DETERMINING AUTOMATION EFFECT ON MARKET EFFICIENCY

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Abstract
        The aim of this research was to better understand technology-induced market changes. The Nairobi Security Exchange was studied and the effects of an automation exercise carried out in 2006, was the research focus. Adoption of case study unraveled how automation impacts efficiency. Secondary data in form of monthly NSE-20 share index from January 2001-December 2011 and transformed into compounded monthly return was used. Run test was then applied. Too many runs indicate a tendency for high and low values to alternate; it was found that returns were normally distributed. As such, a normality test was conducted on the NSE using mean, skewness and kurtosis. Considering the mean and median, the two measures were close , and in almost all the years the skewness was close to zero (0) as well as the kurtosis close to three (3) all this shows that the data was normally distributed which confirmed that the market was weak form efficiency. Finally, t statistics showed that there was a statistical significant difference between manual and automation in the stock market performance during the year of transition, 2005 to 2006 a P value of 0.0006 when it was fully implemented,   implying that there was a difference in the market

performance before and after market automation. These findings are meant to provide an understanding of the automation implication undertaken by market authorities that's CMA and NSE on the market performance. It will assist investors to develop strategies relating to their operational environment.

Introduction

Since the main objective of automation is to create a well-functioning stock market, automation can have positive effects on market microstructure-related characteristics of volume and volatility. Kibuthu (2005*)* showed that automated exchanges can be deeper and more liquid than open outcry exchanges. Dickinson and Muragu, (1994), noted an increase in liquidity and an improvement in efficiency, but volatility increased following the automation of the Singapore stock exchange. Derrabi (1998) studied the effect of automation on the Morrocan exchange, which uses both call and continuous markets. A permanent stock-price increase was observed for securities transferred, but volatility and efficiency improved only for securities transferred to the call-based trading system. In contrast, some authors find that automated trading can have a negative effect on liquidity when transactions are based on human interactions. Bodie *et al*. (2002) suggest that automation decreases liquidity because for important transactions traders cannot negotiate directly and so have no control on trading conditions.

The NSE has not been left behind in undertaking changes so as to bring it at par with other emerging markets. For example, the NSE went into full automation in 2006 which has led to significant improvement in terms of liquidity and size and boosted the operational efficiency of the NSE. It is the policy of the Government of Kenya, as it has now become a cliché in Kenya, to promote the private sector as the engine of growth for the economy. In this regard, the Government has been taking positive steps to attract private investors, both local and foreign, to participate in the economy of the country by providing conducive conditions for investment. Government knows that the capital market is indeed an invaluable key to Kenya's economic development and growth. For this reason, government over the years has consistently nurtured such environments to foster effective functioning of the financial sector for efficient mobilization and allocation of resources. This has given great impetus to government's privatization programs, in line with the objectives for which the Nairobi Security Exchange was established to promote the growth of the private sector.

These changes have led to increased participation from local and institutional investors as was evident in the Safaricom, Kengen and Access Kenya IPOs that had an oversubscription. However, recent political events and the collapse of various brokerages have provided lots of challenges to the growth and development of the NSE as many retail investors seem to shy away. It is such challenges and many more that have called for more reforms inform of increased surveillance and demutualisation so as to increase market efficiency.

In spite of these challenges, the NSE continues to perform well compared to its peers such as Nigeria and Ghana. Recent statistics indicate that the NSE was rated as the best performing market in Africa in 2010 with a gain of 36.5% followed closely by Ghana with a gain of 35.9% while Nigeria lies fifth with a gain of 18.9% (Ngugi, 2003). This has attracted significant interest particularly from foreign investors who account for a large portion of equities traded. With the rising interest from various fonts and significant changes occurring in the market, it's important to carry out an efficiency study.

History and development of the NSE

The NSE was established in 1954 as an overseas stock exchange. Prior to that, the NSE traded as an informal market with no rules and guidelines to govern trading activity. Trading was based on a gentleman's agreement and there was no physical trading floor i.e. much of the trading was conducted over a cup of coffee (NSE, 2011). The establishment of the NSE marked the formalization of share trading and was initiated by stockbrokers who saw the need to access long term capital by private enterprises. To date the NSE is a buzz of activities with fifty six listed companies and boasting of a modern trading platform. The following are some of the key developments that have shaped the market since its establishment.

Automation of the Trading System

At the time of establishment, the NSE had no physical trading floor and transactions were carried out in a coffee-house forum over telephone and prices were determined through negotiation. The NSE used a periodic (call) auction trading system for transacting. In 1991, trading moved from coffee-house to floor based open outcry system. The open outcry system was adopted as it enhanced transparency by allowing brokers an equal opportunity to bid for securities and its ability to handle increased trading activity. Further, it was felt that trading in the coffee-house environment did not generate enough public awareness and the prices obtained by buyers and sellers were not the best (Ngugi, 2003). With the new trading system in

place, trading was conducted from 10.00 a.m. - 12 p.m. Potential buyers and sellers would place their buy or sell orders through stockbrokers who in turn would place their orders through their representatives in the trading floor. Daily limits on price movements were set at 15% of the opening bid or offer prices.

Despite these developments, the manual system of clearing and settlement had a serious impact on the liquidity and efficiency of the stock market. For example it would take about a week or two between the actual sale and confirmation. This led to the need to institute a better system and the proposal to adopt the Central Depository System (CDS) was floated in 1995. The CDS would shorten the registration process, boost liquidity in the market, increase market activity, reduce market risk and attain international standards. The Central Depository System Corporation Limited (CDSC) was established on 23rd March under companies Act (Cap 486) 1999 and the CDS bill passed its 2nd reading in parliament on April 2000. On 1st August 2000, a delivery versus payment system (DvP) was introduced as the initial step towards moving to the electronic system of settlement. The DvP aimed at moving the market closer to the T+3 days environment of the CDS, enhancing investor confidence and liquidity by making the settlement period shorter and safe and enabling brokers concentrate on their core business. However, the DvP faced the main challenge of settling transactions within 5 days of trading and providing shareholders with their shares within seven days of trading. The CDS act was passed by parliament and received presidential assent on 18th August 2000. Due to various complications the CDS was implemented in November 2004 followed by the launch of the ATS in 11th September 2006. Trading hours were increased from 10.00 a.m. to 1 p.m. and settlement period reduced to T+5. Recently the NSE introduced a live trading board that enables one to view the order book. Further, the NSE is on its way to introduce a Broker Back Office (BBO) this will go a long way in assisting in information sharing.

Literature Review

Automation is a process which ties with the number of trades, number of investors and how active a market is. It is worth noting that when the exchange began its activities in 1990, only a few trades were done with a very minimal number of shareholders and listed companies. Automation is costly and couldn't have happened then which could be of great help in efficiency.

The efficiency of financial markets can be classified as allocation efficiency, operation efficiency and information efficiency. Allocation efficiency looks at how well capital markets can channel funds to their most productive use. Operation efficiency deals with the execution of transactions

at minimal costs while informational efficiency looks at how well information is impounded into security prices. Finance theory and research over the years has been mainly concerned with the speed at which information is incorporated in prices. In this regard, Fama (1970) developed three versions of information efficiency with respect to information available i.e. the weak form efficiency, the semi strong form efficiency and the strong form efficiency. African capital markets are said to be characterised by illiquidity, thin trading and high volatility (Mlambo and Biekpe, 2007). It's these limitations that have led to microstructure changes so as to increase liquidity and transparency, enhance efficiency, and reduce transaction costs and volatility.

Effects of Automation

The competition between different market organizations is mainly influenced by traders' inertia. Liquidity attracts further liquidity, which means that traders always want to trade where others are already trading. This is a network effect, which makes it difficult for competing start ups to attract enough orders to reach the critical mass of orders in order to produce a liquid market. This liquidity inertia is a major barrier for innovative market organizations that are attempting to compete against established ones. Berkowitz, Logue, and Nober (1988) conducted a study at the Stock Exchange of Hong Kong and established that the trading system was primarily a computer-assisted semi-automatic quotation system which comprised an information dissemination system and a trading system. Floor traders input orders without the order quantity into the system which would display the broker numbers under each of the two best bid/ask prices. The information of the orders input were disseminated to other floor traders and investors outside the floor through the Exchange Teletext System. With this information displayed on the Teletext screen, floor traders were able to contact their counterparts to negotiate for deals by internal telephone calls or face-to-face bargaining. Once a transaction was struck, the trading details were then disseminated to floor traders and investors. Clearing and settlement was done by the physical delivery of shares and back-office paperwork. At that time, computers were used. Since early 1994 SEHK has been working on the AMS Second Terminal Development Project, and the system was finally launched on 25 January 1996. The second terminal is an additional terminal installed in the Exchange Members" offices. The second terminal has the following advantages to users: - The Members" trading capacity will be raised since orders will be able to be input to both on-floor and off-floor terminals simultaneously, doubling the maximum 200 outstanding orders per membership seat allowed; - Trading efficiency will be increased when orders are entered in the Members" offices, thereby

eliminating the need for telephone communication between the dealer in the office and the floor trader; - The second terminal uses digital broadcasting technology which will provide much faster and better information dissemination services without geographical constraints. On 1 November 1993, a new computerized trading system called Automatic Order Matching and Execution System (AMS) was introduced. Basically AMS is an order-driven system whereby share trading originates from the order of a client, in the form of either a market order or a limit order. Traders submit "messages" through terminals to a central computer. These messages consist of various kinds of order information as well as a personal identifier. Orders are then written to an "electronic order book" and displayed in price/time priority. Transactions automatically occur when the price of the best offer to buy is equal to or greater than the best offer to sell. Instead of simply routing orders and providing market information, automated systems are used to execute and confirm trades, handle clearing and settlement, and even perform surveillance functions; in essence, the system has become the market.

TIF roundtable (22nd July 1996) indicated the key factors fueling the rapid rise in the use of automation by SEHK as summarized as follows. First, intense competition from off-exchange and other exchanges in the region causes the exchange to rely on technology to reduce costs, improve trading efficiency and increase the capacity. In order to maintain Hong Kong as a financial hub in the region, transaction costs are kept low to attract and retain foreign capital. As long as trades were not electronically recorded, it was not possible for investors to short sell in Hong Kong. With the emergence of derivatives market like options and futures, automated and real-time trading is the only way to manage these high-risk transactions effectively. In addition, new regulations adopted by the Securities and Futures Commission as well as guidelines issued by the Group of 30 (G30) place a premium on the efficient trading and timely clearing and settlement offered by electronic exchanges as transparency facilitates investors protection by making it easier for clients to monitor brokers and promotes liquidity, automation allows suspicious transactions and other illegal activity to be more easily identified. In conclusion, the implementation of the electronic trading system has had a measurable impact on price behavior. Market liquidity has been enhanced. The 'quality' of the EDB market is therefore considered to be higher than that of the manual limit order book market. Some authors affirm that automated trading can have a negative effect on liquidity when transactions are often the result of human interactions. Biais & al, (1997) suggest that automation can lead liquidity to decrease because it doesn't allow a direct negotiation between traders for important transactions and doesn't allow them therefore to preserve a certain control on trading conditions. In contrast, Pirrong, (1996) has shown that automated exchanges can be deeper and more liquid

than open outcry exchanges. Naidu & Rozeff, (1994) note an increase of volatility and liquidity as well as an improvement in efficiency following the automation of the Singapore stock exchange. They advance that automation speeds up the dissemination of prices, then volatility is likely to increase, especially when information is hitting the market. Otherwise, the faster 13 availability of prices and trading volume incites investors likely to trade to exploit the published information, what is likely to improve market efficiency. Benimadhu, (2003) said, in the African context, the automation of stock exchanges in other African countries have:

I.   Facilitated the privatization process
II.   Diversified the financial services sector
III. Provided listed companies with a platform to raise long-term capital
IV.   Offered investors" alternative investment opportunities
V.   Attracted foreign capital flows and increased the level of foreign exchange reserves
VI.   Sensitized market operators about the importance of Corporate Governance
VII. Rendered companies more accountable to shareholders
VIII. Set the stage for a gradual alignment of local business practices and standards with international best practice

Challenges of Automation

A study conducted by Benimadhu (2003) established that factors constraining the development of African Stock Markets are mainly Political and macro-economic set-up some of which are listed below:

I.   Political instability and internal strife
II.   Macro-economic uncertainties
III. Liquidity issues
IV.   Absence of an active and well developed domestic investor base
V.   Issues of efficiency and real-time availability of market information
VI.   Corporate Governance practices of Listed Companies
VII. regulatory and supervisory activities by regulatory bodies

A study of the Kenyan case might either confirm or give different results as compared to the Hong Kong and the African Stock Exchanges. Kenyan business news.com; May 4, 2009 published that with barely 30 days of automating the trading platform, the Nairobi Security Exchange (NSE) securities depository has created 6,000 electronic accounts. Significantly, this means that any trading on the market in the last 30 days was effected only in those 6,000 accounts – out of the over-250,000 shareholders on the bourse. General Manager of the NSE therefore urged shareholders to get their paper certificates converted to electronic accounts as quickly as

possible to facilitate trade volumes. "The system is working efficiently as expected. Volumes are picking up except that they are slow," he said at a „facts behind the figures" programme at the NSE last week. Because of the electronic systems, shares and bonds can only trade after they are deposited in the securities depository. The depository allows investors to hold more than one account, just as in the case of a bank account. With the automated market, stock brokers now have the option to transact business from the comfort of their offices or make use of online facilities furnished at the NSE building.

Mr. Afedzie said the few days of trading on the new system testify to the enormous benefits for the market in years to come. "The NSE is poised more than ever to compete with other markets in the world for global volumes and market capitalization. "Past challenges with the trading settlement time of T+3 are all gone. Investors can check their share or bond accounts at anytime (T) while brokers can conveniently cross-check trading results and so on," he said. As part of laid-down procedures, electronic account holders receive statements showing movement in their holdings every quarter from the securities depository and annually from their brokerage firms. This is supposed to help them track their investments and" know how they are performing on the market. An alert system on mobile phones and emails to give investors real-time updates of sales and purchases of shares on their account is also in the pipeline. Many companies have passed resolutions at their annual general meetings, making it legal for boards of companies to ask shareholders to convert paper share certificates into electronic accounts with the depository.

Stock Market Performance Indicators

The prices of stocks around the world do not move together in an exact manner. This is because the economic systems in which stock markets are located have dissimilar environments in terms of taxation, industrial growth, political stability and monetary policies among other factors. Stock markets may experience a general increase in price level referred to as a bull market or general decrease in price level referred to as bear market. Stagnant prices or sudden big price movements downward is referred to as stock market crash.

Among the main measures of stock market performance include; stock market indexing, market capitalization and stock turnover. Stock market indexing is one of the most widely used measures of stock performance. Investors hold portfolios of many assets but it is cumbersome to follow progress on each security in the portfolio. Thus it is prudent to observe the entire market under the notion that their portfolio moved in the same direction as the aggregate market. The market index such as the NSE

index is used to observe total returns for an aggregate market and these computed returns are to judge performance of individual portfolios. The assumption is that randomly selecting a large number of stocks from the total market should enable the investor to generate a rate of return comparable to the market (Simiyu, 1992).

Market capitalization is another measure of stock market performance .This measure is used to measure market movements by measuring the total value of stock in a particular stock market by aggregating the market value of the quoted stocks. Changes in market capitalization occur due to fluctuations in share prices or issuance of new share prices or issuance of new shares and bonus issues. This implies that high activity at the stock market may signal more investments in the stock markets. Market turnover indicates inflows and outflows in the stock market and is based on the actively traded shares. A change occurs due to the actively traded shares and to fluctuations in share prices or number of shares traded in a given day (Otuke, 2006).

Among the determinants of stock market performance include, performance of the economy, monetary policies, fiscal policies, inflation, availability of substitute investments, change of investor preferences and market sentiments. Activities of government and general performance of the economy influence stock market activity and therefore the performance of stock markets. Monetary and fiscal measures enacted by various agencies of national governments influence the aggregate economies of those countries. The resulting economic conditions influence all industries and companies in an economy positively or negatively which in turn affect the performance of stock markets (Reilly, 1997).

Fiscal policy incentives such as tax cuts can encourage spending, where as additional taxes on income ,petroleum products, cigarettes ,and alcoholic beverages discourage spending. Increase or decrease in government spending also influence the general economic activity by triggering multiplier effect (Stiglitz, 1993). Monetary policy has implications to the economy. A restrictive monetary policy reduces the supply of funds for working capital and expansion of business. Alternatively a restrictive monetary policy may lead to increased interests rates thus increasing the cost of capital which makes it more expensive for individuals to finance home mortgage and purchase of durable goods (Mendelson, 1976).

Inflation affects the performance of stock markets as it causes differences between real and nominal interests' rates thus changing the spending and saving behavior of consumers and corporations. Unexpected changes in the rate of inflation make it difficult for firms to plan, which inhibits growth and innovations. Beyond the impact of the domestic economy, differential inflation and interest rate influence the trade balance

between countries and exchange rate of currencies (Reilly, 1997). Events such as war, political upheavals within or outside a country ,or international monetary devaluation produces changes in the business environment that lead to uncertainties and earnings expectations of investors therefore increasing the risk premium of investors (Mendelson, 1976).

Availability of other investments other than shares traded on the stock market affect the stock market performance. Stock markets compete for investments with other assets in an economy such as corporate bonds, governments bonds, treasury bills, real estate and foreign equity among others. The influx of government bonds and treasury bills in Kenya, resulted into-the bull-run at the Nairobi Stock Exchange between 2004 and 2006 (www.nse.co.ke).

Changes in investor composition also affect stock market performance .As supply and demand for security change overtime, different types of investors are attracted to the market. If the risk preferences of the investors are not as those of current investors the required rate of return tend to shift .Accordingly price relationship will change quite independently of any modification in earnings expectations. Participation by institutional investors at Nairobi Stock Exchange influences pricing and returns generated at the stock market (Reilly, 1997).

Market sentiment also referred to as the psychology of market participants affect stock market performance. Market sentiment is often subjective, biased, and obstinate .The uncertain mass reaction of individuals to developments affecting the stock market is one of the factors that handicaps stock market forecasting .A mild stock market flurry caused by a spurt in business activity may generate a wave of buying enthusiasm that raises prices to blossom levels .As an indication to this tendency, from January 1967 through December 1968 the American Stock Exchange index more than doubled in the face of a business activity advance of about ten percent. The stay-eyed optimism of buyers who believe that prices that increase indefinitely may produce substantial advances that are not justified by underlying financial considerations. On the other hand, pervasive investor gloom, generated by political or economic uncertainties, could drive prices to levels that appear equally unjustified by standard financial tests (Mendelson, 1967).

The occasionally irrational attitude of buyers was noted by John Maynard Keynes, who observes that professional investors are concerned not with what an investment is really worth to a man who buys it 'for keeps ,' but with what the market will value it at ,under the influence of mass psychology ,three months or a year later. Psychological factors motivating individuals to buy and sell stocks are difficult to evaluate but may sometimes present opportunities for substantial profits and therefore cannot be ignored

by more adventuresome investors (Mendelson, 1976). This irrational behavior of investors related activities before or after an election could also affect the stock market performance.

Statement of the Problem

Trading in global emerging stock markets has surged significantly in the past few years. An emerging stock market like the Nairobi Security Exchange was not left out of this impressive global trend. Kenya attracted some investors from developed markets owing to the impressive returns recorded. Given that these investors are currently operating on other developed exchanges which are automated it becomes necessary for NSE to automate and give the investors the opportunity to enjoy the attendant benefits of automation. Attempts have been made to automate the Nairobi Security Exchange because of the possible gains in improvement in liquidity; efficiency of processes among others as it was believed that these gains have been recorded after automation of the Nairobi Security exchange initiated it. However, recent political events and the collapse of various brokerages have provided lots of challenges to the growth and development of the NSE as many retail investors seem to shy away. This has attracted significant interest particularly from foreign investors who account for a large portion of equities traded. The study has examined the possible effects that have accrued with respect to liquidity among others as a result of the automation in the NSE. And with the rising interest from various fronts and significant changes occurring in the market, it was important to carry out an empirical study to establish how market automation has had an impact on the weak form efficiency. The grand objective of this study was to examine the effect of automation before and after its initiation on the Nairobi Security Exchange. The specific objective was to determine effect of automation on market efficiency at Nairobi Securities Exchange.

Research Methodology
Research Design

This is a case study research design analyzing the stock market performance before and after the NSE automation in Kenya. The period of study focused on NSE performance for the period between 2001 and 2011. The NSE index performance during this period is analyzed and the performance of the NSE index during automation years compared to none automation years.In addition, the study determined the relationship between market performance and market turnover. The study area was the Nairobi Security Exchange, Kenya. The study utilised secondary data gathered from NSE Annual Reports and published financial statements available at the NSE and the CMA libraries.

Data Collection

The study used secondary data from the NSE. Monthly data on the NSE-20 share index was collected from January 2000-December 2011 and transformed into continuously compounded monthly return by taking the natural logarithm. The data was then split into two samples i.e. 2000-2005 and 2007-2010 so as to conduct the necessary tests. The reason for dividing the sample into two is to capture the period when market activity was on the rise due factors such as automation and investor awareness. The use of monthly data was in accordance with other research and overcomes the problem of thin trading (Kalu, 2008).

Data Analysis

The main data variable for this study was the NSE index. The NSE index was used to measure the performance of the NSE from each trading day. An increase in the NSE indicated that the NSE performance was on an upward trend with share prices of most shares increasing NSE performance indicators, principally the NSE 20 share index and its derivatives (measures of volatility) were analyzed to capture trends of performance of the market for the study period. The pooled-variance t-test for differences in means was used to compare significance of differences for the comparative study periods.

Stock market index movement is used to judge the performance of the stock market and an indication of the economic activities in the country. When the stock market index moves upwards on a continuous basis the market is referred to as bullish and when the index moves downwards the market is referred to as bearish. At times the markets move within a very narrow range and it is neither bullish nor bearish. The stock market index movement before and after the automation was tracked to determine the movement. Tests of significance were undertaken to determine whether there were any significant differences in performance before and after automation.

Data collected from NSE indices was used for calculating return and volatility. NSE-20 Share Index is a basket of 20 constituent stocks representing a sample of large, liquid and representative companies. Due to its wide acceptance amongst the Kenyan investors, NSE 20- share index is regarded the pulse of the Kenyan stock market. To determine whether historical returns can be used to predict the future stock returns, the return on the index at period t was computed using equation 1. A key assumption underlying use of logarithms is that returns are log-normally distributed and trade on a continuous basis, (Simons and Laryea, 2004).

Return is calculated using logarithmic method as follows.

r_t = (log pt–log pt-1)*100...(Equation 1)

where:
r_t = Monthly returns for NSE 20-share index for period $_t$
P_t = NSE 20-share index for month t
P_{t-1} = NSE 20-share index for month $_{t-1}$.
Ln= Natural Logarithm.

Test of weak form efficiency

In order to test for the weak form efficiency in the NSE, a run test was used on the two samples constructed and tested at 5% significance level. A run is defined as a series of increasing values (+) or a series of decreasing values (-).A run test was test for serial independence of returns which determines whether successive price changes are independent of each other. Under the null hypothesis, a series of runs was said to follow of a random walk if successive price changes are independent. If a series of runs doesn't follow a random walk (dependent), the null hypothesis is rejected. To determine whether a series is random, the expected number of runs was compared with the observed number of runs. In a random series the observed number of runs was closer to the expected number of runs. If the observed number of runs is fewer than the expected number of runs then the series may have positive autocorrelation. If the observed runs are more than the expected runs this may indicate negative autocorrelation. Thus, too few runs or too many runs indicate evidence against the random walk.

The expected number of runs is given by;

$$M = \frac{2N_1 N_2}{N} + 1 \dots\dots\dots\dots\dots(Equation\ 2)$$

Where:
N = Total number of observation ($N_1 + N_2$),

N_1 = Number of (+) returns,

N_2 = Number of (–) returns and

M = Expected number of runs.

The run test also converts the total number of runs into a Z statistic. For large samples the Z statistics gives the probability of difference between the actual and expected number of runs. Therefore, the z-value for a random series should lie between ± 1.96. Failure to conform to this leads to rejection of the null hypothesis.

Test of relationship

A relationship test was carried out using correlation. Correlation co-efficient lies between +1 to -1. If correlation co-efficient is closer to +1 or -1, there is strong positive and negative correlation respectively. If the correlation co-efficient is closer to zero it may signify low correlation or no

correlation. A test of correlation coefficient was done to determine whether the existing is an actual relationship or no relationship. A two tailed *t*-test was used at 5% significance level. If the *t* values lies between ±2.101 the null hypothesis that no relationship exist is accept while if it falls outside the null hypothesis is rejected.

Results And Discussion

Secondary data collected from the Nairobi Stock exchange was used in the whole process of analysis. Stata version 11 statistical analysis software together with Microsoft excel software were used. A 95% Confidence level was selected. Univariate analysis was run to establish normality of the data, together with box plots. P-values extracted from t test outputs were interpreted to establish effects, as illustrated in the objective. The dataset was split into two sections, i.e. the period when the Nairobi Stock Exchange was manually operated, the period when the NSE was fully implemented.

The dataset was split depending on the platform in use at that period. A paired t test was conducted to determine the effect of automation on the market efficiency between the different years of the NSE. Basically the t-test value is a statistic that indicates the size of an effect, from the standpoint of a bell curve (a probability distribution). The further away from zero (0), the more likely that the effect is "statistically significant" (another way of saying that the effect is not likely due to random chance – there is likely an underlying repeatable cause). P values were recorded and interpreted. The stock market *operated* manually until 2005, and automaton from 2006 to 2011. Market efficiency experienced an increase stock in the years when the automation was introduced. In 2005-2006, P values of 0.5779 were recorded all showing statistical in significance, implying that the null hypothesis was true, which was "*that stock returns follow a random walk i.e. the market is weak form efficient*" and the alternative hypothesis was ignored ie "*that stock returns do not follow a random walk*". Below tabulations show the results of the t test analysis that was run Stata version 11 software.

Table 1. t-value before automation

Year	t - value	P value
2000 - 2001	0.2156	0.8333
2001 - 2002	1.6060	0.1366
2002 - 2003	-13.6498	0.0000
2003 - 2004	1.8205	0.0960
2004 - 2005	0.4813	0.6397

Source: Research Data,2012

The t – value calculated in the year 2005 – 2006 ie 0.5743 indicates that the effect in the market efficiency is not likely due to random chance, it

shows that there is likely an underlying, repeatable cause, which is automation. This is also supported by the corresponding p-value which is 0.5779 which is greater than the significance level ie 0.05 to imply statistical significance. Hence the null hypothesis is true. The null hypothesis stated that ; H_o=stock returns follow a random walk i.e. the market is weak form efficient. Consequently the alternative hypothesis H_A=stock returns do not follow a random walk was ignored. See the table below.

Table 2 t-value and p-value after automation

Year	t value		P value
2005 - 2006	0.5734		0.5779
2006 - 2007	1.4356		0.1789
2007 - 2008	9.7853		0.0000
2008 - 2009	2.0163		0.0689
2009 - 2010	-10.0345	0.0000	
2010 - 2011	6.7357		0.0000

Confidence level 95% Source: Research Data,2012

Test of normality (weak form efficiency) of the data using run rest

Run test tests whether the observations of turnover are serially independent, ie whether they occur in a random order, by counting how many runs there are above and below a threshold. By default, the median is used as the threshold.   A small number of runs indicate positive serial correlation; a large number of runs indicate negative serial correlation.

Run test performs a runs test on the sequence of observations in the vector x. This is a test of the null hypothesis that the yearly turnover values come in random order, against the alternative that they do not. The test is based on the number of runs of consecutive values above or below the mean of that year. Too few runs indicate a tendency for high and low values to cluster. Too many runs indicate a tendency for high and low values to alternate. The test returns the logical value h = 1 if it rejects the null hypothesis at the 5% significance level, and h = 0 if it cannot. Run test uses a test statistic which is approximately normally distributed when the null hypothesis is true. It is the difference between the number of runs and its mean, divided by its standard deviation. Stata I/C version 11 was used in the computations below.

From the table below most of the runs are small implying a positive serial correlation. Also the p values in all the years shows values above the confidence interval 95% that was used; implying statistical insignificance hence the alternative hypothesis (H_A) that the stock exchange follow a random distribution is true.   This statistics together with the measures discussed above ie kurtosis and skewness supports that the data used in this study was normally distributed.

Table 3 showing P-value, N(runs) and Z-score results

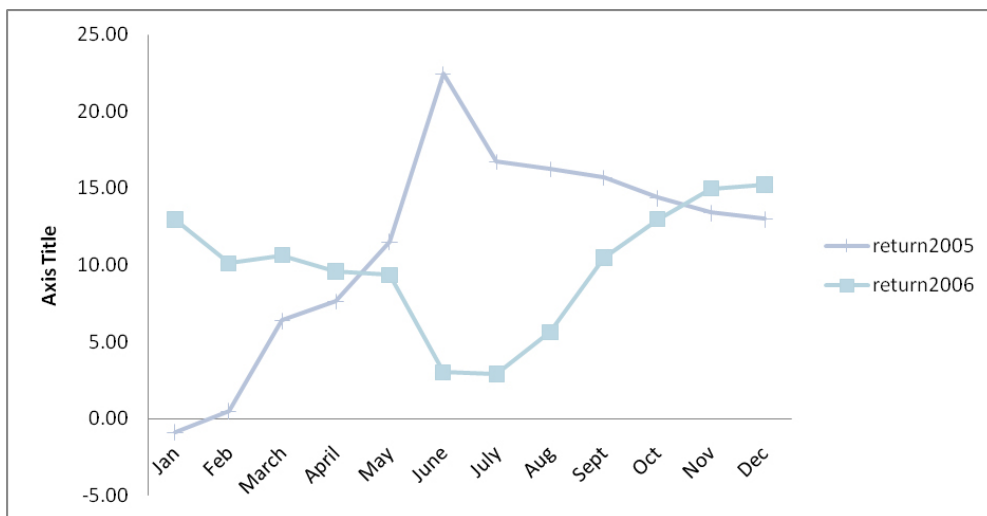| Year	P- value	N(runs)	Z -score
2000	0.54	5	-1.21
2001	0.07	6	-0.61
2002	0.00	2	-3.03
2003	0.07	4	-1.82
2004	0.54	8	0.61
2005	0.07	4	-1.82
2006	0.23	5	-1.21
2007	0.07	4	-1.82
2008	0.07	4	-1.82
2009	0.02	3	-2.42
2010	0.23	5	-1.21
2011	0.07	4	-1.82
2012	0.13	5	-1.53

Source: Research data, 2012

Figure 1: The effect/ trend of automation of market efficiency

The trends above shows that 2005 during the transition period from manual to electronic, the turn over was still high using the manual due to adaptation issues and later when the computerization became stable the market efficiency picked up and this can be seen by the upwards trend as from June 2006 onwards; consequently the market efficiency for 2005 could be seen to dropping during the same period. This shows the impact of automation on the market efficiency.

A paired t test was conducted to determine the effect of automation on the market efficiency between the different years of the NSE. Basically the t- test value is a statistic that indicates the size of an effect, from the standpoint of a bell curve (a probability distribution). The further away from zero (0), the more likely that the effect is "statistically significant" (another

way of saying that the effect is not likely due to random chance – there is likely an underlying repeatable cause). P values interpreted assisted to establish whether there was a significant difference between the period when manual operation was used and that period when automation was implemented.

Market efficiency experienced an increase stock in the years when the automation was introduced. In 2005-2006, P values of 0.5779. this showed that the difference was not statistical in significance, implying that the null hypothesis was true, ie "that stock returns follow a random walk i.e. the market is weak form efficient" and the alternative hypothesis was ignored ie "that stock returns do not follow a random walk".

After automations also the t – statistics showed produced a p value of 0.5743, this indicated that the effect in the market efficiency is not likely due to random chance, it shows that there is likely an underlying, repeatable cause, which is automation. This is also supported by the corresponding p-value which is 0.5779 which is greater than the significance level ie 0.05 to imply statistical significance. Hence the null hypothesis is true. The null hypothesis stated that; H_o=stock returns follow a random walk i.e. the market is weak form efficient. Consecutively the alternative hypothesis H_A=stock returns do not follow a random walk was ignored.

From the above discussion it's found that automation has positive effects on market microstructure-related characteristics of volume and volatility. Kibuthu G.W. (2005*) showed that automated exchanges can be deeper and more liquid than open outcry exchanges. Dickinson and Muragu, (1994), noted an increase in liquidity and an improvement in efficiency, but volatility increased following the automation of the Singapore stock exchange. Derrabi (1998) studied the effect of automation on the Morrocan exchange, which uses both call and continuous markets. A permanent stock-price increase was observed for securities transferred, but volatility and efficiency improved only for securities transferred to the call-based trading system. In contrast, some authors find that automated trading can have a negative effect on liquidity when transactions are based on human interactions. Bodie et al. (2002) suggest that automation decreases liquidity because for important transactions traders cannot negotiate directly and so have no control on trading conditions.

Conclusion

To determine automation effect on the market efficiency a T-test conducted showed that the stock returns follow a random walk, that's the market is weak form efficiency. A research should be conducted by using questionnaire directed to the market dealer in order to get first hand information.

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