Strathmore UNIVERSITY

STOCK RETURNS AND TRADING VOLUMES: THE CASE OF THE NAIROBI SECURITIES EXCHANGE

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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This Research Project has been submitted for examination with my approval as the Supervisor.

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Abstract

This study examines the causal and contemporaneous relationship between stock returns and trading volumes at the Nairobi Securities Exchange. The study makes use of panel data from 44 NSE-listed stocks over the period running from July 2009 to February 2014. Analysis of data is done by use of the Granger and Sims test for causality as well as estimating a contemporaneous relationship equation. The findings indicate an unambiguous causal relationship between stock returns and trading volumes, running from the former to the latter. It is also found that trading volumes do not make the market move. These results, therefore, imply that incorporating trading volume information in investment or stock purchase and sales decisions adds little value to investors' portfolios.

Contents

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List of Abbreviations

NSE= Nairobi Securities Exchange

CMA= Capital Markets Authority

SAI= Sequential Arrival of Information

REAP= Rational Expectations Asset Pricing

DO= Differences of Opinion

GARCH= Generalised Autoregressive Conditional Heteroscedasticity

EGARCH= Exponential GARCH

MDH= Mixture of Distributions Hypothesis

NSE-20= NSE 20 Share Index

ADF= Augmented Dickey-Fuller

VAR= Vector Autoregressive

VECM= Vector Error Correction Model

Chapter One

Background

Trading volume has been defined in a number of different ways. Karpoff (1987) defines it simply as the number of transactions between buyers and sellers who are randomly paired in the trading period. In contrast, Hui-Ching (2014) defines daily volume as the market turnover for the relevant market, in his case the real estate market. His doing so is consistent with Lo and Wang (2000), who suggest that, when focussing on the relation between volume and the equilibrium model of asset markets, turnover has the sharpest empirical implications and is the most natural measure. This research uses the latter definition of trading volume. Karpoff (1987) further identifies four reasons why the price-volume relation is important: it offers insights into the structure of financial markets; it is important for event studies that use a combination of price and volume data from which to draw inferences; it is critical to the debate over the empirical distribution of speculative prices; and it has significant implications for research into futures markets. It has also been shown that stock return and trading volume are jointly determined by the same market dynamics and are inextricably linked in theory (Blume, Easley, & O'Hara, 1994).

Despite this, it has been noted that most models of financial markets ignore the attention given by market participants to trading volume by assuming away the heterogeneity among the said participants (Jeffrey H. Brown, 2009).

Stock returns have been defined in absolute and relative terms by Hui-Ching (2014). Volatility has also been defined by the same.

Clark (1973) and Epps & Epps (1976) developed the mixture of distributions hypothesis (MDH) which allows either simultaneous or gradual information dissemination. This hypothesis implies that stock volatility is positively related to trading volume because of its dependence on the rate of information arrival.

The sequential arrival of information (SAI) model has been put forward as an alternative explanation of the volume/return relation (Copeland, 1976; Jennings & Barry, 1981; Jennings, Starks & Fellingham 1983). This model suggests a positive contemporaneous relation between volume and the absolute value of a price change as well as a positive bidirectional causal relationship.

The rational expectations asset pricing model referred to by Karpoff (1987) and Chen, Firth & Rui (2001) is based on the information asymmetry argument. It implies that there is always a positive correlation between trading volume and absolute price change and that the correlation increases as the information asymmetry increases.

The difference of opinion model (Harris & Raviv, 1993) states that market participants have different opinions as a result of different interpretations of public information. They find that when the cumulative impact of past information switches from favourable to unfavourable, or vice versa, the trading volume increases, which causes absolute price changes and volume to be correlated.

Increasing globalisation has led to interest in how various capital markets interact with each other and consequently a number of studies have been done in the area. For instance, Hui-Ching (2014) investigated the contemporaneous and causal relationships between stock returns, trading volume and volatility in Asian listed real estate companies in a domestic context and between different national markets in seven Asian economies. Arshanapalli and Doukas (1993) found that the US market has extensive impact on the three major European stock markets after 1987. One study (DeFusco, Geppert, & Tsetsekos, 1996) examined the diversification benefits of emerging markets and found these markets to be independent of other countries and that diversification among these countries could be effective. Lee & Rui (2002) found that the US financial market has strong predictive power for UK and Japanese financial market variables.

This research attempts to examine the relationship between trading volume and stock returns at the Nairobi Securities Exchange (NSE) in order to see whether such relations as those found in the developed markets such as the United States and emerging markets such as those in Latin America also hold in a frontier market such as Kenya. It aims to establish whether the incorporation of volume information adds any predictive value to financial market models as applied to the NSE.

Problem statement

Stock trading volumes are keenly followed by portfolio managers in making investment decisions. There exists considerable literature on the same and on its relationship with stock returns and volatilities. These are such as the work done on the mixture of distributions hypothesis by Clark (1973) and Epps & Epps (1976), the differences of opinion model developed by Harris & Raviv (1993) and the sequential arrival of information model developed by Copeland (1976). Sana Hsieh Hui-Ching (2014) was able to investigate these relationships in the case of Asian listed real estate companies. However, most literature that exists on this area focuses on capital markets in the developed world. For instance, Lee & Rui (2002) demonstrate that returns Granger cause trading volume in the US and Japanese markets, but not in the UK. Kamath (2007) finds that there is bidirectional feedback between the two on the Istanbul Stock Exchange and. Saatclioglu & Starks (1998) also carry out a similar examination of six Latin American countries. Such literature is sorely lacking in emerging and more so frontier markets such as Kenya. This research hopes to plug into this gap to examine the existence of the relationship between trading volume and stock returns, the extent of any such relationship, and the predictive value of the relationship to future prices and trading volumes of stocks listed at the Nairobi bourse.

Research objectives

The objectives of this research are as follows:

- To investigate the causal effect of trading volume on stock returns of securities listed at the NSE and vice versa as well as the magnitude of any such effect
- To investigate whether, if at all, the relationship between stock returns and trading volumes is of a lead-lag nature or contemporaneous

Research questions

The questions this research aims to answer are as follows:

- Is there a causal relationship between trading volume and stock returns of NSE listed stocks?
- What predictive value does trading volume have on stock returns at the NSE and vice versa?

Significance of the study

This study will help investors in the NSE by establishing whether and to what extent stock trading volumes contribute to information on stock returns. It may thus help them with the development of trading strategies and stock picking, which investors would benefit from. It will also shed some light on how trading volumes and stock returns interact in frontier markets such as Kenya as most similar studies have focussed on major, well-developed financial markets such as the United States as well as European ones such as the United Kingdom and Switzerland. In doing so, it may contribute to the literature on portfolio theory especially as regards frontier markets which tend to have significant institutional differences with developed markets (Gunduz Lokman, 2005). This study will also provide insights to the NSE and the Capital Markets Authority (CMA) on how they can further deepen the Kenyan public equities market as depth is a desirable characteristic of financial markets.

Chapter Two

Literature Review

Extensive research has been carried out on the relationship between trading volume and stock returns and volatilities. This section of the paper gives a discussion of literature dealing with the topics related to the subject of study. There is a discussion of trading volume in general, various theories that explain its relationship with stock returns and volatilities, theoretical studies that explicitly investigate the dynamic relation between trading volume and stock returns and empirical evidence of the same from developed and emerging markets, both within specific countries' capital markets as well as across countries. There is then an outline of the research gap followed by a conceptual framework.

Theories on the trading volume/return relationship

The sequential arrival of information (SAI) model was developed and extended by studies by Copeland (1976), Morse (1980), Jennings, Starks and Fellingham (1981) and Jennings and Barry (1983). Their version of the model entails new information being disseminated sequentially to traders. According to the model, traders who are not yet informed cannot infer the presence of informed trading. Consequently, the sequential arrival of new information to the market generates both trading volume and price movements, both of which increase during periods characterized by numerous information shocks.

Karpoff (1986) developed a theory of trading volume based on the assumption that market agents frequently revise their demand prices and randomly encounter trading partners. He found that there are two distinct ways in which informational events affect trading volume: investor disagreements lead to increased trading volume; and volume is lower in the costly market, and volume increases caused by an informational event persist after the event period.

Karpoff (1986) developed a binomial market process for trading. His model provides an explanation of positive exchange volume in a pure exchange market even in the absence of exchange shocks; as long as at least one individual has idiosyncratic demand price adjustments, the expected number of changes is positive. Trivially, he found that the expected exchange volume increases proportionally with the number of outstanding units of the asset. Karpoff (1986) further found that expected trading volume is a decreasing function of the bid-ask spread. He also offered insights into heterogeneous reactions to public information and asymmetric reactions by buyers and sellers.

Copeland and Copeland (1998) investigated the lead and lag structure of market returns in several capital markets in the world. Using Dow Jones and Company global industry indexes based on close-to-close daily rates of return by region, they analysed all classes of traded stocks divided into 3 regions (the Americas, Europe and the Pacific), 29 countries and 121 industry groups. They found strong contemporaneous relationships among regional exchanges that are open at the same time and that the United States has statistically significant one-day leads over markets in Europe and Asia, no significant lead extends beyond one day, changes in foreign exchange rates contribute to the links among markets, and that industries designated 'global' are significantly more sensitive to leads than are 'local' industries.

Epps (1975) studied the relation between security price changes and transaction volumes. He showed that a theoretical framework can be constructed from a fairly broad set of portfolio selection models and that the resulting theory implied a relationship between volume and price change on individual transactions. Epps' theory specifically implies that the ratio of volume to price change for upticks exceeds the absolute value of this ratio for downticks. The model developed predicts with some accuracy the behaviour of security price changes and transaction volumes.

Clark (1973) and Epps & Epps (1976) contribute to the mixture-of-distributions hypothesis. Clark (1973) assumes the daily price change is the sum of a random number of within-day price changes. Thus the variation in the daily price change is a random variable with a mean proportional to the mean number of daily transactions. It is argued that trading volume is positively related to the number of within-day transactions, therefore the trading volume is related positively to the variability of the price change. Epps & Epps (1976) examine the mechanics of intra-day trading. The change in the market price on each within-day transaction is the average of the changes in all of the traders' reservation prices. They assume that there is a positive relation between the extent to which traders disagree when they revise their reservation prices and the absolute value of the changes in the market price, that is, traders disagreeing more can indicate a larger absolute price change. Thus the price variability/trading volume relation arises because the volume is positively related to the extent to which traders disagree when they revise their reservation prices. According to Epps & Epps (1976), speculative trading stems from disagreements among traders over the relation between the announcement and the ultimate performance of the asset in question. Disagreements can arise either because speculators have different private information, or because they interpret public data differently.

A third model on the trading volume/stock return relation is the rational expectations asset pricing (REAP) model. REAP models show disagreement generated by private information and generally involve trading among privately informed traders, uninformed traders, and liquidity or noise traders. An equilibrium model of stock trading is developed by Wang (1994) in which investors are heterogeneous in their information and private investment opportunities, and trade rationally for both informational and non-informational reasons. In the model, trading is always accompanied by price changes, owing to investor risk aversion. The model postulates that trading volume is always positively correlated with absolute price changes and the correlation increases with information asymmetry.

The final theory is the differences of opinion model by Harris & Raviv (1993). They assume that traders receive common information and start with common prior beliefs about the returns to a particular asset. However, traders differ in the way in which they interpret the information, and each trader believes absolutely in the validity of his interpretation; this is the difference of opinion assumption. As information about the asset becomes available, each trader uses his own model of the relation between the news and the asset's returns to update his beliefs about returns. Harris & Raviv (1993) further assume that there are two types of risk-neutral, speculative traders who they term responsive and unresponsive. The two types agree on whether a given piece of information is favourable or unfavourable, but they disagree on the extent to which the information is important. When they receive favourable (unfavourable) information, speculators in the responsive group greatly increase (decrease) their probability expectations of high returns. Speculators in the unresponsive group do not. Therefore, when the cumulative impact of the past information is favourable, the responsive speculators value the asset more highly and will own all of it. But when the cumulative impact of the past information is unfavourable, the unresponsive speculators value the asset more highly and will own all of it. Trading will occur when, and only when, cumulative information switches from favourable to unfavourable, or vice versa. Thus, the Harris & Raviv model predicts that absolute price changes and trading volume are positively correlated. Their other main results are that absolute changes in the mean forecast of the final payoff and volume are positively related; if speculators overestimate (underestimate) the true quality of the signal, then consecutive price changes exhibit negative (positive) serial correlation; volume is positively autocorrelated; and volume is larger than usual on average at the opening of the market after any period in which it is closed (for instance, overnight, weekends, and holidays).

Causal relationship between trading volume and stock price changes

Campbell, Grossman & Wang (1994) develop a model in which one implication is that price changes accompanied by high volume will tend to be reversed, and that this reversal will be less true of price changes on days with low volumes. Blume, Easley & O'Hara (1994) develop a model in which traders can learn valuable information about a security by observing both past price and past volume information. In their model, volume provides data on the quality or precision of information about past price movements. The conclusion is that traders who include volume measures in their technical analysis perform better in the market than those who do not.

Wang (1994) analyses dynamic relations between volumes and returns based on a model with information asymmetry, showing that volume may provide information about expected future returns. He and Wang (1995) develop a rational expectations model of stock trading in which investors have different information concerning the underlying value of the stock. They examine the way in which trading volume relates to the information flow in the market and how investors' trading reveals their private information.

Chordia and Swaminathan (2000) examine the interaction between trading volume and the predictability of short-term stock returns and conclude that "trading volume plays a significant role in the dissemination of market-wide information." They find that daily returns of stocks with low trading volume lag those of high volume stocks and attribute this to the tendency of the latter to respond promptly to market-wide information.

Empirical studies

Sana Hsieh Hui-Chang (2014) investigated the contemporaneous and causal relationship between trading volume, stock returns and volatilities in the listed real estate markets in seven Asian countries. He uses the Granger (1969) causality test to examine the dynamic relationship between trading volume and stock returns and volatilities and the GARCH model to examine their contemporaneous relationship. The empirical results of these tests offered valuable insights into these relationships. One finding was that assets' liquidity characteristics are important for portfolio rebalancing. There will be greater trading volume if there is a greater probability that investors will be able to change the composition of their portfolios efficiently. Additionally, if there is no new information on stocks, there will be low trading volume and correspondingly, stable prices. If there is new information, both trading volume and prices increase sharply. Therefore, trading volume is seen as a proxy for information flow.

Sana Hsieh Hui-Chang (2014) found that there exists a positive contemporaneous relationship between trading volume and returns in all seven markets studied. These results were consistent with previous studies. They imply that bull markets are associated with rising volumes and bear markets with falling volumes. Furthermore, the findings support the sequential arrival of information and the mixture-of-distributions hypothesis models. With regard to the Granger-causal relationship between trading volume and stock returns, a positive contemporaneous correlation between volume and returns was found. Despite this, current trading volume was found not to improve the explanation of future returns. This was consistent with Clark's (1973) model. The current value of returns was found to be helpful in predicting the future value of trading volume, a finding which supports those in the literature on developed countries, which claim that returns Granger-cause volume and, to a much lesser extent, volume Granger-causes stock returns. Hui-Chang's (2014) findings confirmed the difficulty of improving the forecasting of returns by adding public information about trading volume when analysing Asian listed real estate companies. He concluded that there exists a positive contemporaneous absolute return-volume relationship, implying that trading volume brings about stock market movements. These findings are explained by both the sequential arrival of information model and the mixture-of-distributions hypothesis. Further findings were that countries that are geographically close to each other will have similar financial co-movements and that major economies have extensive influence over smaller markets.

Chen et al (2001) examined the dynamic relation between stock returns, trading volume and volatility in and across nine national markets over the period 1973-2000. They used the Granger causality test to investigate the causal relationships between trading volumes and stock returns and volatilities and the exponential GARCH (EGARCH) model to test for contemporaneous relationships. They found that for some countries, returns cause volumes and, to a lesser extent, volumes cause returns and that there was persistence in volatility even after incorporating contemporaneous and lagged volume effects. Chen et al (2001) concluded that more can be learnt about the stock market by studying the joint dynamics of stock prices and trading volume than by focusing only on the univariate dynamics of stock prices. Their results were dynamic across all nine major stock markets, implying that there were similar returns, trading volume and volatility patterns across those markets.

Gunduz & Hatemi-J (2005) examined the causal relationship between stock price and trading volume in five emerging markets in Eastern Europe; Czech Republic, Hungary, Poland, Russia and Turkey. Their found their research to have important implications regarding market efficiency and the effects of different market characteristics on the stock price/volume relation. They sought to determine if the price/volume relation exhibits different characteristics in those markets vis-à-vis a developed market such as the United States and to do so in emerging markets for several reasons. Firstly, such markets have a low correlation with developed markets implying that they constitute a separate data source that is likely to reduce any data snooping biases. They also have significant institutional differences with developed markets. According to Saatcioglu & Starks (1998), information flows that are conjectured to have important implications on the stock price/volume relation are different in emerging markets. Gunduz & Hatemi-J (2005) used the Granger causality tests based on the Toda-Yamamoto (1995) procedure to carry out their research as this procedure provides the possibility to conduct tests for causality in the Granger sense between integrated variables by using asymptotic distributions. Prior to these tests, the time series properties of the data were carefully investigated, giving special attention to the optimal lag order in each case. They concluded that there is no causal relationship between stock prices and volume or market turnover in the Czech stock market while they found bidirectional causality in Hungary irrespective of the volume figure used. They found the causal nexus in Poland to be bidirectional as well as unidirectional from market turnover to stock prices without any feedback. In Russia and Turkey, they found stock prices to cause both volume and turnover without any feedback. Gunduz and Hatemi-J attributed the national differences they found to market size and to the existence of restrictive trading regulations, noting that the effect of various market characteristics on the behaviour of the price/volume relation is hard to identify.

Similar studies have been carried out on such markets as the Istanbul Stock Exchange (Kamath, 2007) and the American market, for example, Hiemstra & Jones (1994) do so using the Dow Jones Indistrial Average. Mustafa & Nishat (2010) investigated the relationship between risk, return and trading volume in the Karachi Stock Exchange. Lee & Rui (1999) also investigated the domestic and cross country relationship between stock returns and trading volume in New York, Tokyo and London.

Research Gap

A previous study conducted in Kenya failed to capture the dynamics of more frequent data and the use of a longer time frame. The study also focused on a smaller sample thus being less representative of the Nairobi bourse. This research looks to contribute to this field by using daily data on stock returns at the NSE as well as trading volumes for a period of almost five years.

Most of the literature regarding the relationship between stock returns and trading volumes has focused on developed and emerging markets. Little or no literature exists explaining the situation in African stock markets, particularly in Kenya. The studies that have been conducted have also lacked the comprehensiveness required to draw reasonable conclusions.

Conceptual Framework

The question of causality between stock returns and trading volumes is a rather unexplored one in frontier markets such as Kenya. From a theoretical perspective, causality may go in both directions. Trading volume may act as a proxy for market information relating to stock returns thus feeding into those returns. On the other hand, stock returns may cause trading volumes by, for instance, triggering stock sales when target prices are achieved or when stop loss prices are reached in the market. The five theories outlined in this section seek to address this relationship. For instance, the differences of opinion model by Harris and Raviv (1993) maintains that investors' different reactions to public information about stocks spurs an increase in trading volume.

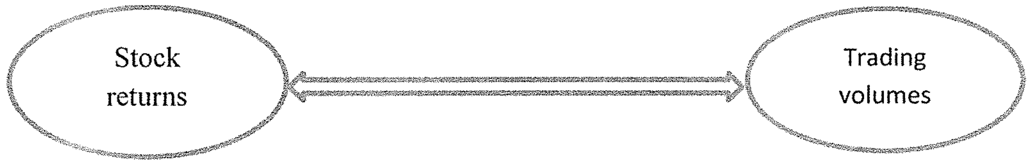

Figure 1 Causality Between Stock Prices and Trading Volumes

Chapter Three

Methodology

Research design

Chapters 1 and 2 provide clear evidence that extensive research has been carried out on the stock price/volume relation. Parahoo (2006) notes that in any research, the design selected should be suited to achieve a solution the proposed research questions. This research will use a causal research design because the direct relationship between the two variables under study is unknown. This research utilizes quantitative methods.

Population

The population of interest comprises all stocks listed at the Nairobi Securities Exchange (NSE).

Sample and sampling design

This research employs a purposive sampling technique. The daily price and volume data of stocks included within the NSE 20 Share Index (NSE-20) will be used since this index serves as a good proxy for the entire market as the companies included within it represent the largest market capitalisation at the bourse, in addition to being periodically reviewed to ensure it mirrors the performance of the stock exchange (Olweny & Kimani, 2011). The index is also advantageous in that it is based on an equally-weighted geometric mean of the stock prices of listed companies.

Data collection

This research relies exclusively on secondary data for its purposes. The data series comprises of stock prices and trading volumes (defined as turnover) of NSE-20 companies. These are obtained from the NSE database since it provides a comprehensive spreadsheet of the same.

Data processing

The data on daily stock prices and turnover will be relied upon. Daily data is analysed as this is the most popular frequency used in the literature (Chen et al., 2001; Gunduz & Hatemi-J, 2005; Sana Hsieh Hui-Chang, 2014; Kamath, 2007).

The data will be analysed as follows. The return and absolute return for each company in the NSE-20 Index is calculated as follows:

$$R_t = ln\left(\frac{MV_t}{MV_{t-1}}\right) = \ln(MV_t) - \ln(MV_{t-1})$$

$$AR_t = |R_t| = |\ln(MV_t) - \ln(MV_{t-1})|$$

Where:

R_t and AR_t are the daily return and daily absolute return on the index at time t.

MV_t is the overall market value of the listed companies in the NSE 20-share index.

Daily volume for the index is calculated as the market turnover for the index, defined as follows:

$$V_t = \frac{Value\ of\ shares\ traded}{Shares\ market\ cap} = \frac{\sum VO_{it} \times P_{it}}{\sum MV_{it}}$$

Where:

V_t is the daily market turnover of companies included in the index at time t

VO_{it} is the trading volume of stock i at time t

MV_{it} is the market value of stock i at time t

Optimal Lag Length Selection

It is necessary to define the lag length of the model. Lag length selection may be done according to the Akaike or Schwarz information criteria. Two common approaches in selecting the lag-length are cross-equation restrictions and information criteria. Verbeek (2012) suggests the use of Akaike's information criterion (AIC) or the Schwarz's Bayesian Information Criterion (BIC) when deciding the appropriate lag length. Information criteria include two factors: a term that is a function of the residual sum of squares (RSS) and a penalty term which is the loss of degrees of freedom from adding extra parameters (Brooks, 2008). Thus adding a new variable or an additional lag to the model will have the effect on the information criterion where the RSS will fall but the value of the penalty term will increase. Therefore, the object is to choose the number of lags that minimizes the value of the information criteria. The model with the lowest AIC or BIC will be preferred.

Akaike Information criterion

$$AIC = \log \frac{1}{N} \sum_{i=1}^{N} e_i^2 + \frac{2k}{N}$$

Schwarz Bayesian Information Criterion

$$BIC = \log \frac{1}{N} \sum_{i=1}^{N} e_i^2 + \frac{K}{N} \log N$$

BIC favours a more parsimonious model since it gives a bigger penalty than AIC does. BIC is strongly consistent but AIC is generally more efficient (Brooks, 2008). Moreover, the BIC will be consistent to show the model in the data set. This research applies both these information criteria and compares the results in order to arrive at the appropriate number of lags.

Test for Stationarity

A check for the stationarity of the time series data of daily stock returns and trading volumes is carried out using a unit root test. This is because the variables are desired to be stationary as non-stationary data may result in spurious regressions. A time series Y_t is said to be stationary if the distribution of the variable does not depend on time, that is the mean and variance of the time series are time-invariant (Verbeek, 2012).

Stationarity may be tested in several different ways. Two such methods are the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. This research uses the ADF which is mostly used to test for unit roots and complement it with Phillips & Perron (1988) to ensure robustness of the results obtained.

The basic DF test was employed to investigate the presence of unit roots in first-order autoregressive models. Considering an AR(1) process:

$$y_t = \rho y_{t-1} + \varepsilon_t$$

For ease of computation and interpretation, the process is transformed to the following expression where $y = \rho - 1$

$$\Delta y_t = \gamma y_{t-1} + \varepsilon_t$$

Testing for stationarity implies testing for the null hypothesis that the time series is non-stationary, against the alternative hypothesis. That is:

$$H_0: \gamma = 0 \text{ and } H_1: \gamma < 0$$

Since the Dickey Fuller test is restricted to including only one lag, the ADF test was introduced to test for stationarity in models with more complex dynamics. The hypotheses for stationarity is the same as for the original DF test. The extended test equation is expressed as follows:

$$\Delta y_t = \beta + \gamma y_{t-1} + \sum_{i}^{n} a_i \, \Delta y_{t-1} + \varepsilon_t$$

If unit roots are found, a test for integration is carried out to check for a common stochastic trend (Johansen, 1988). In each case, the null hypothesis is that the variables have no cointegration at the 5% level of significance. If the variables have unit roots at their log levels, there is a need to take the first difference of the log level of the variable to induce stationarity.

Test for Cointegration

After establishing stationarity, a Johansen cointegration test for the variables with a unit root is done to check for the existence of any common stochastic trend. The Johansen test enables the testing of a hypothesis about one or more coefficients in the cointegrating relationship.

The Johansen and Juselius framework applied allows for the testing of more than one cointegrating vectors in the data by estimating the maximum likelihood estimates on these vectors. Two test statistics, trace statistic (λ_{trace}) and max-eigenvale (λ_{max}), are used to determine the number of cointegrating vectors (Brooks, 2008). The two test statistics are expressed as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1 - \hat{\lambda}_i)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

where r is the number of cointegrating vectors under the null hypothesis, g is the number of variables and are the ordered eigenvalues. For each value of r, for the given orders: (r=0, 1, 2, 3...g-1), the test statistic is compared to the critical value to determine the number of cointegrating vectors. If the test statistic is greater than the critical value, then the null hypothesis of r=0 cointegrating vector is rejected in favour of the alternative hypothesis and one check the critical value for r=1. If the test statistic is lower than the critical value, however, the null hypothesis of no cointegrating vectors is not rejected. For the λ_{trace} test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r, against an unspecified or general alternative that there are more than r. For the λ_{max} test, the null hypothesis is that there is r cointegrating vectors, against the alternative of r+1.

Granger Causality

Granger (1969) and Sims (1972) formalized the application of causality in finance and economics. This research employs the Granger-Sims test for causality in determining the direction of causality, if any, between stock returns and trading volumes at the NSE. The idea behind the direction of causality is a straightforward one. If variable X unambiguously causes variable Y, then changes in X should explain changes in Y. Specifically, the two conditions outlined below should be met:

1) In a regression of Y against past values of Y, the addition of the past values of X should significantly increase the explanatory power of the regression.
2) In a regression of X against the past values of X, the addition of the past values of Y should not significantly increase the explanatory power of the regression.

Condition (1) ensures that X causes Y, while condition two ensures that Y does not explain X. Therefore, the direction of causality is unambiguously determined as X causing Y. Causality can also be bidirectional as opposed to being unambiguous.

The above idea is tested statistically by running four regressions:

$$Y = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{i=1}^{m} \beta_i \, X_{t-i} + \varepsilon_i$$

$$Y = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \varepsilon_i$$

$$X = \sum_{i=1}^{m} \gamma_i X_{t-i} + \sum_{i=1}^{m} \delta_i \ Y_{t-i} + \varepsilon_i$$

$$X = \sum_{i=1}^{m} \gamma_i X_{t-i} + \varepsilon_i$$

The outputs of these regressions are then subjected to F-tests to determine if adding variables increases the explanatory power of the regression. The hypotheses in both cases is that there is no causality, that is, "X does not cause Y" and "Y does not cause X".

One of the biggest limitations of the causality test is that there may be a third variable actually causing one of the variables in the model and contemporaneously correlated with the one deemed to be the Granger-causing one. Thus the Granger-Sims test should be applied with caution.

Test for Contemporaneous Relationship

Since stock returns and trading volumes are time series variables, it is desirable to know whether movements in returns precede movements in volume, movements in volume precede movements in returns or the two are contemporaneous (Hsieh, 2014). This research first estimates the relationship between the daily stock returns and the daily trading volume measure:

$$V_t = a_0 + a_1 R_t + u_t$$

In order to test whether the volume makes the market move, the contemporaneous relationship between the absolute value of the return and the trading volume is tested:

$$V_t = a_0 + a_1 AR_t + u_t$$

Chapter Four

Results

Introduction

Throughout the data analysis, stock returns have been converted into logarithms and trading volumes into fractions because relative changes are better to analyse owing to their reduced fluctuations. Acceptance or rejection of tests results is based on the 5% level of significance.

Stationarity

Unit root tests are supposed to evaluate the stationarity of the data provided for the tests. Stationarity is a critical test in econometrics. The two variables in this research were subjected to this test.

The stationarity test for stock returns is conducted below with the use of Augmented Dickey Fuller:

Null Hypothesis: RETURNS has a unit root

Exogenous: Constant

Lag Length: 39 (Automatic - based on AIC, maxlag=57)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-34.21611	0.0000
Test critical values:	1% level	-3.430311	
	5% level	-2.861407	
	10% level	-2.566740	

*MacKinnon (1996) one-sided p-values.

Table 8 Augmented Dickey Fuller Test on Stock Returns

The p-value for the test was 7.74*10^-39, therefore the null hypothesis for the presence of a unit root can be rejected at the 5% level of significance.

The complementing Pillips-Peron test results are shown below:

Null Hypothesis: RETURNS has a unit root
Exogenous: Constant
Bandwidth: 45 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-269.1546	0.0001
Test critical values:	1% level	-3.430307	
	5% level	-2.861405	
	10% level	-2.566738	

*MacKinnon (1996) one-sided p-values.

Table 9 Phillips-Peron Test on Stock Returns

Complementing the results with Phillips-Perron test which evaluates the stationarity based on a non-parametric approach provides robustness for the non-stationarity results of stock returns in Kenya. In this case, just like with ADF, the null hypothesis can be rejected at the 5% level of significance as the p-value of 0.0001 is much lower. As a result, a comprehensive conclusion can be drawn on the stationarity of stock returns in Kenya, implying that the data has a constant mean and variance.

The ADF test on trading volumes is presented below:

Null Hypothesis: VOLUME has a unit root
Exogenous: Constant
Lag Length: 15 (Automatic - based on AIC, maxlag=57)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-47.13217	0.0001
Test critical values:	1% level	-3.430307	
	5% level	-2.861405	
	10% level	-2.566738	

*MacKinnon (1996) one-sided p-values.

Table 10 Augmented Dickey Fuller Test on Trading Volumes

The null hypothesis that trading volumes are non-stationary is rejected at the 5% level of significance implying that there is no unit root problem with trading volumes.

The complementary Phillips-Perron test is shown below:

Null Hypothesis: VOLUME has a unit root
Exogenous: Constant
Bandwidth: 106 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-247.4016	0.0001
Test critical values:	1% level	-3.430307	
	5% level	-2.861405	
	10% level	-2.566738	

*MacKinnon (1996) one-sided p-values.
Table 11 Phillips-Perron Test on Trading Volumes

The null hypothesis of the presence of a unit root problem at the 5% significance level was rejected. It can therefore be concluded that trading volumes at the Nairobi Securities Exchange are stationary.

Cointegration

The Johansen test for cointegration is applied to establish whether there is a common stochastic trend among the variables. The null hypothesis is that the variables have no cointegration at the 5% level of significance. The results of the test are as shown below:

Sample (adjusted): 59 51831
Included observations: 49059 after adjustments
Trend assumption: Linear deterministic trend
Series: RETURNS VOLUME
Lags interval (in first differences): 1 to 57

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.015533	1377.799	15.49471	1.0000
At most 1 *	0.012352	609.7615	3.841466	0.0000

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.015533	768.0373	14.26460	0.0001
At most 1 *	0.012352	609.7615	3.841466	0.0000

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 12 Johansen test for Cointegration between Stock Returns and Trading Volumes

The implementation of the Johansen test leads to the finding that there exists cointegration between stock prices and trading volumes for NSE-listed stocks.

Granger-Sims causality

The main issue in this research is whether or not trading volumes can be used to improve forecasts of stock returns and vice versa. The Granger (1969) and Sims (1972) test for causality is applied to test for the existence and directionality of causality between stock returns and trading volumes. The variables used in the test are relative stock returns (R_t) and trading volume (V_t).

The optimal lag length m for the model is selected using information criteria (AIC and BIC). E-views performs the lag length selection tests automatically and shows an optimum result.

The results of the Granger-Sims test for causality are shown below:

Pairwise Granger Causality Tests
Date: 12/07/15 Time: 07:43
Sample: 1 51832
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
VOLUME does not Granger Cause RETURNS	51597	0.89106	0.4682
RETURNS does not Granger Cause VOLUME		2.43810	0.0448

Table 13 Granger-Sims Causality between Stock Returns and Trading Volumes

At the 5% significance level, the null hypothesis that volume does not cause stock returns is accepted, while the null hypothesis that returns do not cause volume is rejected owing to the higher (0.4682) and lower (0.0448) p-values respectively. The results of the test are that stock returns unambiguously cause trading volumes, that is, the direction of causality is from stock returns to trading volumes. This implies that stock returns cause trading volumes while trading volumes do not cause stock returns.

Contemporaneous Relationship

The results of the examination of the contemporaneous relationship between stock returns and trading volumes are shown below. Trading volumes are first regressed on relative stock returns before being regressed on absolute returns. The results of the regression on absolute returns are as follows:

Dependent Variable: VOLUME
Method: Least Squares
Date: 12/13/15 Time: 12:37
Sample (adjusted): 1 51831
Included observations: 51785 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ABSOLUTE_RETURNS	0.001539	0.001037	1.484053	0.1378
C	0.000530	3.28E-05	16.14339	0.0000

R-squared	0.000043	Mean dependent var	0.000550
Adjusted R-squared	0.000023	S.D. dependent var	0.006798
S.E. of regression	0.006798	Akaike info criterion	-7.144384
Sum squared resid	2.392927	Schwarz criterion	-7.144042
Log likelihood	184988.0	Hannan-Quinn criter.	-7.144277
F-statistic	2.202414	Durbin-Watson stat	1.888216
Prob(F-statistic)	0.137801		

Table 14 Test for Contemporaneous Relationship between Trading Volume and Stock Returns

At the 5% level of significance, we fail to reject the null hypothesis that volume makes the market move because the p-value (0.137801) is much higher than 0.05.

Chapter Five

Conclusion and Recommendations

Conclusion

The findings of this research show evidence of the existence of unambiguous causality from stock returns to trading volumes. The results show that stock returns cause trading volumes and trading volumes do not at all cause stock returns. This is partly consistent with studies carried out in other economies, especially emerging and developed ones, in which stock returns were found to cause trading volumes but trading volumes were also found to cause stock returns, although to a much lesser extent. Thus most studies find bi-directional causality as opposed to the unidirectional causality found in this study. The findings are also consistent with Clark's (1973) mixture of distributions hypothesis as well as the differences of opinion model (Harris & Raviv, 1993).

The research also finds that there exists no contemporaneous relationship between trading volumes and stock returns at the NSE. This is also contrary to previous studies such as Chen (2001) and Hsieh (2014) which established a contemporaneous relationship between the two variables. Similar relationships were found by Copeland & Copeland (1998). These results suggest that investors at the Nairobi bourse cannot know beforehand anything about stock return movement by relying on information on trading volumes.

Limitations

This research only focused on the causal and contemporaneous relationships between trading volumes and stock returns at the NSE as a whole. However, not the entire market was included in the study so reaching a definitive conclusion was a challenge.

Recommendations

Based on the findings of this study, it is apparent that portfolio managers and other investors at the NSE would not stand to gain much by incorporating trading volume information in their investment decision-making process. This is because trading volume neither Granger-causes stock returns nor makes the market move. Thus undertaking to consider trading volumes before making buy or sell decisions would likely be an exercise in futility and lead to greater portfolio management costs without the corresponding benefits. This is not to say trading volume information is completely starved of relevance as other researchers such as Clark (1973) have found it to act as a proxy for other information.

Areas for further research

This research focused on the causal and contemporaneous relationships between stock returns and trading volumes at the NSE as a whole. However, only 44 companies were included in the sample. Thus further research is needed in this area incorporating the market in its entirety so that more conclusive findings can be achieved.

The study does not account for the inter-sectoral relationship between the two variables at the NSE. For example, its results cannot be used to answer the question "Do the trading volumes of bank stocks move the stock returns of insurance stocks?" The cross-country relationship between the two variables has also not been paid attention to. This is a particularly rich area of research as both investors and academics would benefit from a more concretely defined relationship between trading volumes and stock returns in, say, the East African region or between Kenya and other markets such as Nigeria and Egypt. Yet another rich area of research is the relationship of trading volumes not only with stock returns both within and across countries and sectors but also with the volatility of those returns.

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