**MARKET MICROSTRUCTURE AND STOCK MARKET EFFICIENCY IN NAIROBI SECURITIES EXCHANGE,**

**KENYA**

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  *Nairobi Security Exchange has undergone a revitalisation process to enhance efficiency. However, the exchange efficiency has been an issue with stakeholders. This paper uses event study methodology to examine the effect of adoption of Central Depository and Settlement System, Automated Trading System, installation of Automated Market Surveillance System and Brokers Back Office System on the market Semi Strong form of efficiency within the Efficient Market Hypothesis framework. Nairobi Security Exchange (NSE) 20-Share indices data collected from 2002 to 2012 was used. Results indicate that adoption of Automated Trading System had significant effect on market efficiency at Nairobi Securities Exchange. The results suggest that the Exchange and the regulator, Capital Market Authority should be proactive in curbing market malpractices rather than being reactive.*

1. **Introduction**

The global economy has greatly transformed in the 20th century due to technological advancements. Accordingly, there has been ease with which financial assets are transferred between economies, especially from developed to developing countries (Alagidede,2011). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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This is evidenced by the high capital inflows from developed economies to emerging markets, primarily in the form of Foreign Direct Investments (FDIs) and equity investment.

For example, the increase in capital flows from less than $10 billion in 1990 to $40 billion in 2013, were partly fuelled by growth in the equity financing of publicly listed securities in emerging markets (World Bank, 2015).Too, the vibrant and efficient security markets have influenced performance of the capital (stock) markets in realising their roles of diversifying risks, pricing and allocation of capital (Mensah, Adom & Pooma-Berko, 2010). To this end governments have shifted their attention to private sector financing by revitalising their security markets. Globalisation and rapid technological advancement and the need to ensure efficiency, have contributed to gradual shifts from manual systems to automated systems in many African security markets (Alagidede, 2011). According to Latif, Ashard, Fatima and Farooq (2011), the gradual shifts, level of technology adopted and the characteristics of the listed firms may explain timings and the differing levels of information efficiency. For example, Morocco Stock Exchange, Singapore Stock Exchange, Nairobi Stock Exchange automated their trading system in 1998, 1992 and 2006 respectively.

1.1 **Nairobi Securities Exchange**

Since its establishment in 1954, Nairobi Securities Exchange (NSE) has undergone revitalisation process to strengthen the market infrastructure with a view of enhancing operational and information efficiency. In 1991, the Exchange adopted the open outcry floor trading system in favour of call auction coffeehouse forum trading system. In 2004, Central Depository and Settlement System (CDS) was adopted with a view of minimizing the delivery and settlement risks and speed up securities distribution (Kariuki & Onyuma, 2012). In 2006, NSE adopted the Automated Trading System (ATS) which enabled doubling of trading period to six hours from three hours and reduction of settlement period (NSE, 2012).

In 2011, the Exchange installed Broker Back Office (BBO) system, coupled and interfaced with the ATS and CDS (NSE, 2011) but it was not until 2012 when the system was launched. The system not only automates order collection but also enables tracking of changes through an audit trail functionality and receiving of customers’ orders by stock brokers through an online system. To maintain an orderly, fair and efficient market and hence protect investor interests, Capital Market Authority (CMA) implemented a robust surveillance system known as Automated Market Surveillance System (AMSS) in 2012. The system was to curb fraudulent practices witnessed between 2007 and 2009 at the NSE (Onyuma, 2012). The surveillance is interfaced with NSE, CMA and Central Depository and Settlement Corporation (CDSC) such that all parties can monitor transactions online simultaneously.

1. **Literature Review**

 Harris (2007) describes market microstructure as a discipline that studies how securities prices are determined under different market mechanisms. Though from the economic theory point of view, price of a security is determined by supply and demand forces, no single price can be attributed to a security due to divergent views of the market players, non-accessibility of full information and that investor’s act under different constraints. Hautcoeur and Riva (2011) point out that security exchanges act as organizations processing information by receiving informational inputs, processing the informational inputs by matching the convergent interests and finally producing informational outputs in form of prices. Madhavan (2000) justifies that agents’ behaviours are sensitive to the information structure shaped by market organization.Harris (2007), posits that informed traders trade solely on fundamental values of a security that depend on available information to the trader and hence the importance of a reliable clearing and settlement system. The argument is that traders would not actively trade, if their trades are not settled immediately after they negotiate them. The recognition that trading in security markets is not similar to investing or other professional engagement, makes market microstructure more of a concern to the participants because markets are neither perfectly efficient, either informationally or operationally, nor are they liquid.

Theoretically, an informationally efficient market has large number of rational and informed investors who are profit oriented and actively engaged in predicting future market values of securities in an environment where information is available to all at no cost (Fama, 1970). This theory may not hold true for NSE, an emerging market that is characterised by few listed firms (61as at December 2012) and few securities traded in the Exchange. Too, the infrastructure in NSE has not been adequate to allow active participation in the market. This paper focuses on the level of NSE information efficiency with adoption of CDS, ATS, AMSS System and BBO System.

On the basis of available information set, Fama (1970) categorized the Efficient Market Hypothesis (EMH) into the three levels, namely weak form level, semi strong form level and the strong form level. An investor in a weak form efficient market cannot earn abnormal returns using historical prices or return information. According to the semi strong form efficiency, no trader is able to earn abnormal returns using any publicly available information, while strong form efficiency implies that no trader is able to earn abnormal returns based on any type of information, whether past, present or private. Obere (2009) posits that in an efficient market, prices follow a random walk model; hence, no single person can earn abnormal return because the information is easily accessible to all.

Empirical studies on stock market efficiency invoking market microstructure in emerging markets have produced contradicting results. For example, Naidu and Rozeff (1994) find Singapore Stock Exchange efficient on adoption of electronic trading system, Freund, Larrain and Pagano (1997) do not find material effect on the weak form efficiency of the Toronto Stock Exchange on introduction of the Automated Trading System, while Mikailu and Sanda (2007) find Nigerian stock Exchange being efficient in the weak form. Sioud (2003) finds no improvement in efficiency on automation of Tunis Stock Exchange, Chauhan and Argawal (2010) report enhanced informativeness of stock quotes following automation of trading in Indian Stock Market, Mensah, Adam and Pooma-Berko (2010) report weak form inefficieny on automation of Ghana stock exchange (GSE). Kakiya *et al*., (2013), Obere (2009) among others have attempted to examine NSE level of efficiency without regard to market microstructure reforms.

Comparative studies on the performance of African Stock Markets conducted by CMA in 2003 and 2008 singled out Kenya’s Security Exchange having a run for her money due to longer settlement cycles, restrictions on foreign participation, non-automation of securities traded in the market, unavailability of derivative market and lack of diversified nature of trading mechanisms.The few studies based on NSE microstructure have even produced mixed findings. Omuchesi, Bosire and Muiru (2014) on examination of NSE, following adoption of ATS, find no statistical effect on the market efficiency, while Kariuki and Onyuma (2012) find improvement in the market efficiency. Asewe, Mule, and Ndichu (2013) equate improved performance in NSE to enhanced market efficiency following the shift from manual to automated trading system. However, the effects of specific market microstructure variables within the study periods were overlooked by the scholars.

According to Agathee (2008), stock markets defy rationality of agents and efficiency market theory. Anomalies in stock markets do exist where asset returns tend to display predictable seasonality at certain days of the week, week of the month, month of the year among others. This systematic pattern permits trading strategies to earn excess profits and hence contradict EMH and the claimed accuracy of the asset pricing model. This paper focuses on Day of the Week effect and Turn of the Month effect due to the dates of market microstructure events announcements; CDS was adopted on 24th November, 2004, ATS was adopted on 11th September 2006, while AMSS was installed on 27th June 2012 and BBO System installation on 5th September 2012.

1. **The Methodology and Model**

In order to test our hypotheses; adoption and implementation of CDS, ATS, AMSS and BBO Systems have no statistical significant effect on stock market efficiency in Nairobi Securities Exchange, Kenya; we applied the event study methodology, using the daily NSE 20 share indices. We followed the outline given by Mackinlay(1997) of defining the event of interest, determining the event window, determining the method of measuring normal returns, defining the estimation window and choosing benchmarks to calculate price responses. In this respect, we identified the four events of interest and used constant mean return model in determining normal returns in an estimation period of one hundred and twenty days. The use of the constant mean return model was necessitated by the data available and the need to avoid data problems associated with thin trading in NSE. Event window of a period of 41 days, comprising of 20 trading days before the event, the event date and 20 trading days after the event was considered. Abnormal returns were tested for their significance using both parametric (t-tests) and non-parametric tests (Wilcoxon Signed Rank Test).

 We have used constant mean return model; , , where  is period-t return of market is the constant term and is the disturbance term, also expressed as=, to determine normal returns of the market. Actual returns during the event windows are calculated as, where Pt is the closing index at day t and the Pt-1 the index of the previous day. Though the concern in event studies is the post event Abnormal Returns (Actual returns less Normal returns), we present descriptive statistics and test the significance of both the Pre and Post Abnormal Returns.

 To examine existence of calendar anomalies we used the (Ordinary Least Squares) OLS model (no intercept model) for Day of the Week stated as;

 Rit = α1 D1t + α2 D2t + α3 D3t + α4 D4t + α5 D5t + εt , Where, Dit =1, for each of the trading days, otherwise zero(0), while α1- α5, the coefficients of the model. For Turn of the Month(TOM) Effect, we used OLS regression model; Rti= αt + β ∙DTOMi + εt, where, Rti is the NSE index return on day t, α1…α t are mean return of NSE non-Turn of the Month(NTOM) days, βi is the difference between the average NSE returns during the TOM days and the NTOM days and DTOMi is a dummy variable which takes the value 1 if it is TOM day, and 0 otherwise,

**3.1 Diagnostic Tests**

Two diagnostic tests, namely normality and stationarity tests were conducted to determine, one, the type of tests (parametric or non parametric) for testing the significance of abnormal returns and two, to determine whether the market exhibits random walk behaviour (weak form efficiency) before testing the semi strong level efficiency (Mugenda & Mugenda, 2003).Jarque-Bera (JB) and Shapiro-Wilk (SW) tests were conducted to determine whether the returns follow a normal distribution;

, 

Where, *S* denotes sample skewness, *K*, sample kurtosis, *N*,sample size ,is the *i*th-smallest number in the sample and****, is the sample mean using the following hypothesis of data series being normally distributed against alternative hypothesis of data series are not normally distributed at 5% significance level. Stationarity was tested using Augmented Dickey–Fuller (ADF) test at 5% significance level, the null hypothesis being presence unit root/ time series is non stationary against null of time series is stationary.

## The Findings

The results are presented thematically starting with the diagnostic tests, descriptive statistics showing distribution of the Abnormal returns (AR) and tests of AR significance and calendar anomalies results.

**4.1 Diagnostic Tests**

## Normality tests (JB& SW) conducted on NSE return data of 644 observations which comprised of event estimation periods and event windows are presented in Table 4.1

## Table 4.1: Normality Tests Results

|  |  |
| --- | --- |
| Events  |  Jarque-Bera Shapiro Wilk Statistic p-value Statistic. df. p-value |
| CDS  |  17.238 0.000 0.681 161 0.0122  10.427 0.005 0.787 161 0.0224 0.212 0.899 0.896 161 0.0966 0.145 0.930 0.831 161 0.0900 |
| ATSAMSSBBO |
|  |

Null hypothesis of normal distribution of market returns is rejected by both tests except for AMSS and BBO as shown by *p*-values. We nevertheless conducted both parametric and non parametric tests in the study as advocated by Lo (2004) who recommends use of both types of tests to corroborate the results of each type.. Augmented Dickey–Fuller (ADF) test used to determine whether the mean and variance of time series are constant show the following results,

**Table 4.2: ADF Unit Root Tests Results**

|  |  |
| --- | --- |
| Model  |  ADF Test Statistics: CDS ATS AMSS BBO  |
| Constant  |  -7.376854 -5.692351 -8.712233 -8.553835  -7.38048 -5.733307 -8.711436 -8.679265  |
| Constant and trend  |
|  |  |  |  |

 The ADF test fails to reject the null hypothesis of existence of unit root in both constant and constant and trend models since the test statistics are more negative than the critical value. Critical values for Model with constant for CDS, ATS, AMSS and BBO are -3.4725(1%),-2.8797(5%) and -2.5763 (10%) respectively while similar values for the model with constant and trend are -4.0182(1%), -3.4387(5%) and -3.1434(10%) for CDS, ATS, AMSS and BBO respectively.

**4.3 Abnormal Returns**

Abnormal return /excess of the actual return over the normal return (AR) are presented in Table 4.3

**Table 4.3.Descriptive statistics for Abnormal returns with CDS, ATS, AMSS and BBO System**

|  |  |  |  |
| --- | --- | --- | --- |
| Events | Mean Std Dev  | S S K  |  JB Prob |
|  |  |  |  |
| Pre-CDSPost-CDSPre-ATSPost-ATS  Pre-AMSSPost-AMSSPre-BBOPost-BBO |  0.0001 0.0058 0.-0.0008 0.1060 0.0008 0.0034 0.0026 0.0099 0.0003 0.00410.0005 0.0053-0.0008 0.0044 0.0005 0.0085 |  - 0.0609 1.8393  -0 0.1060 1.8131-0.7157 2.4033-0.8070 3.3479-0.2002 1.9376 0.8585 4.0706 -0.0111 4.48361.9586 7.8738 |  1.13501 0.5669 1.2114 0.05462.0044 0.36712.2716 0.32121.0742 0.58443.4121 0.18161.834685 0.399632.57911 0.0000 |
|  |  |  |  |

Where,S denotes skewness,K, kurtosis,JB, Jarque Bera and Prob, Probability

Whereas, the results indicate high scores in the mean of AR with the exception of CDS, risk (dispersion) increased for all the events implying returns were more risky after adoption/ installation of the events. Abnormal returns associated with CDS, AMSS and BBO System became positively skewed, indicating a probability of experiencing increases than decreases in the market returns relatively after adoption/ installation of events. The return for BBO was highly peaked than normal after the system installation, as confirmed by JB test for normality that had P-value less than 0.05.

**4.4 Tests of Significance Results**

The abnormal returns were tested for their significance using Student t-test and Wilcoxon signed Rank Test. The results are presented in the following Tables.

**Table 4.4: T-tests results for significance of Pre and Post Events Abnormal Returns.**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable |  t-statistic | P-value |  95% Conf. Interval  Lower Upper  |
| Pre-CDS Post- CDS |  0.078 -0.608 | 0.09390.0550 | -0.0026 0.0028-0.0035 0.0019 |
| Pre- ATSPost- ATSPre- AMSSPost- AMSSPre- BBOPost- BBO | 1.0981.188 0.380 0.462-0.820 0.269 | 0.0286 0.02490.07080.06490.0423 0.0791 | -0.0076 0.0024-0.0020 0.0073-0.0016 0.0022-0.0019 0.0030-0.0028 0.0012-0.0035 0.0045 |

Based on the hypothesis results presented in Table 4.4, we fail to reject the no significant effect of CDS, AMSS and BBO on NSE efficiency. The tests conducted at 5% significance level present higher *p*-values for CDS, AMSS and BBO with an exception of ATS.

**Table 4.5: Wilcoxon Signed Rank tests for significance of Pre and Post events Abnormal Returns.**

|  |  |  |
| --- | --- | --- |
| Variable |  N Mean Rank Sum of ranks  | Test statistic |
| Post- CDS -Pre-CDS | Negative ranks 12 9.92 119 Positive ranks 8 11.38 91  | Z= -0.523p-value 0.0601 |
| Post- ATS-Pre- ATS | Negative ranks 8 8.88 71 Positive ranks 12 11.58 131  | Z= -1.269p-value 0.0204 |
| Post- AMSS-Pre- AMSS | Negative ranks 10 11.3 113 Positive ranks 10 9 97  | Z= -0.299p-value 0.0765 |
| Post- BBO-Pre- BBO | Negative ranks 11 9 99 Positive ranks 9 12.33 111  | Z= -0.224p-value 0.0823 |

Based on Table 4.5, we fail to reject the null hypothesis of no significant effect on NSE efficiency with adoption of CDS, AMSS and BBO System.

**4.4 Calendar Anomalies**

Day of the Week effect and Turn of the Month Effect results are presented in the following Tables

**Table 4.6: Regression Results of the Day of the Week Effect**

|  |  |  |  |
| --- | --- | --- | --- |
| Measures/Days | Std coefficient  |  t-Statistics | Sig(P-value) |
| Monday | 0.393 |  2.382 | 0.024 |
| Tuesday | 0.540 |  3.573 | 0.001 |
| Wednesday | 0.006 |  0.031 | 0.928 |
| Thursday | 0.193 |  1.112 | 0.305 |
| Friday | 0.105 |  0.586 | 0.562 |
|  |  |  |  |

On the basis p-values, there is Monday and Tuesday effect in NSE. Obere (2009) and Makhoha (2012) reported Tuesday and Wednesday, while Onyuma (2009) reported higher returns on Mondays and lower returns on Fridays. Existence of the day of the week is a common phenomenon even in developed markets, and thus, market inefficiency cannot possibly explain this phenomenon well in NSE. Higher returns posted on Mondays compared with Friday’s confirm the hypothesis that investors view end of the week with pessimism. The relatively large size of Monday returns can be seen as the cumulative effect of Saturday and Sunday; the non-trading days in NSE.

### Table 4.7: Regression Results for Turn –of-the-Month Effect

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coefficient  | Standard error | Test statistic |
| Constant  | 0.0002 | 0.0008 | 0.0333 |
| TOM | 0.0415 | 0.0415 | 0.0195 |

The positive coefficient during the TOM days as shown by Table 4.7 implies that the TOM is higher than during the NTOM days. The test statistic shows that it is statistically significant at 5% significance level. The average daily return during the TOM days is 0.0307 % higher than during the non-TOM days

## Summary and Conclusions

This paper examines whether NSE exhibits semi strong form level of efficiency with adoption and implementation of CDS, ATS, AMSS and BBO System. Numerous studies conducted on the effects of automation have examined the effect of automation on market characteristics such as volume, liquidity and volatility. Examination of calendar anomalies; day of the week and turn of the month effect were infused in this study due to the timings of the adoption and installation of the events.

The findings of this paper indicate that NSE is efficient in the semi strong form of EMH on adoption of ATS. However, efficiency is refuted with adoption of CDS, installation of AMSS and BBO. This shows that efficiency of stock markets is a work in progress and thus the market players must continue taking actions that will keep on enhancing efficiency of the market. The existence of the Day of the Week effect and Turn of the Month effect raises concerns about the efficiency of NSE market. This study found significant Tuesday effect and Turn of Month effect. Although the specific day of the week may differ from other markets, it is a common phenomenon in developed and emerging markets and therefore, we still conclude calendar anomalies do not that NSE is efficient in the semi strong level of EMH

The findings presented in this paper have several policy implications; the regulator, CMA and NSE has several policy challenges that need to be confronted to enhance the efficiency of NSE, which include, increasing membership of the NSE, strengthening regulatory capacities to enhance market discipline and restore investor confidence. This will involve taking proactive measures such as enhancing their surveillance, analytical and investigative mechanisms to curb malpractices by stock brokers and investment banks. The NSE should enhance investor’s education through a mechanism that allows for timely release of relevant information that will ensure that all investors have equal access to reliable information. A case in point was the gradual shifts to CDS system that many Kenyan investors were not aware of. In order to adequately address these challenges, financial resources to CMA, the regulator should be increased.

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