00
7	Kenya Airways Ltd	Ordinary KShs. 5.00
8	Marshalls (E.A.) Ltd	Ordinary KShs. 5.00
9	Nation Media Group	Ordinary KShs. 5.00
10	TPS Ltd (Serena)	Ordinary KShs. 5.00
11	Standard Group Ltd	Ordinary KShs. 5.00
	FINANCE AND INVESTMENT	
12	Barclays Bank Ltd	Ordinary KShs. 10.00
13	C.F.C Bank Ltd	Ordinary KShs. 5.00
14	Diamond Trust Bank Kenya Ltd	Ordinary KShs. 4.00
15	Housing Finance Co Ltd	Ordinary KShs. 5.00
16	I.C.D.C Investments Co Ltd	Ordinary KShs. 5.00
17	Jubilee Insurance Co. Ltd	Ordinary KShs. 5.00
18	Kenya Commercial Bank Ltd	Ordinary KShs. 10.00
19	National Bank of Kenya Ltd	Ordinary KShs. 5.00
20	NIC Bank Ltd	Ordinary KShs. 5.00
21	Pan Africa Insurance Holdings Ltd	Ordinary KShs. 5.00
22	Standard Chartered Bank Ltd	Ordinary KShs. 5.00
	INDUSTRIAL AND ALLIED	
23	Athi River Mining	Ordinary KShs. 5.00
24	Bamburi Cement Ltd	Ordinary KShs. 5.00
25	British American Tobacco Kenya Ltd	Ordinary KShs. 10.00

26	Crown Berger Ltd	Ordinary KShs. 5.00
27	Olympia Capital Holdings ltd	Ordinary KShs. 5.00
28	E.A.Cables Ltd	Ordinary KShs. 5.00
29	E.A.Portland Cement Ltd	Ordinary KShs. 5.00
30	East African Breweries Ltd	Ordinary KShs. 2.00
31	Sameer Africa Ltd	Ordinary KShs. 5.00
32	Kenya Oil Co Ltd	Ordinary KShs. 0.50
33	Mumias Sugar Co. Ltd	Ordinary KShs. 2.00
34	Kenya Power & Lighting Ltd	Ordinary KShs. 20.00
35	Total Kenya Ltd	Ordinary KShs. 5.00
36	Unga Group Ltd	Ordinary KShs. 5.00
	ALTERNATIVE INVESTMENT MARKET SEGMENT	
37	A.Baumann & Co.Ltd	Ordinary KShs. 5.00
38	City Trust Ltd	Ordinary KShs. 5.00
39	Eaagads Ltd	Ordinary KShs. 1.25
40	Express Ltd	Ordinary KShs. 5.00
41	Williamson Tea Kenya Ltd	Ordinary KShs. 5.00
42	Kapchorua Tea Co. Ltd	Ordinary KShs. 5.00
43	Kenya Orchards	Ordinary KShs. 5.00
44	Limuru Tea Co. Ltd	Ordinary KShs. 20.00

APPENDIX 5: STOCKS MEAN VOLUMES

Stock No.	Volume		
	Period A	Period B	Period C
1	4,721	4,776	2,510
2	23,809	10,799	11,173
3	36,411	62,018	61,333
4	19,840	28,065	66,602
5	4,669	5,511	17,514
6	23,304	36,424	193,786
7	311,145	256,637	296,714
8	12,802	21,424	5,621
9	18,558	20,101	23,460
10	5,408	6,617	79,937
11	11,035	11,481	14,599
12	44,763	36,615	163,791
13	16,900	14,052	19,569
14	38,097	29,175	79,256
15	31,140	38,983	228,258
16	11,104	5,965	122,324
17	7,603	7,300	9,045
18	76,842	98,158	194,450
19	55,785	83,043	129,803
20	25,124	17,310	38,159
21	34,878	86,023	14,905
22	34,623	25,444	34,203
23	62,548	67,573	86,029
24	42,243	29,169	29,986
25	14,434	18,253	30,671
26	19,233	15,852	18,390
27	8,713	40,923	8,793
28	15,027	14,470	116,878
29	10,669	11,990	11,591
30	32,914	176,205	146,838
31	19,863	169,447	247,215
32	16,260	37,583	61,644
33	1,156,550	1,118,879	780,616
34	84,974	77,211	149,989

35	97,627	42,503	66,543
36	23,232	44,978	51,866
37	10,397	6,891	18,343
38	8,840	9,874	3,754
39	867	1,050	20,932
40	62,591	92,370	66,376
41	6,236	5,265	5,208
42	4,500	2,986	10,256
43	71,763	383	1,050
44	7,156	5,137	3,174

APPENDIX 6: STOCKS DAILY AVERAGE VOLATILITY

Stock No.	Volatility		
	Period A	Period B	Period C
1	0.00384	0.00252	0.00528
2	0.00262	0.00843	0.01207
3	0.00961	0.01681	0.02961
4	0.00424	0.01136	0.02962
5	0.00354	0.00346	0.01312
6	0.00885	0.00735	0.02672
7	0.01535	0.01814	0.02566
8	0.00372	0.00643	0.00325
9	0.00479	0.00596	0.01276
10	0.00731	0.00844	0.02257
11	0.00801	0.00635	0.01775
12	0.00946	0.00552	0.02007
13	0.00583	0.00578	0.02021
14	0.00917	0.01117	0.02549
15	0.01010	0.01169	0.03886
16	0.00585	0.00526	0.02825
17	0.00597	0.00414	0.01523
18	0.01872	0.01496	0.02270
19	0.01531	0.01776	0.04270
20	0.01097	0.00766	0.02071
21	0.00275	0.00633	0.00969
22	0.01042	0.00774	0.01634
23	0.01047	0.01498	0.03064
24	0.00374	0.00521	0.00833
25	0.00473	0.00310	0.00949
26	0.00804	0.00712	0.01641
27	0.00679	0.00519	0.01902
28	0.00744	0.00832	0.02546
29	0.00245	0.00747	0.00521
30	0.00497	0.01131	0.01408
31	0.00552	0.01151	0.03196
32	0.00444	0.00755	0.01162
33	0.02479	0.02198	0.03291
34	0.01243	0.01042	0.02021

35	0.01107	0.00913	0.01641
36	0.00754	0.00925	0.02327
37	0.00323	0.00178	0.00495
38	0.00467	0.00326	0.00816
39	0.00000	0.00000	0.00764
40	0.00522	0.01223	0.02544
41	0.00196	0.00378	0.00867
42	0.00000	0.00599	0.00823
43	0.00000	0.00000	0.00000
44	0.00110	0.00106	0.00000

APPENDIX 7: MEAN LIQUIDITY, LR 1

Stock No	Mean Liquidity L1		
	Period A	Period B	Period C
1	525,344	243,442	157,909
2	1,722,432	909,755	575,227
3	2,719,524	5,630,621	2,424,495
4	2,802,779	1,859,784	2,117,585
5	269,678	331,360	781,129
6	2,454,340	3,675,018	7,736,476
7	34,814,226	19,780,754	14,562,814
8	1,090,831	75,402	97,879
9	2,594,746	3,704,048	3,322,146
10	391,497	670,085	2,593,335
11	854,675	1,030,382	869,517
12	6,572,593	6,966,170	9,987,861
13	1,661,398	957,974	1,306,508
14	3,545,976	2,746,521	3,990,081
15	4,632,393	5,748,553	7,443,679
16	1,023,089	684,147	2,846,426
17	413,906	493,116	545,415
18	6,069,422	9,908,137	11,077,986
19	4,755,753	5,591,436	3,620,714
20	2,515,019	1,624,078	2,198,924
21	1,911,957	4,342,844	510,815
22	4,125,367	3,122,470	3,138,403
23	5,517,553	4,956,664	3,639,576
24	5,286,085	3,475,675	2,519,319
25	1,744,164	4,504,067	4,629,511
26	1,497,684	1,042,713	1,095,124
27	474,118	5,083,162	337,086
28	1,167,564	1,232,429	3,663,181
29	496,095	519,122	507,099
30	8,468,738	18,147,790	15,871,028
31	2,568,481	16,734,918	10,134,342
32	1,815,857	2,070,761	3,260,152
33	65,049,718	71,154,258	28,232,716
34	7,996,615	7,997,447	12,513,975
35	7,665,172	4,199,254	4,443,016

36	2,809,218	5,000,350	3,592,253
37	918,168	294,897	872,938
38	94,665	637,341	239,738
39	-	-	887,946
40	5,956,110	8,175,178	4,320,390
41	492,606	310,970	277,595
42	-	31,941	305,733
43	-	-	-
44	114,247	112,618	-

APPENDIX 8: MEAN LIQUIDITY, LR 2

Stock No.	Mean Liquidity L2		
	Period A	Period B	Period C
1	35,849,271	26,503,017	13,578,349
2	48,455,556	44,531,887	23,836,142
3	24,705,607	81,044,047	54,048,600
4	50,786,761	59,740,961	135,997,721
5	3,563,608	5,758,565	31,704,495
6	148,402,475	185,274,192	567,030,163
7	453,750,814	905,726,924	1,560,922,009
8	13,407,624	1,904,417	3,496,952
9	515,500,896	746,623,301	756,014,549
10	12,810,676	43,853,636	231,876,036
11	47,226,284	40,743,933	44,368,526
12	1,583,944,040	1,604,211,484	2,032,119,846
13	92,553,322	60,581,056	106,992,782
14	134,574,391	86,000,221	214,097,459
15	64,385,422	70,500,162	177,865,579
16	76,337,902	44,411,080	319,238,924
17	24,757,000	32,890,683	93,634,997
18	434,037,290	688,952,036	1,783,573,337
19	96,657,057	118,333,068	156,062,289
20	125,926,483	81,686,488	177,443,739
21	44,460,695	148,507,025	33,450,045
22	684,581,968	411,791,536	504,783,769
23	108,347,917	118,560,962	218,959,660
24	575,898,491	399,838,085	418,074,573
25	426,128,990	982,906,390	937,663,663
26	55,291,548	32,319,879	42,043,132
27	9,378,143	83,683,595	7,780,274
28	35,246,140	133,687,299	608,572,162
29	28,384,442	48,234,300	61,627,869
30	4,011,483,099	2,448,608,726	2,216,814,395
31	31,435,675	306,286,617	211,110,874
32	150,116,348	196,458,820	381,445,296
33	638,390,182	1,153,925,508	1,284,762,826
34	723,669,319	952,601,224	2,232,727,935
35	321,169,575	170,710,536	175,481,738

36	46,114,968	79,225,125	66,792,113
37	7,430,569	3,746,506	10,835,650
38	5,064,729	32,964,808	14,578,615
39	-	-	30,535,435
40	57,152,837	116,101,385	84,694,961
41	43,852,786	36,970,317	30,330,048
42	-	5,669,006	33,647,337
43	-	-	-
44	18,279,486	39,754,165	-

APPENDIX 9: MEAN CLOSING PRICES AND VOLUME RANGES

Mean closing price ranges			Mean volume ranges		
Period A	Period B	Period C	Period A	Period B	Period C
3.80	4.57	5.00	867	383	1,050
8.22	10.88	14.15	4,500	1,050	2,510
8.72	12.10	18.36	4,669	2,986	3,174
9.56	12.30	19.80	4,721	4,776	3,754
9.82	14.46	21.24	5,408	5,137	5,208
11.54	15.33	21.98	6,236	5,265	5,621
11.84	16.16	22.00	7,156	5,511	8,793
12.11	17.00	29.03	7,603	5,965	9,045
12.86	18.99	33.53	8,713	6,617	10,256
15.10	19.00	34.09	8,840	6,891	11,173
15.34	20.91	37.87	10,397	7,300	11,591
17.00	21.49	38.40	10,669	9,874	14,599
18.76	22.00	40.72	11,035	10,799	14,905
19.21	23.28	41.81	11,104	11,481	17,514
19.67	29.52	44.39	12,802	11,990	18,343
23.03	30.04	46.96	14,434	14,052	18,390
25.67	31.20	48.58	15,027	14,470	19,569
26.73	32.23	52.28	16,260	15,852	20,932
29.29	40.25	56.08	16,900	17,310	23,460
32.31	40.54	64.67	18,558	18,253	29,986
32.49	41.55	67.06	19,233	20,101	30,671
34.72	48.93	70.48	19,840	21,424	34,203
42.72	50.41	77.39	19,863	25,444	38,159
45.28	50.63	85.26	23,232	28,065	51,866
48.54	51.29	87.04	23,304	29,169	61,333
48.99	60.71	89.13	23,809	29,175	61,644
50.45	61.29	95.62	25,124	36,424	66,376
54.24	64.50	105.66	31,140	36,615	66,543
57.27	65.05	106.62	32,914	37,583	66,602
63.36	71.17	113.20	34,623	38,983	79,256
64.06	76.50	119.65	34,878	40,923	79,937
65.95	86.28	125.05	36,411	42,503	86,029
73.58	92.27	136.04	38,097	44,978	116,878
86.69	103.98	138.92	42,243	62,018	122,324

90.21	105.61	161.32	44,763	67,573	129,803
95.95	113.70	165.35	55,785	77,211	146,838
100.00	116.80	167.15	62,548	83,043	149,989
163.15	129.96	169.93	62,591	86,023	163,791
190.12	145.30	174.31	71,763	92,370	193,786
194.53	151.94	191.82	76,842	98,158	194,450
233.22	197.98	199.50	84,974	169,447	228,258
235.21	215.77	230.39	97,627	176,205	247,215
236.86	228.54	245.39	311,145	256,637	296,714
470.05	357.31	363.06	1,156,550	1,118,879	780,616

APPENDIX 10: PRICE INCREASES / DECREASES OVER THE PERIODS

Stock No.	Mean closing prices			% Change	
	Period A	Period B	Period C	Period B	Period C
1	73.58	105.61	85.26	43.54	(19.27)
2	26.73	48.93	40.72	83.05	(16.77)
3	8.72	15.33	21.98	75.84	43.36
4	19.21	32.23	52.28	67.77	62.18
5	12.86	23.28	41.81	80.97	79.59
6	64.06	51.29	87.04	(19.93)	69.70
7	12.11	41.55	105.66	243.20	154.31
8	15.10	21.49	33.53	42.38	56.00
9	190.12	197.98	230.39	4.13	16.37
10	32.31	61.29	95.62	89.72	56.01
11	50.45	40.54	48.58	(19.64)	19.83
12	236.86	228.54	245.39	(3.51)	7.37
13	48.99	60.71	89.13	23.92	46.82
14	32.49	30.04	56.08	(7.55)	86.69
15	11.84	10.88	29.03	(8.17)	166.94
16	65.95	64.50	136.04	(2.18)	110.90
17	57.27	65.05	174.31	13.59	167.97
18	63.36	71.17	167.15	12.32	134.87
19	19.67	20.91	44.39	6.33	112.22
20	48.54	50.41	77.39	3.85	53.53
21	25.67	31.20	70.48	21.52	125.91
22	163.15	129.96	165.35	(20.34)	27.23
23	18.76	22.00	64.67	17.25	193.96
24	95.95	113.70	169.93	18.49	49.46
25	233.22	215.77	199.50	(7.49)	(7.54)
26	34.72	29.52	38.40	(14.98)	30.08
27	23.03	19.00	21.24	(17.53)	11.80
28	29.29	92.27	161.32	215.03	74.84
29	54.24	76.50	125.05	41.04	63.46
30	470.05	145.30	138.92	(69.09)	(4.39)
31	11.54	16.16	19.80	40.06	22.48
32	194.53	86.28	119.65	(55.65)	38.67
33	9.56	18.99	46.96	98.60	147.36
34	90.21	103.98	191.82	15.26	84.48
35	42.72	40.25	37.87	(5.79)	(5.91)

36	15.34	14.46	18.36	(5.70)	26.94
37	8.22	12.30	14.15	49.68	15.05
38	45.28	50.63	67.06	11.82	32.46
39	17.00	17.00	34.09	-	100.54
40	9.82	12.10	22.00	23.24	81.77
41	86.69	116.80	106.62	34.73	(8.72)
42	100.00	151.94	113.20	51.94	(25.49)
43	3.80	4.57	5.00	20.18	9.49
44	235.21	357.31	363.06	51.91	1.61

APPENDIX 11: STOCKS MEAN RETURNS

Stock No.	Returns	
	Period B	Period C
1	0.36	(0.21)
2	0.60	(0.18)
3	0.56	0.36
4	0.52	0.48
5	0.59	0.59
6	(0.22)	0.53
7	1.23	0.93
8	0.35	0.44
9	0.04	0.15
10	0.64	0.44
11	(0.22)	0.18
12	(0.04)	0.07
13	0.21	0.38
14	(0.08)	0.62
15	(0.09)	0.98
16	(0.02)	0.75
17	0.13	0.99
18	0.12	0.85
19	0.06	0.75
20	0.04	0.43
21	0.19	0.81
22	(0.23)	0.24
23	0.16	1.08
24	0.17	0.40
25	(0.08)	(0.08)
26	(0.16)	0.26
27	(0.19)	0.11
28	1.15	0.56
29	0.34	0.49
30	(1.17)	(0.04)
31	0.34	0.20
32	(0.81)	0.33
33	0.69	0.91
34	0.14	0.61

35	(0.06)	(0.06)
36	(0.06)	0.24
37	0.40	0.14
38	0.11	0.28
39	-	0.70
40	0.21	0.60
41	0.30	(0.09)
42	0.42	(0.29)
43	0.18	0.09
44	0.42	0.02
Total	**7.26**	**17.04**
Mean	**0.16**	**0.39**
STDEV	**0.417**	**0.356**

APPENDIX 12: MEAN VOLUME AND STANDARD DEVIATIONS

Stock No.	VOLjB/VOLjA	ln(B/A)	VOLjC/VOLjB	ln(C/B)
1	1.0118	0.0117	0.5255	(0.6435)
2	0.4536	(0.7906)	1.0346	0.0340
3	1.7033	0.5325	0.9889	(0.0111)
4	1.4145	0.3468	2.3732	0.8642
5	1.1804	0.1659	3.1779	1.1562
6	1.5630	0.4466	5.3203	1.6715
7	0.8248	(0.1926)	1.1562	0.1451
8	1.6734	0.5149	0.2624	(1.3381)
9	1.0832	0.0799	1.1671	0.1546
10	1.2234	0.2016	12.0813	2.4917
11	1.0404	0.0396	1.2716	0.2403
12	0.8180	(0.2009)	4.4733	1.4981
13	0.8315	(0.1845)	1.3926	0.3312
14	0.7658	(0.2668)	2.7166	0.9994
15	1.2519	0.2246	5.8554	1.7674
16	0.5372	(0.6215)	20.5083	3.0208
17	0.9601	(0.0407)	1.2391	0.2144
18	1.2774	0.2448	1.9810	0.6836
19	1.4886	0.3979	1.5631	0.4467
20	0.6890	(0.3726)	2.2045	0.7905
21	2.4664	0.9028	0.1733	(1.7529)
22	0.7349	(0.3081)	1.3443	0.2959
23	1.0803	0.0773	1.2731	0.2415
24	0.6905	(0.3703)	1.0280	0.0276
25	1.2645	0.2347	1.6803	0.5190
26	0.8242	(0.1933)	1.1601	0.1485
27	4.6969	1.5469	0.2149	(1.5378)
28	0.9629	(0.0378)	8.0775	2.0891
29	1.1239	0.1168	0.9667	(0.0338)
30	5.3535	1.6777	0.8333	(0.1823)
31	8.5306	2.1437	1.4589	0.3777
32	2.3114	0.8378	1.6402	0.4948
33	0.9674	(0.0331)	0.6977	(0.3600)
34	0.9086	(0.0958)	1.9426	0.6640
35	0.4354	(0.8316)	1.5656	0.4483

36	1.9360	0.6606	1.1532	0.1425
37	0.6628	(0.4113)	2.6620	0.9791
38	1.1169	0.1106	0.3802	(0.9670)
39	1.2115	0.1919	19.9357	2.9925
40	1.4758	0.3892	0.7186	(0.3305)
41	0.8442	(0.1693)	0.9893	(0.0107)
42	0.6636	(0.4101)	3.4345	1.2339
43	0.0053	(5.2322)	2.7391	1.0076
44	0.7178	(0.3315)	0.6178	(0.4816)
	Total	**1.0022**		**20.5222**
	Mean	**0.023**		**0.466**
	STDEV	**1.004**		**3.160**

APPENDIX 13: SIGNIFICANCE TEST FOR VOLUME

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	10.008984	9.986207
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	0.106832	
P(Z<=z) one-tail	0.4574611	
z Critical one-tail	1.6448536	
P(Z<=z) two-tail	0.9149222	
z Critical two-tail	1.959964	

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	10.475397	10.008984
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	2.1876728	
P(Z<=z) one-tail	0.0143467	
z Critical one-tail	1.6448536	
P(Z<=z) two-tail	0.0286934	
z Critical two-tail	1.959964	

APPENDIX 14: REGRESSION ANALYSIS FOR VOLUME

Regression Statistics	
Multiple R	0.730
R Square	0.533
Adjusted R Square	0.522
Standard Error	0.839
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	33.716	33.716	47.950	1.8634E-08
Residual	42	29.532	0.703		
Total	43	63.248			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	3.887	0.890	4.367	8.054E-05	2.091	5.682	2.091	5.682
X Variable 1	0.609	0.088	6.925	1.863E-08	0.432	0.787	0.432	0.787

Regression Statistics	
Multiple R	0.748
R Square	0.559
Adjusted R Square	0.548
Standard Error	0.976
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	50.737	50.737	53.214	5.5207E-09
Residual	42	40.045	0.953		
Total	43	90.782			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	2.197	1.081	2.033	0.048	0.016	4.379	0.016	4.379
X Variable 1	0.746	0.102	7.295	5.522E-09	0.539	0.952	0.539	0.952

APPENDIX 15: MEAN AND STANDARD DEVIATION FOR VOLATILITY

Stock No.	Volatility		
	Period A	Period B	Period C
1	0.00384	0.00252	0.00528
2	0.00262	0.00843	0.01207
3	0.00961	0.01681	0.02961
4	0.00424	0.01136	0.02962
5	0.00354	0.00346	0.01312
6	0.00885	0.00735	0.02672
7	0.01535	0.01814	0.02566
8	0.00372	0.00643	0.00325
9	0.00479	0.00596	0.01276
10	0.00731	0.00844	0.02257
11	0.00801	0.00635	0.01775
12	0.00946	0.00552	0.02007
13	0.00583	0.00578	0.02021
14	0.00917	0.01117	0.02549
15	0.01010	0.01169	0.03886
16	0.00585	0.00526	0.02825
17	0.00597	0.00414	0.01523
18	0.01872	0.01496	0.02270
19	0.01531	0.01776	0.04270
20	0.01097	0.00766	0.02071
21	0.00275	0.00633	0.00969
22	0.01042	0.00774	0.01634
23	0.01047	0.01498	0.03064
24	0.00374	0.00521	0.00833
25	0.00473	0.00310	0.00949
26	0.00804	0.00712	0.01641
27	0.00679	0.00519	0.01902
28	0.00744	0.00832	0.02546
29	0.00245	0.00747	0.00521
30	0.00497	0.01131	0.01408
31	0.00552	0.01151	0.03196
32	0.00444	0.00755	0.01162
33	0.02479	0.02198	0.03291
34	0.01243	0.01042	0.02021

35	0.01107	0.00913	0.01641
36	0.00754	0.00925	0.02327
37	0.00323	0.00178	0.00495
38	0.00467	0.00326	0.00816
39	0.00000	0.00000	0.00764
40	0.00522	0.01223	0.02544
41	0.00196	0.00378	0.00867
42	0.00000	0.00599	0.00823
43	0.00000	0.00000	0.00000
44	0.00110	0.00106	0.00000
Total	**0.30706**	**0.35390**	**0.78676**
Mean	**0.00698**	**0.00804**	**0.01788**
STDEV	**0.00500**	**0.00494**	**0.01027**

APPENDIX 16: SIGNIFICANCE TEST FOR VOLATILITY

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	0.0080432	0.0069786
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	0.0049934	
P(Z<=z) one-tail	0.4980079	
z Critical one-tail	1.6448536	
P(Z<=z) two-tail	0.9960158	
z Critical two-tail	1.959964	

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	0.0178809	0.0080432
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	0.046143	
P(Z<=z) one-tail	0.4815981	
z Critical one-tail	1.6448536	
P(Z<=z) two-tail	0.9631963	
z Critical two-tail	1.959964	

APPENDIX 17: REGRESSION ANALYSIS FOR VOLATILITY

Regression Statistics	
Multiple R	0.773
R Square	0.598
Adjusted R Square	0.588
Standard Error	0.920
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	52.883	52.883	62.475	7.6199E-10
Residual	42	35.552	0.846		
Total	43	88.435			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-0.408	0.565	-0.722	0.474	-1.548	0.732	-1.548	0.732
X Variable 1	0.917	0.116	7.904	7.62E-10	0.683	1.151	0.683	1.151

Regression Statistics

Multiple R	0.304
R Square	0.093
Adjusted R Square	0.071
Standard Error	1.166
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	5.821	5.821	4.281	0.045
Residual	42	57.104	1.360		
Total	43	62.925			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-3.348	0.686	-4.878	1.582E-05	-4.733	-1.963	-4.733	-1.963
X Variable 1	0.348	0.168	2.069	0.045	0.009	0.687	0.009	0.687

APPENDIX 18: MEAN LIQUIDITY, LR1

Stock No.	LR1(B)/LR1(A)	ln LR1(B/A)	LR1(C)/LR1(B)	ln LR1(C/B)
1	0.4634	(0.7692)	0.6487	(0.4329)
2	0.5282	(0.6383)	0.6323	(0.4584)
3	2.0704	0.7278	0.4306	(0.8426)
4	0.6636	(0.4102)	1.1386	0.1298
5	1.2287	0.2060	2.3573	0.8575
6	1.4974	0.4037	2.1052	0.7444
7	0.5682	(0.5653)	0.7362	(0.3062)
8	0.0691	(2.6719)	1.2981	0.2609
9	1.4275	0.3559	0.8969	(0.1088)
10	1.7116	0.5374	3.8702	1.3533
11	1.2056	0.1870	0.8439	(0.1697)
12	1.0599	0.0582	1.4338	0.3603
13	0.5766	(0.5506)	1.3638	0.3103
14	0.7745	(0.2555)	1.4528	0.3735
15	1.2409	0.2159	1.2949	0.2584
16	0.6687	(0.4024)	4.1605	1.4256
17	1.1914	0.1751	1.1061	0.1008
18	1.6325	0.4901	1.1181	0.1116
19	1.1757	0.1619	0.6475	(0.4346)
20	0.6458	(0.4373)	1.3540	0.3030
21	2.2714	0.8204	0.1176	(2.1403)
22	0.7569	(0.2785)	1.0051	0.0051
23	0.8983	(0.1072)	0.7343	(0.3089)
24	0.6575	(0.4193)	0.7248	(0.3218)
25	2.5824	0.9487	1.0279	0.0275
26	0.6962	(0.3621)	1.0503	0.0490
27	10.7213	2.3722	0.0663	(2.7134)
28	1.0556	0.0541	2.9723	1.0893
29	1.0464	0.0454	0.9768	(0.0234)
30	2.1429	0.7622	0.8745	(0.1341)
31	6.5155	1.8742	0.6056	(0.5016)
32	1.1404	0.1314	1.5744	0.4539
33	1.0938	0.0897	0.3968	(0.9244)
34	1.0001	0.0001	1.5647	0.4477

35	0.5478	(0.6018)	1.0580	0.0564
36	1.7800	0.5766	0.7184	(0.3307)
37	0.3212	(1.1358)	2.9601	1.0852
38	6.7326	1.9070	0.3762	(0.9778)
39	-	-	-	-
40	1.3726	0.3167	0.5285	(0.6378)
41	0.6313	(0.4600)	0.8927	(0.1135)
42	-	-	9.5719	2.2588
43	-	-	-	-
44	0.9857	(0.0144)	-	-
	Total	**3.3378**		**0.1818**
	Mean	**0.0759**		**0.0041**

APPENDIX 19: SIGNIFICANCE TEST FOR LIQUIDITY, LR1

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	13.82601808	13.51444115
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	**1.461425348**	
P(Z<=z) one-tail	0.071949374	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.143898749	
z Critical two-tail	1.959963985	

z-Test: Two Sample for Means

	Variable 1	Variable 2
Mean	13.87707972	13.82601808
Known Variance	1	1
Observations	44	44
Hypothesized Mean Difference	0	
z	**0.2395003**	
P(Z<=z) one-tail	0.405358832	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.810717664	
z Critical two-tail	1.959963985	

APPENDIX 20: MEAN LIQUIDITY, LR2

Stock No.	LR2(B)/LR2(A)	ln LR2(B/A)	LR2(C)/LR2(B)	ln LR2(C/B)
1	0.739	-0.302	0.512	-0.669
2	0.919	-0.084	0.535	-0.625
3	3.280	1.188	0.667	-0.405
4	1.176	0.162	2.276	0.823
5	1.616	0.480	5.506	1.706
6	1.248	0.222	3.060	1.119
7	1.996	0.691	1.723	0.544
8	0.142	-1.952	1.836	0.608
9	1.448	0.370	1.013	0.012
10	3.423	1.231	5.287	1.665
11	0.863	-0.148	1.089	0.085
12	1.013	0.013	1.267	0.236
13	0.655	-0.424	1.766	0.569
14	0.639	-0.448	2.489	0.912
15	1.095	0.091	2.523	0.925
16	0.582	-0.542	7.188	1.972
17	1.329	0.284	2.847	1.046
18	1.587	0.462	2.589	0.951
19	1.224	0.202	1.319	0.277
20	0.649	-0.433	2.172	0.776
21	3.340	1.206	0.225	-1.491
22	0.602	-0.508	1.226	0.204
23	1.094	0.090	1.847	0.613
24	0.694	-0.365	1.046	0.045
25	2.307	0.836	0.954	-0.047
26	0.585	-0.537	1.301	0.263
27	8.923	2.189	0.093	-2.375
28	3.793	1.333	4.552	1.516
29	1.699	0.530	1.278	0.245
30	0.610	-0.494	0.905	-0.099
31	9.743	2.277	0.689	-0.372
32	1.309	0.269	1.942	0.664
33	1.808	0.592	1.113	0.107
34	1.316	0.275	2.344	0.852
35	0.532	-0.632	1.028	0.028

36	1.718	0.541	0.843	-0.171
37	0.504	-0.685	2.892	1.062
38	6.509	1.873	0.442	-0.816
39	0.000	0.000	0.000	0.000
40	2.031	0.709	0.729	-0.315
41	0.843	-0.171	0.820	-0.198
42	0.000	0.000	5.935	1.781
43	0.000	0.000	0.000	0.000
44	2.175	0.777	0.000	0.000
	Total	**11.169**		**14.022**
	Mean	**0.254**		**0.319**

APPENDIX 21: REGRESSION ANALYSIS FOR LIQUIDITY

LR1

Regression Statistics	
Multiple R	0.895
R Square	0.801
Adjusted R Square	0.796
Standard Error	1.770
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	528.220	528.220	168.602	2.68609E-16
Residual	42	131.583	3.133		
Total	43	659.803			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-0.619	1.121	-0.552	0.584	-2.880	1.643	-2.880	1.643
X Variable 1	1.022	0.079	12.985	2.686E-16	0.863	1.181	0.863	1.181

Regression Statistics

Multiple R	0.642
R Square	0.413
Adjusted R Square	0.399
Standard Error	2.659
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	208.553	208.553	29.495	2.60192E-06
Residual	42	296.970	7.071		
Total	43	505.524			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	4.676	1.732	2.700	0.010	1.181	8.171	1.181	8.171
X Variable 1	0.659	0.121	5.431	2.602E-06	0.414	0.904	0.414	0.904

LR 2

Regression Statistics	
Multiple R	0.867
R Square	0.751
Adjusted R Square	0.746
Standard Error	2.468
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	773.744	773.744	126.999	2.8133E-14
Residual	42	255.885	6.093		
Total	43	1029.629			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	-0.816	1.622	-0.503	0.618	-4.090	2.458	-4.090	2.458
X Variable 1	1.012	0.090	11.269	2.813E-14	0.831	1.193	0.831	1.193

Regression Statistics	
Multiple R	0.589
R Square	0.347
Adjusted R Square	0.331
Standard Error	3.429
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	261.910	261.910	22.277	2.62947E-05
Residual	42	493.790	11.757		
Total	43	755.700			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	7.249	2.250	3.222	0.002	2.709	11.790	2.709	11.790
X Variable 1	0.577	0.122	4.720	2.629E-05	0.331	0.824	0.331	0.824

APPENDIX 22: REGRESSION ANALYSIS FOR VOLUME AGAINST RETURNS

Regression Statistics period B	
Multiple R	0.057
R Square	0.003
Adjusted R Square	(0.020)
Standard Error	1.468
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.298	0.298	0.138	0.712
Residual	42	90.484	2.154		
Total	43	90.782			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	10.042	0.238	42.132	5.42E-36	9.561	10.523	9.561	10.523
X Variable 1	(0.200)	0.537	(0.372)	0.712	(1.283)	0.884	(1.283)	0.884

Regression Statistics period C	
Multiple R	0.495
R Square	0.245
Adjusted R Square	0.227
Standard Error	1.281
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	1	22.320	22.320	13.603	0.001
Residual	42	68.915	1.641		
Total	43	91.235			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	9.691	0.287	33.726	4.77E-32	9.111	10.271	9.111	10.271
X Variable 1	2.026	0.549	3.688	0.001	0.917	3.135	0.917	3.135

APPENDIX 23: REGRESSION ANALYSIS FOR VOLUME AGAINST RETURNS AND VOLATILITY

Regression Statistics period B

Multiple R	0.159
R Square	0.025
Adjusted R Square	(0.022)
Standard Error	1.469
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	2	2.281	1.141	0.528	0.594
Residual	41	88.501	2.159		
Total	43	90.782			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	9.205	0.905	10.172	8.9E-13	7.378	11.033	7.378	11.033
X Variable 1	(0.208)	0.537	(0.387)	0.700	(1.293)	0.877	(1.293)	0.877
X Variable 2	(0.178)	0.185	(0.959)	0.343	(0.552)	0.197	(0.552)	0.197

Regression Statistics period C

Multiple R	0.495
R Square	0.245
Adjusted R Square	0.208
Standard Error	1.296
Observations	44

ANOVA

	df	SS	MS	F	Significance F
Regression	2	22.374	11.187	6.661	0.003
Residual	41	68.860	1.680		
Total	43	91.235			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95%	Upper 95%
Intercept	9.554	0.811	11.783	9.6E-15	7.917	11.192	7.917	11.192
X Variable 1	2.034	0.558	3.648	0.001	0.908	3.160	0.908	3.160
X Variable 2	(0.034)	0.187	(0.180)	0.858	(0.412)	0.345	(0.412)	0.345

APPENDIX 24: NUMBER OF TRADING DAYS

STOCK NO.	NUMBER OF TRADING DAYS			% OF TOTAL TRADING DAYS		
	PERIOD A	PERIOD B	PERIOD C	PERIOD A	PERIOD B	PERIOD C
1	119	124	214	0.50	0.51	0.59
2	131	171	289	0.55	0.71	0.80
3	210	218	352	0.88	0.90	0.98
4	167	212	343	0.70	0.88	0.95
5	26	38	205	0.11	0.16	0.57
6	206	217	356	0.87	0.90	0.99
7	234	237	357	0.98	0.98	0.99
8	47	28	108	0.20	0.12	0.30
9	211	221	355	0.89	0.92	0.98
10	193	204	285	0.81	0.85	0.79
11	197	157	309	0.83	0.65	0.86
12	234	234	357	0.98	0.97	0.99
13	197	196	310	0.83	0.81	0.86
14	195	226	357	0.82	0.94	0.99
15	229	230	357	0.96	0.95	0.99
16	205	218	349	0.86	0.90	0.97
17	169	178	321	0.71	0.74	0.89
18	234	236	357	0.98	0.98	0.99
19	234	234	357	0.98	0.97	0.99
20	232	224	354	0.97	0.93	0.98
21	75	110	250	0.32	0.46	0.69
22	233	231	353	0.98	0.96	0.98
23	228	229	357	0.96	0.95	0.99
24	196	204	317	0.82	0.85	0.88
25	196	213	344	0.82	0.88	0.95
26	200	200	329	0.84	0.83	0.91
27	86	87	214	0.36	0.36	0.59
28	161	214	341	0.68	0.89	0.94
29	110	154	266	0.46	0.64	0.74
30	229	236	356	0.96	0.98	0.99

31	201	209	356	0.84	0.87	0.99
32	153	209	327	0.64	0.87	0.91
33	234	240	357	0.98	1.00	0.99
34	228	226	355	0.96	0.94	0.98
35	231	236	356	0.97	0.98	0.99
36	216	215	356	0.91	0.89	0.99
37	30	39	89	0.13	0.16	0.25
38	38	131	149	0.16	0.54	0.41
39	3	2	78	0.01	0.01	0.22
40	84	150	353	0.35	0.62	0.98
41	84	104	183	0.35	0.43	0.51
42	1	16	91	0.00	0.07	0.25
43	3	3	1	0.01	0.01	0.00
44	14	16	17	0.06	0.07	0.05

APPENDIX 25: SUMMARY OF TOTAL TRADING DAYS

Year	Month	Trading days	Total Trading days
Period A			
2003	Dec	14	
2004	Jan	21	
	Feb	20	
	Mar	23	
	Apr	20	
	May	22	
	Jun	21	
	Jul	23	
	Aug	22	
	Sep	22	
	Oct	22	
	Nov	8	**238**
Period B			
2004	Nov	13	
	Dec	21	
2005	Jan	21	
	Feb	20	
	Mar	21	
	Apr	21	
	May	22	
	Jun	21	
	Jul	21	
	Aug	23	
	Sep	22	
	Oct	15	**241**
Period C			
2005	Oct	4	
	Nov	19	
	Dec	20	
2006	Jan	21	
	Feb	20	
	Mar	25	
	Apr	17	
	May	22	
	Jun	21	
	Jul	21	

2007	Aug	24	
	Sep	21	
	Oct	19	
	Nov	22	
	Dec	18	
	Jan	22	
	Feb	23	
	Mar	22	**361**
Total Trading days			**840**