CONTAGION AND SPILLOVER EFFECT FROM UNITED STATES OF AMERICA STOCK MARKETS TO EAST AFRICAN SECURITIES MARKETS

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Declaration

This Thesis is my original work and has not been presented for a degree in any other University.

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Dedication

I dedicate this study to the following people who have meant and continue to mean so much to me. To my parents, Shadrack and Susan Kengere whose love for me knows no bounds. I also give special thanks to the two great knowledge philanthropist; Prof. Leonidas Sandoval and Prof. Sayed Hossain whom I benefited greatly from their rich knowledge, experience and generosity.
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Operational Definition of Terms

Bubble Burst: A sharp rise in price of an asset in a continuous process in a manner suggesting of further increases and attracts new investors, the rise is later followed by a reversal of expectations and a sharp decline in price resulting to a financial crisis.

Conditional Mean/volatility: A concept in the ARCH family model, meaning the period ahead estimate of mean or volatility (conditional on the past fundamental information).

Contagion: An incident in which there are significant immediate effects in a number of countries following an event in one market or group of markets caused by investors behaviour (The consequences are understood to be fast and furious and evolve over a matter of hours or days).

Credit Crisis: A type of a financial crisis in which lenders substantially reduce the volume of credit provided to a group of borrowers whose risk is fundamentally unchanged.

Developed Stock Market: A market rated high on development scorecard such as market size, market liquidity, market concentration, market volatility, institution development and international integration (Such as United States, Great Britain and Japan markets).

Leverage effect: Phenomena in which a negative shock to a stock market causes volatility to rise by more than a positive shock of the same magnitude. In equity returns, such phenomenon is attributed to leverage effects, whereby a fall in the value of a firm's stock causes the firm's debt to equity ratio to rise.

Market Shock: Event that triggers significant changes within an economy or to a financial system.

Volatility Spillovers: An influence of mature markets' volatility to volatility in other markets every time/normal period (Associated with fundamental linkages in Markets).
Abbreviation and Acronyms

BRVM- The Bourse Regionale De ValeursMobiliere
CDO- Collateralized Debt Obligation
CDS-Credit Default Swap
CLRM- Classical Linear Regression Model
DSE-Dar Salaam Stock Market
EA-East Africa
EASEA-East African Securities Exchange Association
EASRA-East Africa Securities Regulatory Authority
EGARCH-Exponential Generalized Autoregressive Conditional Heteroscedastic
EMS-Emerging Stock Markets
FED- Federal Reserve Bank.
FTSE-Financial Times and the London Stock Exchange
GARCH-Generalized Autoregressive Conditional Heteroscedastic
IFCI-International finance corporation Investable Index
IPO - Initial Public Offer
IT- Information Technology
JSE- Johannesburg Stock Exchange
MENA- Middle East and North Africa
MSCI- Morgan Stanley Capital International
NSE-Nairobi Securities Exchange
NSM-Nigeria stock market
NSX-Namibia Stock Market
OECD-Organization for Economic Cooperation and Development
PEV-Post Election Violence
S&P- Standard and Poor
REIT-Real Estate Investment Trust
USE-Uganda Securities Exchange
U.S./USA-United States of America
VAR-Vector Autoregressive
VECM-Vector Error Correction Model
WW II- Second World War
Abstract

The purpose of this study is to model volatility effects between the United States of America stock markets and volatility of the East African securities markets during the global financial downturn of 2007-2009. The period was divided into three sub-sample phases; pre-crisis:-January 2006 to December 2007; In-crisis:-January 2008 to March 2009; Post crisis:-March 2009 to December 2010. A modified Asymmetric Generalized Autoregressive Conditional Heteroscedastic (E-GARCH 4/1) model was used to model the volatility between the markets and was estimated by the Eviews package. The data comprised of the daily closing stock indices for the three East African markets: Kenya-Nairobi Securities Exchange 20 Share Index, Uganda-Uganda Securities Exchange Index and Tanzania-Tanzania Share Index and the United States Standard and Poor's 500 for the 2006-2010 sample periods, making up to 956 observations. It was found that the market volatility in East Africa experienced during the 2007 – 2009 period was influenced both by volatility spillover from the U.S. markets and internal or domestic influences especially for the Kenyan and the Ugandan markets. No observed volatility contagion to the East African markets during the pre-crisis and post-crisis phases were found however the study reveals that the Tanzania market experienced volatility contagion from the U.S. market after the main crisis phase. Also the leverage effect was detected in the Ugandan and Tanzania markets. The effect is more prevalent in the Ugandan market in all the three phases of the crisis, and pre-crisis phase for the Tanzania market but absent in the Kenyan market in all the phases. Explosive volatility was observed on the Kenyan and Ugandan market meaning that volatility takes a longer period to decay off in those markets. Moreover the study found out that the Kenyan Market has strong influence on the Uganda Securities exchange during volatile periods. The study recommends a diversified bilateral trading model for the countries that would offer a range of policy choices during global shocks; secondly, the East African countries should delay the process of lessening market restrictions to foreigners; Tanzania and Uganda to put in place mechanisms that may possibly encourage more of local firms to list in their respective exchanges to curb the undue influence from the Kenyan Market. Finally, policies should be in place to enhance more of foreign institutional investors rather than individual or foreign retail investors. Further study on interconnectedness of the East African Exchanges is advised to base on Cointegration and Granger causality models. Moreover, a study on impact of foreign market restrictions on market volatility should be undertaken so as to disclose whether market restrictions to foreign traders help to curb higher volatility during global market shocks.
1.1 Background to the Study

The world is exponentially moving to a more globalized and integrated market. Amid the wave of financial meltdowns, the academics and practitioners adherent to volatility modelling in financial markets are persistently developing theories, further utilizing different financial econometric models to help understand the intricacies surrounding the behaviour of the global stock markets in an event of a shock to the financial system.

The history of financial crises has raised concerns over the intensity and extents to which shocks emanating from one market are transmitted internationally. Considering the number of crises that have hit the global financial markets since the Second World War, the 2007/08 US credit crisis is viewed as the only crisis that meets the canons of being named a Global Financial Crisis, consequently marking the beginning of the Second Great Contraction whose effect was contagious across the global financial markets (Reinhart & Rogoff, 2011). Appendix 2 presents a snap shot of major financial crisis that have been recorded in history as summarized by (Kindleberger & Aliber, 2011).

United States financial markets are considered among the most advanced and globally integrated. The markets have experienced major financial shocks that have had an impact on other world stock markets. The market crash of October 1987 precipitated increased volatility for equity markets across the globe, into effect investors sold stocks in haste and in big volumes out of panic. The world major indices such as of Australia, Hong Kong, Singapore and New Zealand were mostly affected by the adverse effects (Ciro, 2013). Before the Subprime attack, analysts had foretold on the risks and vulnerability of the U.S.
financial system (Adams, Mathieson, & Schinasi, 1999), and cautioned on its ability to withstand the effects of sudden and sustained correction in equity markets such as one experienced in 1987.

In 2007, the U.S. markets were hit by the Subprime crisis that resulted in a stampede in the worldwide financial system. The returns and value of stocks held by Individual investors and companies in financial institutions declined as the whole financial system in the U.S. experienced a breakdown. Madura (2011) highlights at a glance the wave impact of the meltdown on financial elements, from mortgage lenders and home owners, investment banks, mortgage insurer's Hedge funds, Mutual funds and Pension funds and in extreme renowned companies such as Lehman Brothers, Washington Mutual and IndyMac Bancorp went bankrupt. Consequently the financial and the real sector were negatively influenced due to the counterparty relationships or financial trading.

The impact of the crisis on the analysed major world stock markets and sub-regions was evident as reported across the various studies; the New York S&P dipped 38.5% in one year and from a record high of 15,000, the Dow Jones Industrial Average dropped to 14,000. Similar happening was experienced in the UK, the FTSE 100 index recorded the poorest performance since its launch closing at 4,434.17, down 31.3% on the 2008 period, while the Japan's Nikkei 225 dropped by 42% during the same period (Bianco, 2008) and (Adair, Berry, Haran, Lloyd, & McGreal, 2009).

On the African segment, The World Bank (2010) Africa's market analysis report indicated that Africa's capital markets were affected by the global downturn in 2008-2009 as evidenced by the increased volatility in the markets. For example the market turnover on the Uganda Bourse dropped 60% during the third quarter of 2008, The Nairobi Stock
Exchange 20 share index fell 31% and the Johannesburg Stock Exchange all-share index declined 42% between May and October 2008.

The literature available on the contagion effect of the 2007/09 USA crisis and inter-linkages of Africa's stock markets within and without not only reveal deficiency in scope, but also incoherence in findings. The studies present findings mainly on the West (BRVM), North (MENA) and South African regional markets, however no conclusive study has focused on the East African securities markets to determine the extent of exposure and interlinkages within the region. The studies fail to distinguish the actual effect of internal and external shocks, moreover fail to advice whether the markets as block or individually are efficient to provide a good platform for global asset diversification during market shocks.

1.1.1 Volatility Contagion and Volatility Spillovers

Empirical studies on volatility of stock markets agree that market shocks resulting from unfavourable events such as financial meltdowns, political crises and even natural disasters significantly increase volatility in stock markets and the effect may transmit to the whole financial system and other economic sectors within a country. Furthermore, due to the inherent shock transmission channels, the same effect is propagated across borders, an effect termed as financial contagion (Chorafas, 2013).

The term financial contagion is coined from the field of epidemiology, a concept referring to an epidemic resulting from a contagious disease transmitted by either direct contact with the disease or indirect through a mechanism (Kolb, 2011). Similarly, contagion in financial markets refers to a phenomena in which a distress of one market or institution propagates to others in the financial system just like a contagious disease. Specifically, Forbes and Rigobon (2002) define contagion as any significant increase in market co-movement after a shock to one country or a group of markets.
Previously the financial contagion concept was understood to be explained only by fundamental or financial linkages such as bilateral (Vester, 2006). However during the Asian financial contagion of 1998 several stock markets across the Asian region that were not intrinsically linked by the early observed channels were impacted by the shocks. As a result new paradigms emerged explaining other possible channels of shock transmission between markets. Evidence indicated that channels such as portfolio flow of international investors could be the best explanation of the wider spread of shocks across markets. As a result of these developments a distinction is made between the theories that explain volatility effect caused by fundamental or financial linkages that is Spillovers/interdependence and volatility explained by behaviour of investors that is contagion (Vester, 2006). This study will use the classification by (Forbes and Rigobon 2001).

1.1.2 Overview of the East African Bourses

The East African region has three key bourses, Kenya - NSE, Uganda - USE and Tanzania - DSE. The Kenyan market has sixty six listed companies making it the leading in the region, Dar Salaam Stock Exchange comes second with nineteen listed companies and Uganda Securities Exchange has eighteen listed companies (USE, NSE, DSE website). About 40% of the companies listed in Uganda and Tanzania exchanges are Kenyan companies that have cross-listed to the respective exchanges. Considering the existing trade and financial linkages between these markets, it stands well to reason that there exists some interdependence between the markets in the region.

The total market capitalisation for East African markets is about $28.5 billion, Kenyan market constituting the largest percentage. followed by Tanzania and Uganda (The Exchange, July 2016). Following the global trends across the markets, such as integration and demutualization, the securities have followed suit. The Kenyan market was the second
to demutualize and self-list in Africa after Johannesburg exchange. According to TanzanianInvest (2016), Tanzania exchange is at its middle levels of demutualization while the Ugandan market is currently putting in place legal frameworks that would allow the implementation of the process.

Just like other sub-regions in Africa, the BRVM, MENA and South African block of exchanges that have established regional or integrated markets, the East African regional markets are in the process of having an integrated market platform in the region. East African Securities Regulatory Authorities (EASRA) was established in 1997 with the mandate of developing a common market for the East African Capital markets and to harmonize the legal and regulatory framework structure to realize shared trading systems, boost cross-border investments and enhance growth and development of the regional exchanges (CMA). In 2004 the East African Stock Exchange Association (EASEA) was formed to foster the integration agenda. The association is spearheading several initiatives, notably: streamlining regional IPOs to mitigate related challenges such as exchange rate risk, transaction cost and bank transfer charges while paying for shares during regional IPOs, EASEA is also pushing for recognition of East African Stock Broker unit (EASB) to ease the operations of stockbrokers across markets (ASEA).

1.1.3 The East African Securities and Exposure to the Global Effects

According to Renaissance Capital Kenya, the interest by foreign investors in Sub-Saharan Africa Equity markets is growing rapidly and more so in East Africa. The MSCI 2013 global index return ranking classified the Kenyan stock market as the best performing market in Africa and fourth best performing stock market in the world, with a 43.58 per cent return, coming after Bulgaria at 91.55%, UAE 79.02% and Argentina at 68.97%
Kenya’s position as Eastern Africa’s financial hub has attracted substantive international investors. The foreign investor activity in the Nairobi Securities Exchange (NSE) surpassed local participation to hit 61% of total turnover towards the end of 2009 ("Foreign investors alter stockbrokers’ fortunes", 2010), implying that the foreign investors (both institutional and individual) play a significant role at the NSE. The presence of international investors in domestic markets present an implication for the market expectations, the activities of foreign investors are considered to be more analytical of the investment environment, therefore their increased participation signifies a good outlook for the country, in the same way a decreased activity may signal unfavourable position (Griffith-Jones, Gottschalk, & Cailloux, 2009).

The foreign participation in capital markets can be attributed to country specific policy on level of foreign investment restriction. The IFCI ranking rates the African stock markets low in terms of foreign investment restriction. In the East African region the Ugandan Security Exchange is the freest, with no restriction on foreign ownership (USE). Contrary, Tanzanian government restricts levels of each stock’s foreign ownership to a total of 60% on its exchange with an aim of protecting and promoting the Tanzanians’ participation in the market (Hoover, 2014).

According to the Frontier Market Intelligence, the Kenyan market has no restrictions on the percentage of equity that foreign citizens may hold in a locally incorporated company; however foreign ownership of equity is delimited in some industries such as in insurance at 66.7%, telecommunications at 70% and companies listed on the Nairobi securities Exchange at 75%, though, in a move to achieve emerging markets status, both the CMA
and the treasury are fast-tracking the removal of the ownership cap and allow 100% foreign ownership of stakes in the market (Mwaniki, 2015).

This move will position the market for better integration with other global markets, similarly exposing it to global shocks. Market observers in the East African markets hold that, when the Kenyan exchange experience increased volatility, foreign investors in the market opt for Uganda and Tanzania Exchanges for better returns or diversifications (Odhiambo, 2011). According to the financial contagion theories, investors fleeing from crisis affected countries leads to herding behaviour which destabilizes markets and increases volatility across markets (pure contagion). On the other hand, under spillover theory bilateral trade and financial linkages such as one observed within the East Africa region and between the U.S. markets are viable channels for shock transmission across markets.

Also another dimension of volatility transmission across markets is illustrated using a third party trade perspective under volatility spillover theories. In this channel a crisis can be transmitted from one market to another even though the two countries are not linked directly through direct trade (Vester, 2006). For example it can be hypothesised that the observed increased volatility in Uganda and Tanzania was not necessarily a result of the linkages between them and the U.S. markets but was due to existing linkages with the Kenyan market. The tickle down effect as explained by Baker and Kiymaz (2013) illustrates that if a relatively high developed country in a region is affected by a crisis from another country, the same effect may be contagious to other markets closely linked to it (also referred to as two-stage contagion). The scenario sets a justifiable ground to look at the activities and behaviour of the three markets as a block to clearly understand the inter-linkages within and without the East African sub-region.
1.2 Statement of the Problem

Capital markets are barometers for economic performance and integration as they are key channels for capital flows and portfolio investment opportunities, both domestic and international. Amid the increasing stock market liberalization and integration both regional and global, investors have benefitted immensely from the presented diversification opportunities across the borders. On the flipside, a breakdown in the financial system has often resulted in panic, depleted investments further forcing investors to make delicate reinvestment decisions across borders, worse off; loss of confidence in the markets.

In the 2007/08 period, the world major stock markets experienced the worst volatility since the 1929 market crash; New York S&P 500 dipped 38.5% in one year and from a record high of 15,000, the Dow Jones Industrial Average dropped to 14,000. Similar happening was experienced in the UK, the FTSE 100 index recorded the poorest performance since its launch, closing at 4,434.17, down 31.3% on the 2008 period (Adair et al, 2009) and (Bianco, 2008). Over the same period, a similar trend was experienced in the African segment, a number of African stock markets experienced unusual increased volatility and drop of market activities. Representatively, the Nairobi Securities Exchange reported a drop in 20 share index by 31 percent. The Ugandan Bourse dropped 60 percent during the third quarter of 2008 and the Johannesburg Stock Exchange all-share index declined 42 percent between May and October 2008 (The World Bank, 2010).

The earlier studies that sought to explain the increased volatility and inter-linkages in the African regional markets examined the West African region, The Bourse Regionale De Valeurs Mobiliere (BRVM) (Aka, 2009); The Middle East and North African Stock markets (MENA) (Khallouli & Sandretto, 2012), South African and frontier exchanges (Mattes, 2012; Sandoval & Franca, 2012). The trend disconnects at the East African
regional markets and inter-linkages thereto. Even with studies analysing the Kenyan NSE as a standalone market in the region, their conclusions are unreliable as the analysis is based either only on economic variables or traditional theories. Also, statistical models employed such as the rudimentary GARCH, correlations and CLRM cannot capture the volatility dynamics in stock markets such as volatility clustering, leverage effect and other inherent features of financial time series data. Besides, the studies neglect the potential effect of internal shocks experienced during the same time.

Basing on the two stage contagion theory, third-party trade influences and existing linkages in the East African regional stock markets such as cross-market listings, bilateral trade, financial linkages and relative easiness for investors to trade in the region, it established a reasonable ground to analyse the markets as a block to determine actual influences from external markets such as U.S. Similarly, the influence originating within the region. Contrary to previous studies, this study analysed the region as a block and used the modified asymmetric EGARCH \((p,q)\) model suggested by Baur (2003) to test for spillovers and contagion effect to the E.A. stock markets and regional inter-linkages thereto, complementing studies on other African sub-regions.

The aim of the study therefore was to reveal whether the markets are exposed to external shocks from developed markets and the role of internal shocks, market linkages with developed markets and within the East African region. Further the role of the Kenyan market on the capital markets activities in the region.
There are statistically significant market internal effects to the volatility of East Africa market i

$H_{06}$: There is statistically significant effect of the Kenyan Market to volatility in other East African Markets; (Where $i = 1, 2, 3$; 1 – Kenya, 2-Tanzania and 3 – Uganda)

1.5 Significance of the Study

The study benefits both domestic and foreign investors targeting the African segment by providing information on vulnerability or resilience of the markets this will aid in making viable decisions on international portfolio diversification.

Provides a good resource to policy makers in the three East African markets to develop appropriate policies for managing the bourses during global shocks.

The study findings will aid the members of the East African Securities Regulatory Authority (EASRA), spearheading the formation of a common market for the sub-region in developing informed strategies for managing an integrated market.

In addition the study presents literature for methodological comparison and analysis on volatility modelling and besides form basis for further research.

1.6 Scope of the Study

In modelling volatility from the U.S Stock markets the study analysed three East African regional Stock markets; NSE, DSE and USE during the 2007/09 Global Financial Crisis period. It examined transmission mechanisms of shocks from the U.S markets to the East African markets. The study employed the E-GARCH model with modifications in line with Baur (2003) where the contagion effect is divided into two; volatility spillovers (interdependence) and volatility contagion. Moreover the moderating effect of specific market internal shocks and the influence of the Kenya to other markets was investigated.
1.7 Organization of the Study

This study is arranged as follows: the foregoing chapter one provides the research background, research objectives, significance of the study, scope, and the limitations of the study. Chapter two presents literature review about empirical work on contagion, types of crisis and contagion concepts. Chapter three illustrates the methodology employed in the study, Chapter four presents the findings and discussion of study objectives. Lastly, Chapter five sums up with summary, conclusions, recommendations and suggestions for further study.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction
This chapter discusses two sets of shock transmission mechanism that is Non-Crisis contingent and Crisis contingent theories further looks at the volatility dynamics commonly observed in financial markets during market shocks. Also it reviews the empirical work on volatility and its contagion effect between developed and emerging markets, developed and emerging markets versus the African Equities.

2.2 Theoretical Literature Review
This section looks at the theories explaining the behaviour and inter-linkages of markets during market shocks.

2.2.1 Financial Contagion Theories
The contagion theories seek to explain the channels for shock transmission from a single (or group of markets) to other markets. Discussion on contagion and its possible channels is neither exhaustive nor at consensus, conspicuously some channels have gotten superior attention under the theories that is, trade linkages, financial linkages and herding behaviour. Much as these channels get prevalent discussion, other channels include wake-up calls and political links.

The theories on transmission mechanism have been broadly classified into two categories by different scholars but with slight modifications. Forbes and Rigobon (2001), describes the first category as Non-Crisis contingent theories in which international propagation of shocks are caused by financial linkages, trade links, wake-up calls and common external factors, which Masson (1998) terms as monsoonal effect and interdependence factors. Under this theory, these channels remain unchanged or remain insignificantly different
during the crisis moment and stable periods. The scenario is also referred to as fundamental based contagion.

A second category, Crisis contingent theories, also labelled irrational behaviour by Jithendranathan (2013) is caused by non-economic variables such as herding, multiple equilibria and endogenous liquidity. Contrary to the non-contingent channels, these mechanisms are believed to change during the crisis and hence markets across borders experience increased linkages.

2.2.2 Non-Crisis Contingent Theories

Non-crisis contingent transmission channels argues that global shocks simultaneously affect the fundamentals of several economies (Velasco, 2001). Broadly this covers fundamentals such as financial links, trade links and common external factors. Under financial links, through globalisation of financial markets and services such as cross-border listing and global financial instruments, investors are able to make investments across borders. Hence, due to this interconnectedness a crisis in one country is propagated to other countries or markets. According to Moser (2003) this transmission is endorsed by investors seeking to rebalance their portfolios due to liquidity and capital constrains or as a risk management measure. Further Dornbusch, Park, and Classes (2000), adds that, the decrease in capital flows abroad and deterioration of stocks value results to high correlation of stock prices across markets.

Secondly, trade and investment framework agreements between countries such as bilateral trading are considered channels for shock transmission. A financial meltdown in one country will directly affect its trading partners in scenarios where there exists significant trading. For instance, if a currency of one country depreciates resulting to slow economic
activity, the trading partner will also suffer (Jithendranathan, 2013; Costinot, Roncalli, & Teiletche, 2000).

Likewise through common external factors unfavourable changes in the global variables such as on the U.S. interest and exchange rates, presents a common shock to emerging or developing economies. In such circumstances, the behaviour of financial markets across the globe tends to correlate in response to the unfavourable changes. Costinot et al., (2000) explains that the magnitude of the effect would largely be influenced by the extent of which these countries are largely exposed to foreign currency borrowing, inefficiency of their banking system and huge national debts.

The financial contagion theories suggest that, reality in the global financial transactions generally accepts the thinking that, whichever the micro-system that exist within a global financial system, there are interconnectedness within the global markets and therefore there is no such a scenario as ‘vacuumed system or economy’ per se.

Particularly on the East African region, financial linkages with developed stock markets such as of the USA, UK and the European regions exist. This is explained by the existing trade and financial linkages between these markets; foreign firms operating in the region, exposure to U.S. dollar fluctuations in the international transactions. These linkages according to the financial contagion theories form channels for shock transmission across markets.

### 2.2.3 Crisis Contingent Theories

The crisis contingent theories are divided into three main mechanisms; multiple equilibria, herding behaviour and endogenous liquidity. Under multiple equilibria, also known as self-fulfilling expectations, investors in the financial market depend on each other as a result of unfavourable event in one market. In keeping with (Kleimeier, Lehnert, and Verschoor
(2003); Costinot et al., (2000) the shift from a good to a bad equilibrium in one country and its propagation is driven by a change in investors’ expectations and not the change in actual fundamentals. Hence investors’ confidence in financial markets deteriorates globally during a crisis moment in one market or country leading to coordination of expectations and trading activities.

On herding behaviour, Wärneryd (2001) argues that in the presence of information asymmetry among investors (informed and uninformed investors) uninformed investors disregard their beliefs and mimic the trading pattern of the informed investors. Bochco and Sharma (2000) further dissect the herding concept into intentional herding (to refer to the one given by Wärneryd) and spurious herding. They point out that under spurious herding, investors unintentionally respond and act in a similar manner to information set (reaction as result of changes of underlying economic fundamentals) hence this does not account to a mimic.

Lastly, under endogenous liquidity channel, a crisis in a market or country may result to reduction of liquidity of the investors and in order to meet margin calls or remain relevant in the market, they sell assets held in other countries. Following this trend, uninformed traders may fail to distinguish whether the reaction of investors is as a result of liquidity shocks or is indeed a bad signal, and they overreact. Consequently increased correlation of stock prices is experienced in these countries (Calve, 1999; Valdés, 1997).

Over the last two decades, the developments in the East African Exchanges has opened up the equities to increased foreign participation. The developments have lessened exchange controls making it easier for international equity inflows to the markets. Participation of international investors increase liquidity and market volume of an exchange, on the flip side, the huge capital inflows may be countered by unprecedented outflows during market
shocks. This and other foreign investor’s activities may cause panic result to increased volatilities in the markets.

2.3 Volatility Dynamics
The section discuses phenomenal or hypotheses that describe commonly observed behaviour in return or volatility in stock markets when hit by shocks.

2.3.1 Asymmetric volatility in stock returns
Volatility in stock markets impose an asymmetric behaviour to negative and positive shocks to returns. This behaviour is broadly explained by two phenomena; leverage effect and volatility feedback effect. Leverage effect explains that falling stock prices raise debt to equity ratio leading to higher volatility of equity, consequently shareholders perceive their future cash flows as being relatively more risky (Brooks, 2014). Under volatility feedback effect, increase in volatility result in negative returns (Campbell & Hentschel, 1992). Such that expected returns rise when share price volatility increases and fall when volatility rises assuming constant dividends. This study examined the leverage effect in the East Africa’s stock markets to assess the extent to which both positive and negative shocks influence the volatilities of the markets.

2.3.2 Volatility persistence
According to Bentes (2014), volatility in stock markets take longer time to decay off, meaning that market does not respond immediately to information arriving into the financial system, but reacts to it gradually over time. Therefore shocks to volatility process tend to have long lasting effect making it easier to predict the markets, this is contrary to Efficient Market hypothesis suggested by Fama (1970). A number of studies has proved that most market exhibit volatility persistence during market shocks consequently exposing them to speculators (Andersen, Bollerslev, Diebold, & Labys, 2001; Choi & Richardson, 2016). The study tested the long memory of shocks in the East African Equities by
evaluating the extent to which older and most recent shocks predict future volatilities in the exchanges to determine their efficiency during volatile global periods.

2.4 Empirical Literature Review

As noted earlier, empirical studies on contagion has been carried out on a multidimensional manner by different researchers; while some test contagion on markets in relation to their geographical setting, others focus on market size classification such as developed, emerging, frontier, developing and undeveloped financial markets. This section discusses various literatures on past episodes of crisis with special emphasis on the crises that have occurred in the last two decades. The review of the empirical evidence explores the literature on contagion encompassing the three facets of crisis; credit frictions and market freezes, currency crisis and banking crisis. As well, different econometric models used to test contagion and market connectedness or interdependence, such as VAR, VECM, GARCH \((p,q)\), Copula and Network analysis approaches, shall be considered.

2.4.1 Contagion and Volatility Spillovers in Developed and Emerging Markets (EMs)

The 2007-2009 crisis contamination on financial markets has received considerable attention by researchers essentially due to its higher magnitude and peculiarity. Assessments of the impact of the crisis in emerging markets indicate greater inter-linkages and co-movements among stock markets. Guidi (2012) through Cointegration tests explored the links between the Indian Stock market and other three Asian developed stock markets, Hong Kong, Japan and Singapore during the Subprime, Dot-com and Russian incidences and found high correlation during these three episodes.

Kazi, Guesmi, and Kaabia (2011), on a relatively broader analysis, analysed sixteen OECD countries using Dynamic Conditional Correlation GARCH model Engle (2002) and
during these periods report inconsistent findings. On a fairly exceptional account, Bordo and Murshid (2000, 2002) in the two papers; using VAR, Cluster analysis and other techniques, contrasts the nature and strength of shock transmission in recent periods of crisis (1975-2001) and the previous eras (1880-1914).

The studies conclude that shock transmission in financial markets between developed countries and emerging countries today, is not significantly contagious as of the previous periods. The justification on the findings was centred on the gold standard previously adopted and therefore shocks were transmitted quickly through gold flows. Co-jointly, financial systems of developed countries then were inadequately advanced to guarantee stability. Whereas the findings of the studies and justification are plausible for the eras covered, at least two aspects present a paradox; in recent times financial inter-linkages has relatively increased as a result of financial liberalization and technology, precipitating multinational branching and international selling of financial securities.

As well, basing on non-fundamental channels, the latest market microstructure characteristic and other aspects are likely to foster market volatility during crisis moment. On this account both on recent fundamental and non-fundamental transmission mechanisms; the justification of higher correlation of financial markets in the earlier episodes in relation to recent cases is unfulfilled. Besides the conclusions by Bordo and Murshid (2000, 2002), other two different studies on the contagion report inquisitive findings, attributed mainly to the restrictive definition of the term contagion and statistical adjustments.

To start with, Forbes and Rigobon (2002) acknowledge high correlation of markets during the 1997 Asian, 1994 Mexican Crisis and 1987 US market crash crises, but they hold that high co-movement does not amount to contagion and thus they term the phenomena as
'Interdependence of markets'. Another study by Bekaert and Harvey (2003) using a two factor CAPM model, tested twenty two countries sampled from Latin America, Asia and Europe indicated no evidence of contagion during the Mexican devaluation. While on the Asian crisis, increases of correlation were experienced only in the Asian region.

Several other studies differ from the conclusions above. An event and regression analysis by Mathure et al., (2002) on the volatility spillover effect of the Mexican crisis to the Chilean stock markets revealed the significant contagion effect on the Chilean markets. Earlier study by Kaminsky and Reinhart (2000) using a cluster analysis on the Mexican, Asian and the Russian crises admits the existence of contagion and explains transmission channels, that is: trade links and increased financial inter-linkages through portfolio flows to emerging countries and cross-market hedges as the possible channels.

Kleimeier et al., (2003) approached the Asian contagion test from two phases (Thai Phase and Hong Kong phase) using correlation analysis, emphasizing on the use of synchronous as a substitute to synchronized data they found strong evidence of contagion from the Hong Kong Phase to other markets compared to Thai phase. Similar study by Chancharoenchai and Dibooglu, (2006) using the GARCH-M test on six emerging markets in Asia (Malaysia, Philippines, Indonesia, Korea, Taiwan and Hong Kong), indicated strong market interactions and a spillover effect from Thailand to the rest of the markets in the region. Other studies based on firm level data (Claessens, Kose, & Terrones, 2009; Moser, 2003; Fratzscher, 1998) report matching findings.

2.4.2 Volatility Spillovers and contagion in African Equity Markets

In the African equity markets, just as in the developed and emerging markets, empirical studies have been carried out basing on two dimensions; one aspect looks at contagion to markets according to their level of development such as developed, emerging, frontier and
developing stock markets and another side analyses the markets in relation to their geographical/regional setting such as (North, Western and southern African segments).

The grouping in financial markets has been verified by (Sandoval, 2012, 2013) using cluster/network and minimum spanning tree analysis and justified this phenomena on geographical, economic and cultural links. Considering the gap existing on the East African group of exchanges in the African regional studies, this study therefore takes a geographical/regional perspective in analysing the African markets and examines the three east African markets NSE, USE and TSE for interdependence and contagion effect.

Studies on volatility of African exchanges during the 2007-2008 Global Financial Crisis and inter-linkages thereto report incoherent findings. Nevertheless, a great part of the studies agree that the two largest markets, South Africa and Egypt (as ranked by the International finance corporation Investable Index (IFCI)) are more volatile during the moments of crisis. In a multi-regional investigation (Sandoval & Franca, 2012) using the eigenvalues and eigenvectors of correlations matrices analysis, analysed the 1987, 1998, 2001 and 2008 episodes of crises. In general, they noted that exchanges in the seventeen examined sub-regions are more correlated during these periods. In particular to Africa the study tested South Africa, Mauritius, Botswana, and Namibia from the Southern, Kenya on the East region and Morocco, Tunisia and Egypt from the North. On the Russian crisis with exception of South Africa, the rest of the countries’ indices had slightest participation to eigenvectors with Kenya and Morocco having negative values. Similar findings are reported during the Dot-com Bubble turmoil.

In addition, on the 2008 subprime crisis, South Africa, Mauritius and Namibia indicated relatively greater participation, with lower contribution from Kenya and Ghana. Conversely, Nigeria, Botswana showed negative contribution. Mattes (2012) study on five
markets; South Africa, Mauritius, Nigeria, Kenya and Egypt by BEKK-GARCH model considered among others, cross and own innovation volatility, shock persistence, and unconditional volatility of these markets covering the Asian, Brazilian, Russian, Dot Com Bubble and the credit crises.

Mattes (2012) study agree with Sandoval and Franker (2012) on at least three perspectives; that assessing the comparative effect of the crises, the 2008 crisis had a greater effect in overall, among the markets examined during the credit crisis, Nigeria’s volatility was the weakest and that the effect of Russian crisis on the African Markets was relatively weak. The studies differ on Nigeria’s findings during the Russian crisis and on a comparative measure between Mauritius and Kenya. While Mattes’ findings show high volatility for Nigeria among the five markets and Kenyans volatility higher than Mauritius, Sandoval & Franca’s findings diffract on these aspects.

Likewise the MENA region has been diagnosed for possible contagion. Using Markov-Switching EGARCH framework, Khallouli and Sandretto (2012) affirm mean and volatility contagion from the US stock markets to Egyptian market and only mean contagion on Morocco. On a standalone market, Gharsellaoui (2012) analysed the Tunisia stock market using correlation coefficients and implied that the market was independent from the contagion effect. The findings contradict with other studies such as Sandoval and Franca whose findings indicated some spillovers, indeed higher than on Egyptian market which surprisingly exhibited both mean and volatility contagion in Khallouli and Sandretto’s study.

On the western region Aka (2009) investigated mean and volatility contagion at aggregate and sectorial level at the BRVM regional market using a modified EGARCH model proposed by Baur (2003). The results revealed that the aggregate level exhibited mean and
volatility contagion while the sectorial level experienced mean and/or volatility contagion. Other two studies on Nigeria stock market as a standalone, Ezepue and Omar (2012) and Olowe (2009) echo these findings, specifically Ezepue and Omar sought to determine whether NSM is weak form efficient in light of financial reforms and financial crisis and found out that the market is not weak-form efficient.

Earlier study by Collins and Biekpe (2003) using correlation coefficients examined interdependence of African Equities and contagion from developing and emerging markets showed that from the seven analysed markets; Egypt, Kenya, Mauritius, Morocco, Nigeria, South Africa and Zimbabwe, markets within Africa are fairly isolated though some causal relationships exist between South Africa and Egypt. They validated this phenomenon by citing the activities of foreign investors in these two markets. Also, for strange reasons, links between South Africa and Zimbabwe were detected, with Zimbabwe influencing South Africa market.

Macharia (2013) employed the OLS model using inflation, capital flows, interest rates and foreign exchange variables to test the effect of the global financial crisis on commercial banks offering mortgage finance in Kenya. Qualitative and quantitative data on these variables were collected from 77 bank respondents using a questionnaire. Notwithstanding the weak data and approach used, the study concluded that the banks were affected by global shocks. Another study by Mibe (2010) examined the impact of the 2007/09 crisis on the behaviour of stock prices at the NSE. The study used trend analysis based on descriptive graphs and concluded that the market was affected by the global financial crisis.

According to Dougherty (2011), advanced financial econometric methods are reliable in modelling and understanding volatility in financial markets since they combine both theories plus statistical tools to predict or explain quantitative problems arising from
finance, therefore the above studies present weak findings on statistical scale. Therefore the studies failed to distinguish the actual effect of internal and external shocks over the same period, and consequently failed to advice whether the markets as block or individually are efficient to provide a good platform for global asset diversification during market shocks.

Studies that examined the east African stock markets as a block based on earlier events also fail to detail the market inter-linkages in the region. For instance Suva (2013) examined the comovement of the East African markets prior and after the signing of the Customs Union Treaty in 2004 using the researcher’s calculated Paasche’s monthly indices by the Granger and Engler (1987) method. The study did not provide reliable findings, consequently recommending a relook on the problem and other aspects. The ineffectiveness of the study was utterly affected by the methodology employed. For example remarkable financial econometric literature on financial time series data analysis techniques such as cointegration state the inappropriateness of using Granger and Engler (1987) to explain the behaviour of markets (Committee, 2003; Gonzalo & Economics, 1992; Poh, 1997) and (Kendall, Park, & Tan, 1997), instead advocating for the use of Johansen’s Test (1988). In addition high frequency data is best in analysing the stock market behaviour contrary to the low frequency data employed by (Suva, 2013).

The unusual increased volatility experienced in the East African regional markets during the 2007/09 period, presents a puzzle that requires comprehensive analysis using advanced models and approach. The prevailing circumstances during this period were multifaceted, the Kenyan market which records remarkable lead in the region as the advanced economy and a prime choice for foreign investors was hit by the worst political crisis which affected
even its economic organs and resulted to downgrading of its S&Ps and Fitch sovereign ratings (Ibpus.com & USA, 2012).

The earlier studies that looked at market inter-linkages singled out the Kenyan market from the East African block, and those that analyse it on a standalone analysis base the investigation and conclusions on market symptoms or only on economic variables. This approach is weak since it does not factor in the potential effect of domestic shocks. Even those which conclude that the market was affected fail to distinguish whether the influence was through economic or non-economic channels (Contagion or Spillover effect).

2.4.3 Summary of Knowledge Gap

Besides the above studies investigating the shock transmission to the African Regional Stock markets, the rest of the literature is narrative-based and scant. The studies on correlations, volatilities and integration of the African Equity Markets within and the rest of the world have majorly focused on the exchanges in the North and Southern Regions. The preference on the regions is always cited on their developed state relative to the rest of other African markets or regions (Mattes, 2012).

In as much as the whole of African markets are insufficiently researched, the EASEA exchanges as a whole are largely under-researched on these propositions, considering the literature on the same existing on exchanges of the western, southern and northern sub-regions of Africa, more remarkably vast outside the continent. The Kenyan NSE is the only exchange in the East African region that has received some attention though insignificant. The rational for biased approaches on the African studies is disputable, understanding that volatilities and interrelatedness even among smaller exchanges or sub-regions is vital for investors in various risk classes and at different preferential tastes who desire to adopt an investment or diversification strategy in favour of such markets. Moreover the native
market participants in respective regions can benefit largely as the process of cross-investing is somewhat less restrictive compared to actual foreigners who are majorly slowed down by inherent restrictions.

Considering the growing trend in volatility and correlation studies in the world stock markets and benefits thereto and amid integration processes and other developments across regions, it would be a great injustice to market participants and other beneficiaries if policy makers and practitioners or scholars ignored these trends or segregate other sub-regions in studies. This study therefore sought to carry out a study on some of these concerns in the EASEA exchanges in order to close down the existing wide gap of knowledge.
<table>
<thead>
<tr>
<th>AUTHORS</th>
<th>TITLE</th>
<th>METHODOLOGY</th>
<th>MARKETS</th>
<th>CRISIS/EVENT</th>
<th>FINDINGS</th>
<th>RESEARCH GAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akia (2009)</td>
<td>Subprime Crisis and Contagion Evidence from the BRM</td>
<td>IGARCH with [Basu, 2003]</td>
<td>HRVM</td>
<td>2007/08</td>
<td>Aggregate level exhibited both mean and volatility contagion and sectoral level either mean or volatility contagion</td>
<td>Focus was on West African region</td>
</tr>
<tr>
<td>Khalaf &amp; Sadekia (2012)</td>
<td>Testing for &quot;contagion&quot; of the subprime crisis on the Middle East and North African stock markets</td>
<td>Markov Switching IGARCH Framework</td>
<td>MENA</td>
<td>2007/08</td>
<td>Found mean and volatility contagion in Egyptian and mean contagion in Morocco</td>
<td>Study focused on the MENA segment only</td>
</tr>
<tr>
<td>Macharia (2013)</td>
<td>The effects of global financial crisis on the financial performance of commercial banks offering mortgage finance in Kenya</td>
<td>Ordinary Least Squares Method</td>
<td>Commercial Banks in Kenya</td>
<td>2007/08</td>
<td>The Banks were affected</td>
<td>Weak methodology; Did not test contagion; Study covered banks only and not exchanges; Findings unfulfilled</td>
</tr>
<tr>
<td>Sanda &amp; Frnza (2012)</td>
<td>Correlation of financial markets in times of crisis</td>
<td>Eigenvectors and Eigenvectors of Correlations Matrices</td>
<td>African Frontier Markets</td>
<td>1987, 1998, 2001 and 2008 episodes of crises</td>
<td>Markets affected at different levels with low effect on Kenyan market during the 2007/08 Crisis</td>
<td>Failed to look at internal shocks; EA markets not examined as a block; method not able to capture all aspects of volatility modelling</td>
</tr>
</tbody>
</table>

Table 2.1 Summary of Studies on African Equity Markets
2.5 Conceptual Framework

The framework below conceptualizes the effect of financial contagion from the U.S.A market to the East African Stock markets during financial crises. The variables are founded on the financial contagion theories under the EGARCH framework.

- **Independent Variables**
  - \( H_01 \) Spillovers
    - Financial Links
    - Trade Links
    - Common External Factors
  - \( H_02 \) Contagion
    - Endogenous Liquidity
    - Multiple Equilibria
    - Speculative attack

- **Moderating Variables**
  - Volatility Dynamics
    - \( H_{03} \) Volatility persistence
    - \( H_{04} \) Leverage Effect
  - \( H_{05} \) Internal Shocks
    - Political shocks
    - Financial shocks

- **Dependent Variables**
  - Market Volatility
    - 1. Kenya - NSE Index
    - 2. Uganda* - USE Index
    - 3. Tanzania* - DSE Index
  - \( H_{06} \) Kenyan Influence *
    - Shocks from Kenyan Market to USE and DSE

(Source: Researcher, 2016)

Figure 2.1: Conceptual Framework

The USA financial market is used as a proxy for developed markets and source of crisis. Spillovers refer to shocks that transmit from one market to the other during normal periods or any time as result of market fundamentals or linkages. Contagion is the significant immediate effect in a number of countries following an event in one market or group of markets resulting from the investor's activities. Volatility persistent explains the length
shocks take to decay off from the affected market, leverage effect accounts for the asymmetric effect (impact of either positive or negative shocks) to the markets’ volatility. The moderating effect result from country specific shocks/events experienced during the same period such as Post-Election Violence or market specific happenings and is explained by the ARCH q term on the EGARCH system. Moreover to capture the two stage contagion effects or regional inter-linkages, the Kenyan market was included in the Tanzania and Uganda model to explain the role of the Kenyan market as a developed market in the region’s stock markets.
CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research design used, the underlying philosophical assumption, elaborates on the empirical models and variables used. In addition, it explains the data analysis models and procedures.

3.2 Research Philosophy

Inspired by Crotty’s (1998), Creswell (2003) coined three guidelines to research thesis development; assessing the knowledge claims or philosophical assumptions taken by the study, considering the strategy of inquiry to be used and identification of certain methods of data collection and analysis. This study is inclined to the post-positivism school of thought (a reflection after positivism) (Trochim, 2006).

Post-positivism views that observations or measurements are imperfect, besides the study may be largely affected by the researcher’s contextual characteristics. Therefore there is need for considerable number of studies in an area of interest from which objective conclusions can be drawn. It is in the view of this study that few available literature on volatility modelling in the East African region in light of the global financial crisis is not only contradictory but ignored critical facts that if looked at could alter or give more meaning to conclusions we already have in the literature. This study compliments Mattes (2012) and Sandoval and Franker (2012) studies.
3.2.1 Research design

Khan (2011) explains research design as a scheme of those procedures employed by a researcher for testing relationships between variables; explains the framework of activities to be completed, scheme of integrating the variables under investigation and methodology used to conduct research analysis. There exist a number of classifications of research designs by different authors. This study used causal design suggested by (Bajpai, 2013). Causal or explanatory research design is a well-structured design in which the explanatory variables are structured to detect the causal and/or effect relationship between two or more variables; hence it discloses the functional relationship between the explanatory variable and its predicted impact on the dependent variable under investigation. Unlike descriptive, the design is able to answer the why and how parts of the research problem. Therefore the design was appropriate in this study as it addresses facets inherent in the research problem.

3.3 Empirical Model and Variables

The section explains the variables and how they are derived it also explains the EGARCH framework and its superiority in capturing the dimensions of the study.

3.3.1 Testing Spillovers and Contagion Effect: E-GARCH (p, q) Model

In modelling volatility of the three East African Markets, the study used the modified Exponential Generalised Autoregressive Conditionally Heteroscedastic model, a standard financial econometric model appropriate for volatility modelling. According to Brooks (2014) the common linear structural models such as CLRM are unable to capture or explain relevant features common to financial time series data such as volatility clustering, leptokurtosis and leverage effects and hence the ARCH family model best explains the intrinsic non-linear features or changing volatility in the financial time series data.
The standard GARCH (p, q) model could have been an option for the study, but the model is limited due to its two main weaknesses; the non-negativity requirement could have been violated and couldn’t explain the leverage effects that is volatility to shocks displays an asymmetric response rather than a symmetric one (Brooks, 2014). The generalized autoregressive conditional heteroskedasticity (GARCH) model introduced by Engle (1982) and Bollerslev (1986) suggests the following specification.

\[ V h_t = W + \rho \varepsilon_t^2 + \gamma h_{t-1} \]

and \( \omega, \beta \) and \( \gamma \geq 0 \)

Where \( r_t = \) Asset return at time \( t \)

- \( \mu = \) Mean return/long term average value
- \( \varepsilon_t = \) Error term
- \( h_t = \) Conditional Variance (one period ahead estimate)
- \( \varepsilon_t^2 = \) Squared error (news about volatility from previous period) ARCH q term
- \( h_{t-1} = \) Last period forecast variance (GARCH p term)

\( \omega, \beta \) and \( \gamma \geq 0 = \) Non-negativity requirement on coefficients to ensure \( h_t \) remains positive.

The standard EGARCH model specification

\[ ln(h_t) = \omega + \beta ln(h_{t-1}) + \alpha \left( \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right) - \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \]

According to Brooks (2014), the model above guarantees the positivity of dependent \( h_t \) (conditional variance) even if the parameters happen to be negative since \( \log h_t \) is estimated. Coefficient \( \alpha \) Measures GARCH effect or symmetric effect of the model, \( \beta \) capture the persistence in conditional volatility in any period, moreover if the relationship
between volatility and return is negative, parameter $\gamma$ will be negative explaining the leverage effect (a negative shock has a larger effect on volatility of returns compared to a positive shock of the same magnitude).

Hence EGARCH system outstands for this study. According to the financial contagion theories, a shock from one market to the other transmits in two kinds or channels; spillover channels (interdependence between markets through market/fundamental linkages) and contagion channels (Based on investors’ behaviour). Baur (2003) modified the Exponential GARCH to capture both aspects of shock transmission.

The full models under EGARCH system was estimated as follows:

**Mean Equation:**

\[ r_{t,i} = \beta_0 + \beta_1 r_{us,t-n} + \beta_2 r_{us,t-n}D_{crisis,t-n} + \epsilon_t \]

- $r_{t,i}$ = Return of an East African $i = 1, 2, 3$: 1 = Kenya 2 = Uganda 3 = Tanzania
- $\beta_0$ = The constant term
- $r_{us,t-n}$ = Lagged US (S&P 500) stock index return; $\beta_1$ measures the spillover effect or normal shock effect from US markets to the East African market
- $r_{us,t-n}D_{crisis,t-n}$ = Interactive term, US index return with a dummy variable that takes the value 1 during the crisis period and 0 otherwise, thus $\beta_2$ will measure the contagion effect or any additional effect during the crisis period.
- $\epsilon_t$ = Error term.

**Variance Equation:**

\[ \ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-q} + \beta_4 [z_{t-n} - E(z_{t-n})] + C_1 \ln (h_{EA,t-P}) + d_1 r_{us,t-n}^2 + d_2 r_{us,t-n}^2 D_{crisis,t-n} + d_3 r_{ke,t-n}^2 D_{crisis,t-n} \]
\[ \ln h_{E,t} = \text{Logged Conditional variance of an East Africa market at time } t \]

\(1 = \text{Kenya} \quad 2 = \text{Uganda} \quad 3 = \text{Tanzania} \)

- \(z_{t-q} = \text{White noise (ARCH q term), the variable explains the volatility effect caused by country domestic or internal influences (measured by magnitude and significance of parameter } \beta_3)\).
- \([|z_{t-n}| - E(|z_{t-n}|)] = \text{Difference between absolute residuals and expectation of absolute residuals; the } \beta_4 \text{ parameter explains the impact of either negative or positive news to the markets. (Tendency of volatility to increase more following a negative shock than following a positive one of the same magnitude.)}\)
- \(\ln(h_{E,t-p}) = \text{The lagged dependent variable (GARCH p) the parameter } C_1 \text{ in conjunction with } \beta_2, (\beta_2 + C_1) \text{ measured by magnitude and significance of sum of the parameters explains whether the shocks to the markets are persistent or are short lived.}\)
- \(r^{2}_{ust-n} = \text{First exogenous US squared returns; parameter } d_1 \text{ explains the volatility spillover effect from the US markets to the East African Market } i.\)
- \(r^{2}_{ust-n} D_{crisis,t-n} = \text{Interactive second exogenous US squared returns variable; depicts volatility contagion during the crisis period (} D_{crisis,t-n} = 1 \text{ during the crisis moment and 0 otherwise), } d_2 \text{ explains the contagion effect from the crisis source country.}\)
- \(r^{2}_{K,t-n} D_{crisis,t-n} = \text{Kenyan variable to explain its influence in the East African region (moderating) during volatile periods. } d_3 \text{ explains volatility effect to the Ugandan or Tanzanian markets from Kenya during the USA crisis phases and the Kenyan post-election violence (PEV) period, (} D_{crisis,t-n} = 1 \text{ during the crisis moment and 0 otherwise).}\)

Subscripts: \(t\) refers to time \(t\) and \(q, p \text{ and } n\) refers to the number of lags.
3.3.2 Operationalization and Measurement of Variables

The table below outlines how the variables were derived. The derivation was based on the EGARCH Model.

Table 3.1 Operationalization of Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Operationalization</th>
<th>Measurement</th>
<th>Hypothesised Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spillovers</td>
<td>Independent</td>
<td>Lagged S&amp;P 500: Squared Index returns for variance equation and Index return for mean equation.</td>
<td>Ratio Scale: Daily USA S&amp;P 500 Index returns</td>
<td>Negative</td>
</tr>
<tr>
<td>Contagion</td>
<td>Independent</td>
<td>Lagged S&amp;P 500 Index returns: Interactive term - Index return over crisis phase (Dummy 1=Crisis . Index returns for variance equation and Index return for mean equation.</td>
<td>Ratio scale: Daily USA S&amp;P 500 Index; Squared Index returns for variance equation and Index return for mean equation.</td>
<td>Negative</td>
</tr>
<tr>
<td>Leverage Effect</td>
<td>Independent</td>
<td>Difference between absolute residuals and expectation of absolute residuals.</td>
<td>Daily market returns for an East African Market</td>
<td>Negative</td>
</tr>
<tr>
<td>Volatility persistent</td>
<td>Independent</td>
<td>Sum of GARCH and ARCH terms</td>
<td>Range of 0.85 – 0.9</td>
<td>Positive</td>
</tr>
<tr>
<td>Market Volatility</td>
<td>Dependent</td>
<td>Conditional Variance of an East African market i Index</td>
<td>Ratio Scale: Daily Variance of an East African market i Index</td>
<td>None</td>
</tr>
<tr>
<td>Market Return</td>
<td>Dependent</td>
<td>Conditional Mean of an East African market i Index</td>
<td>Ratio Scale: Daily Index Return of an East African market i</td>
<td>None</td>
</tr>
</tbody>
</table>

(Source: Researcher, 2016)

3.4 Target Population

The study targeted all the three East African regional Stock markets (The EASEA Exchanges); Nairobi Securities Exchange (NSE), Dar Salaam Stock Market (DSE) and Uganda Securities Exchange (USE). The three markets had not been analysed for spillovers and contagion effect as a block compared to other sub-regions in the African continent. Such as West-BRVM, Northern-MENA and Southern Sub-region-CoSSE.
3.5 Data Collection

The study used the Time Series data of the daily observations of closing stock indices for the three East African markets: (Kenya- NSE 20 share, Uganda-USEI and Tanzania-TSI Indices) and the USA S&P 500 for the 2006-2010 sample period making up to 956 observations (actual trading days). The data was obtained electronically from Bloomberg Data services (Tickers KNSMIDX, DARSIDSEI, UGSINDX and SPX). Bloomberg is one of the leading online databases that offer worldwide real time and historical financial data for research and analysis. Accessing data from Bloomberg was both efficient and convenient as the data is appropriately tailored for research; saves the hazy of compiling data from multiple sources, moreover other databases do not compile data for most markets in Africa. The period was determined basing on two dictates, that is the crisis phase period occurred in the period 2007-2009 and the availability of the DARSIDSEI index (commenced on 2006).

3.6 Data Analysis and Presentation

Data was analysed using specialised econometric software: EViews 8, with inbuilt commands and menus, the software appropriately captures the features of the proposed model. Data was analysed as follows: First the data was synchronized by disregarding trading data in other markets as result of public holidays and during trade glitches in any of the four markets (Kleimeier, Lehnert, & Verschoor, 2008); then daily return for all markets was calculated using the formula:

\[ r_{i,t} = \log \left( \frac{p_{i,t}}{p_{i,t-1}} \right), \]

where \( r_{i,t} \) denotes index return for country \( i \) at time \( t \) in percentages; \( p_{i,t} \) denotes current closing index for country \( i \) and \( p_{i,t-1} \) previous closing market index. The appropriate lag
length was determined by the information criteria. The models were estimated in three sub-sample periods, namely pre-crisis: Jan 2006 to Dec 2007; In-crisis: Jan 2008 to March 2009; Post crisis: April 2009 to Dec 2010. Further, another sub-sample period covering PEV period, the Dec 2007 to March 2008 was considered for the Kenyan market to capture the actual impact of the violence event. Hence the models were estimated separately for the different periods.

Preliminary data analysis was conducted to check the appropriate of the data for the model; as the norm is in modelling GARCH \((p,q)\) type framework, ARCH effects were tested first through heteroscedasticity tests to examine the appropriateness of the model for the data. Descriptive tests were conducted next to report basic statistics such as mean, standard deviation and correlation matrix. The GARCH type models consist of two equations; the mean and the variance equation. The models were run separately for each country to test for mean or volatility spillovers and contagion effect for the hypotheses: Mean; \(H_{0,i} = \beta_n \leq 0\) there is no increased contamination of shocks from the US market to the EA market \(i\) during the credit crisis against \(H_{A,i} = \beta_n > 0\); Volatility: \(H_{0,i} = d_n \leq 0\) There is no volatility contagion/spillovers to the E.A market \(i\) during the credit crisis period against \(H_{A,i} = d_n > 0\); The leverage effect by the hypothesis \(H_0 = \gamma > 0\); downward movement in the market is not followed by relative higher volatilities against \(H_0 = C_1 \neq 0\). Moreover persistence in volatility shocks to the conditional variance was determined by examining the sum of ARCH and GARCH coefficients \(\beta_3 + C_1\).

The estimated models were evaluated for fitness by the following diagnostic checks; Ljung-Box test statistic for serial correlation in the residuals (Ruppert & Matteson, 2015). The non-normality test was conducted by the JarqueBera statistic to confirm whether the
residuals are normally distributed, normality test ensures that the inferences made about the coefficient estimates are not wrong.
CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Introduction
The general focus of the study was to model the effect of volatility between the United States stock markets and volatility of the East African securities markets during the 2007-2009 global financial downturns. This section reports findings on the following specific goals: Spillover and contagion effect from U.S. stock Markets to the East Africa regional markets, Volatility persistent in the East African Exchanges, Leverage effect and role of the Kenyan Market on other East African Securities Market.

4.2 Descriptive Statistics
The section highlights basic data characteristics such as correlations and summary of mean, median and standard deviations.

4.2.1 Correlation Coefficients
The table below presents findings on correlation of indices in the four markets during the three stages of crisis

Table 4.1: Correlation Coefficients

<table>
<thead>
<tr>
<th>IN-CRISIS</th>
<th>NSE</th>
<th>TSI</th>
<th>USEI</th>
<th>S&amp;P500</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSI</td>
<td>0.102366476</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEI</td>
<td>0.008172511</td>
<td>-0.000548509</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S&amp;P5000</td>
<td>0.082939173</td>
<td>0.05824998</td>
<td>0.076814581</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRE-CRISIS</td>
<td>NSE</td>
<td>TSI</td>
<td>USEI</td>
<td>S&amp;P500</td>
</tr>
<tr>
<td>NSE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSI</td>
<td>0.057382697</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEI</td>
<td>0.023460785</td>
<td>0.106643139</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S&amp;P5000</td>
<td>-0.034644196</td>
<td>0.049633399</td>
<td>0.001222975</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST-CRISIS</td>
<td>NSE</td>
<td>TSI</td>
<td>USEI</td>
<td>S&amp;P500</td>
</tr>
<tr>
<td>NSE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSI</td>
<td>-0.050939933</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>USEI</td>
<td>0.012761967</td>
<td>-0.032046287</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S&amp;P5000</td>
<td>-0.001249369</td>
<td>0.000455661</td>
<td>-9.75037E-05</td>
<td>1</td>
</tr>
</tbody>
</table>

(Source: Research Data, 2016)
The correlation coefficients of the four stock markets were computed in three sub-samples; pre-crisis, in-crisis and post-crisis periods. In the pre-crisis period, the NSE and S&P500 were negatively correlated. All other indices in the three markets TSI, USEI and S&P500 were positively correlated. During the crisis period the correlation pattern shows positive correlations between all indices except between the TSI and USEI. The post crisis analysis indicates weak negative correlations between the NSE and TSI; NSE and S&P500; TSI and USEI and strong on USEI-S&P500. Coefficients for full sample reported positive correlations between indices, except TSI and USEI which was negatively correlated.

The above results show shifts between positive and negative correlation coefficients between the three sub-sample periods. Meaning the markets responded to both negative and positive shocks during the period. During the pre-crisis sample the NSE and S&P 500 showed negative correlation coefficient, however during the crisis the coefficient turns out to be positive. Indicating that the markets reacted similarly to market shocks ruling out diversification opportunities. Between the TSI and USEI, the pattern indicates positive correlations in the pre-crisis period and negative correlations within the crisis period, indicating a viable diversification between the markets during the crisis period. Similar happening is noted after the crisis phase. The (TSI- USEI and NSE – USEI) and TSI - S&P500 maintained negative and positive correlations respectively, all other indices shifted from positive to negative correlations.
Table 4.2: Basic statistics

<table>
<thead>
<tr>
<th></th>
<th>PRE-CRISIS</th>
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<th>USEI</th>
<th></th>
<th>S&amp;P500</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NSE</td>
<td>TSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.001145283</td>
<td>0.008766593</td>
<td>0.067390657</td>
<td>0.018130337</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>0.001152712</td>
<td>0.003638944</td>
<td>0.008183166</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>0.236555</td>
<td>0.656421426</td>
<td>13.39621022</td>
<td>2.8789579</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>-0.0412586</td>
<td>-1.28137653</td>
<td>-13.3962102</td>
<td>-3.3342692</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
<td>0.001812694</td>
<td>0.003638944</td>
<td>0.008183166</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Skewness</strong></td>
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<td>0.008766593</td>
<td>0.067390657</td>
<td>0.018130337</td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Jarque-Bera</strong></td>
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<td></td>
</tr>
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<td><strong>Observations</strong></td>
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<td>261</td>
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<table>
<thead>
<tr>
<th></th>
<th>POST-CRISIS</th>
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<th>USEI</th>
<th></th>
<th>S&amp;P500</th>
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<td>NSE</td>
<td>TSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>-0.00188919</td>
<td>0.061025933</td>
<td>-0.13634583</td>
<td>-0.2006433</td>
<td></td>
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</tr>
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<td><strong>Median</strong></td>
<td>-0.00303464</td>
<td>0.003638944</td>
<td>0.008183166</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Maximum</strong></td>
<td>0.236555</td>
<td>12.72768036</td>
<td>230.3234027</td>
<td>10.2457328</td>
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</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>-0.10090838</td>
<td>-2.82681244</td>
<td>-233.093345</td>
<td>-9.46951447</td>
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<tr>
<td><strong>Std. Dev.</strong></td>
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<td>0.003638944</td>
<td>0.008183166</td>
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<tr>
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<tr>
<td><strong>Kurtosis</strong></td>
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<td>0.018130337</td>
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<tr>
<td><strong>Jarque-Bera</strong></td>
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<td>0.008766593</td>
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<td>0.018130337</td>
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<td><strong>Observations</strong></td>
<td>258</td>
<td>261</td>
<td>259</td>
<td>265</td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>FULL SAMPLE</th>
<th></th>
<th>USEI</th>
<th></th>
<th>S&amp;P500</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>NSE</td>
<td>TSI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.000180548</td>
<td>0.016334195</td>
<td>0.033331663</td>
<td>0.01071853</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>-0.00016068</td>
<td>0.003640111</td>
<td>0.008976206</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>0.236555</td>
<td>12.72768036</td>
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<tr>
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<td>0.008183166</td>
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<tr>
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<td>0.008766593</td>
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<tr>
<td><strong>Kurtosis</strong></td>
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<td>0.008766593</td>
<td>0.067390657</td>
<td>0.018130337</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Jarque-Bera</strong></td>
<td>0.001145283</td>
<td>0.008766593</td>
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<td>0.018130337</td>
<td></td>
<td></td>
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<tr>
<td><strong>Observations</strong></td>
<td>258</td>
<td>261</td>
<td>259</td>
<td>265</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The means for all indices were positive in the pre-crisis period, (Table 4.2 above) however during the crisis phase the NSE, USEI and S&P500 showed negative means. Contrary the TSI mean remained positive. Interestingly, after the crisis the TSI turned out negative and on the full sample period all indices reported positive means except the S&P500. The Standard deviation for the indices relatively increased during the crisis period, Ugandan USEI exhibited highest volatility with high standard deviations throughout the crisis phases; pre-crisis 2.8, In-crisis 19.0, Post-crisis 19.45 and full sample 16.03. Kenyan market figures indicate low volatility among the East African markets with variance of 0.014 in the full sample analysis.

(Research Data, 2016)
4.3 Preliminary Tests

The section presents discussion on the preliminary tests that were carried out before the model estimation.

4.3.1 ARCH Effect Test

Table 4.3: Heteroskedasticity Test: ARCH

<table>
<thead>
<tr>
<th>Country</th>
<th>F-statistic</th>
<th>Obs*R-squared</th>
<th>Prob. F(4,969)</th>
<th>Prob. Chi-Square(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya_NSE</td>
<td>2.645566</td>
<td>10.52196</td>
<td>0.0323</td>
<td>0.0325</td>
</tr>
<tr>
<td>Tanzania_TSI</td>
<td>3.315668</td>
<td>14.63254</td>
<td>0.0235</td>
<td>0.0262</td>
</tr>
<tr>
<td>Uganda_USEI</td>
<td>7.565523</td>
<td>36.254332</td>
<td>0.0402</td>
<td>0.0426</td>
</tr>
</tbody>
</table>

(Research Data, 2016)

In Estimating a GARCH-type model, a test for determining whether the ARCH effect is present is a precondition to ensure that GARCH model is suitable for the data (Brooks, 2014). The output above (Table 4.3) shows the Engle test results. Both the F-version and the LM-statistic are significant for all the indices, suggesting the presence of ARCH. The same effect can be observed through the graphs of Figure 4.1 below. The graphics indicate volatility clustering effect (Tendency of large volatility in returns to cluster together and small volatility clustering together meaning the series exhibits conditional heteroscedasticity. Therefore the model fits the data well hence the researcher proceeded to estimate the models.
4.3.2 Optimal Lag selection

The section describes the procedure that was followed to select the lag length.

Table 4.4: Optimal Lag selection

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-3440.535883</td>
<td>NA</td>
<td>0.065259</td>
<td>8.622117</td>
<td>8.645563</td>
<td>8.631125</td>
</tr>
<tr>
<td>1</td>
<td>-3273.758574</td>
<td>331.4673</td>
<td>0.044744</td>
<td>8.244702</td>
<td>8.361933</td>
<td>8.28974</td>
</tr>
<tr>
<td>2</td>
<td>-3188.771832</td>
<td>168.0589</td>
<td>0.037648</td>
<td>8.07202</td>
<td>8.283035*</td>
<td>8.153087</td>
</tr>
<tr>
<td>3</td>
<td>-3138.148902</td>
<td>99.59856</td>
<td>0.034523</td>
<td>7.985354</td>
<td>8.290153</td>
<td>8.102451*</td>
</tr>
<tr>
<td>4</td>
<td>-3109.694321</td>
<td>55.69833</td>
<td>0.033463*</td>
<td>7.954179*</td>
<td>8.352762</td>
<td>8.107306</td>
</tr>
<tr>
<td>5</td>
<td>-3094.925031</td>
<td>28.76222*</td>
<td>0.033567</td>
<td>7.957259</td>
<td>8.449628</td>
<td>8.146416</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

(Source: Research Data, 2016)
A multivariate information criterion was employed to determine the appropriate lag length. From the output below, Schwarz information criterion select 2 lags, Hannan-Quinn information criterion 3 lags and both Final prediction error and Akaike information criterion select 4 lags. Hence 4 lags are preferred for model estimation (Table 4.4).
4.4 Inferential Analysis

The results are analysed and discussed separately for each sub-sample period, pre-crisis, in-crisis and post crisis phases. Contagion and spillover effects are discussed in two parts that is, at mean and variance levels consistent with both the EGARCH model and (Baur's, 2003) modifications.

4.4.1 In-crisis Phase

The table below presents findings on the in-crisis phase

Table 4.5: Estimation of EGARCH (4, 1) model In-crisis Phase

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditional Mean Equation</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>Constant</td>
<td>0.000654***</td>
<td>0.07478</td>
<td>-0.0000425</td>
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<tr>
<td></td>
<td>[0.000239]</td>
<td>[0.041047]</td>
<td>[0.003026]</td>
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</tr>
<tr>
<td>$\beta_1$</td>
<td>Mean Spillovers</td>
<td>0.000153</td>
<td>-0.040771</td>
<td>0.0000032</td>
</tr>
<tr>
<td></td>
<td>[0.000153]</td>
<td>[0.033837]</td>
<td>[0.003175]</td>
<td></td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>Mean Contagion</td>
<td>0.000467**</td>
<td>-0.033104</td>
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<tr>
<td></td>
<td>[0.000217]</td>
<td>[0.045957]</td>
<td>[0.003227]</td>
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<tr>
<td>Conditional Variance Equation</td>
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</tr>
<tr>
<td>$\alpha_0$</td>
<td>Constant</td>
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<td>-0.276866***</td>
<td>-1.050427***</td>
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<tr>
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<td>[0.283692]</td>
<td>[0.030416]</td>
<td>[0.087131]</td>
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<tr>
<td>$\beta_3$</td>
<td>Internal Influences</td>
<td>0.856532***</td>
<td>0.729061***</td>
<td>0.075321***</td>
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<td></td>
<td>[0.069767]</td>
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<tr>
<td>$\beta_4$</td>
<td>Leverage Effect</td>
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<tr>
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<td>0.10341***</td>
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<td>[0.017299]</td>
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Residual Diagnostic (Model Fit Test)

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<th>Test Statistic</th>
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<tbody>
<tr>
<td>J-B</td>
<td>J-B: 12480.79</td>
<td>P-Value:0.000</td>
</tr>
<tr>
<td></td>
<td>J-B: 4729266</td>
<td>P-Value:0.000</td>
</tr>
<tr>
<td></td>
<td>J-B: 10430677</td>
<td>P-Value:0.000</td>
</tr>
<tr>
<td>Ljung Box</td>
<td>QLB310</td>
<td>QLB311</td>
</tr>
<tr>
<td></td>
<td>QLB279</td>
<td>QLB311</td>
</tr>
<tr>
<td>ARCH test</td>
<td>R-Squared:0.24719</td>
<td>R-Squared:0.00344</td>
</tr>
<tr>
<td></td>
<td>P-Value:0.06191</td>
<td>P-Value:0.9532</td>
</tr>
</tbody>
</table>

Notes: The figures in parentheses are standard errors of the estimators; *, **, *** denote significance at 10%, 5% and 1% Respectively; J-B - the statistic of Jarque and Bera (1980) Normality test; Ljung Box - Test for serial correlation; Ho: There is no Serial correlation; QLB: Ljung Box at lag k

(Source: Research Data, 2016)
The estimation results from Table 4.5 above depicts findings for the in-crisis period; Jan 2008 to Mar 2009. The parameters of particular interest are Mean spillovers ($\beta_1$) and Mean Contagion ($\beta_2$) in the conditional mean equation, a positive and significant value implies mean spillover (normal or expected effect of shocks) or contagion (additional effect beyond what is normally expected) to the market during the crisis phase under study. All estimated mean spillovers values are insignificant at 1%, supporting the hypothesis of no mean spillovers for all the three markets during the crisis period, similarly mean contagion values for Uganda and Tanzania show absence of mean contagion in these markets, however mean contagion coefficient for the Kenyan Market show significant mean contagion. This indicates that the context of the crisis had an effect to the returns of the Kenyan market.

Parameter on internal influences ($\beta_3$) estimates show prove of strong domestic influence for the Kenyan and Uganda markets. The results on the Kenyan market are consistent with Mattes (2012) findings. The coefficient for Tanzania indicate less influence emanating from within. Notably, the Kenyan coefficient is larger signifying a relative bigger influence from within. Leverage effect ($\beta_4$) coefficient captures the asymmetry in volatility generated by the leverage effect (when a sharp price drop affects volatility differently relative to when a large price increases). The estimates show strong evidence of leverage effect only for the Ugandan market meaning that negative shocks to the market have higher impact compared to positive market shocks. The Persistence measure ($\beta_3 + C_1$) for both Uganda and Kenya is explosive (above unit) 1.35 and 1.04 respectively, meaning that when volatility in the markets increases it takes a longer period before it decays off. The results show that Ugandan market has the highest volatility persistent level and lowest in the Tanzania market.
Volatility spillovers coefficient \((D_1)\) was statistically significant for Kenya and Uganda markets clearly implicating the markets for volatility spillovers from the U.S. markets. Volatility contagion coefficient \((D_2)\) for Ugandan Market is negative and significant which is interpreted as no transmission of volatility shocks during the crisis phase through speculative attacks or financial panic. In overall, the results indicate that the Tanzania market was isolated from shocks during the specific period of the crisis while volatility for Kenya and Uganda markets were influenced by spillovers and not volatility contagion. However mean contagion was detected in the Kenyan market.

### 4.4.2 Pre-crisis Phase

The table below presents findings on the pre-crisis phase.

#### Table 4.6: Estimation of EGARCH (4,1) model Pre-crisis Phase

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditional Mean Equation</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\beta_0) constant</td>
<td>0.000181</td>
<td>-0.026886</td>
<td>-0.00000875</td>
<td></td>
</tr>
<tr>
<td>(\beta_1) mean spillovers</td>
<td>0.003342**</td>
<td>0.041877**</td>
<td>-0.001564***</td>
<td></td>
</tr>
<tr>
<td>(\beta_2) mean contagion</td>
<td>-0.000725**</td>
<td>-0.052874***</td>
<td>0.001582</td>
<td></td>
</tr>
<tr>
<td>pre-crisis</td>
<td>[0.000403]</td>
<td>[0.012396]</td>
<td>[0.001525]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conditional Variance Equation</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha_0) constant</td>
<td>0.044885***</td>
<td>0.058924</td>
<td>-0.679844***</td>
</tr>
<tr>
<td>(\beta_3) internal influences</td>
<td>0.785911***</td>
<td>0.532108***</td>
<td>0.037648***</td>
</tr>
<tr>
<td>(\beta_4) leverage effect</td>
<td>0.049383**</td>
<td>-0.343296***</td>
<td>-0.006429***</td>
</tr>
<tr>
<td>(\beta_3 - c_1) volatility persistence</td>
<td>0.181005</td>
<td>0.623076</td>
<td>0.70269</td>
</tr>
<tr>
<td>(d_1) volatility spillovers</td>
<td>0.01325</td>
<td>-0.013107</td>
<td>-0.025145**</td>
</tr>
<tr>
<td>(d_2) volatility contagion pre-crisis</td>
<td>0.057371</td>
<td>0.057933</td>
<td>0.005772***</td>
</tr>
</tbody>
</table>

#### Residual Diagnostic (Model Fit Test)

<table>
<thead>
<tr>
<th>Test</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-B Normality Test</td>
<td>J-B: 454546.5</td>
<td>J-B: 4131742</td>
<td>J-B: 31953833</td>
</tr>
<tr>
<td>P-Value: 0.000</td>
<td>P-Value: 0.000</td>
<td>P-Value: 0.000</td>
<td></td>
</tr>
<tr>
<td>Ljung Box Serial Correlation</td>
<td>QLB310</td>
<td>QLB279</td>
<td>QLB311</td>
</tr>
<tr>
<td>Ho: True</td>
<td>Ho: True</td>
<td>Ho: True</td>
<td>Ho: True</td>
</tr>
<tr>
<td>ARCH Effect test</td>
<td>R-Squared: 0.01346</td>
<td>R-Squared: 0.00414</td>
<td>R-Squared: 0.00112</td>
</tr>
<tr>
<td>P-Value: 0.9075</td>
<td>P-Value: 0.9487</td>
<td>P-Value: 0.9734</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** The figures in parentheses are standard errors of the estimators; ***, ** denote significance at 10%, 5% and 1% Respectively; J-B - the statistic of Jarque and Bera (1980) Normality test; Ljung Box - Test for serial correlation; Ho: There is no Serial correlation; QLB: Ljung Box at lag k
Table 4.6 presents results from pre-crisis period stemming from Jan 2006 to December 2007. The phase sought to examine how the East African markets related with the U.S. Markets prior to the crisis period. The mean spillovers ($\beta_1$) were found to be positive and significant for Kenya and Uganda and negative significant for Tanzania meaning that the Tanzania market was not influenced by normal or daily happenings in the USA financial market compared to its counterparts. Mean contagion ($\beta_2$ coefficient) indicate negative significant estimates in the Kenyan and Ugandan Markets indicating that shocks from the U.S had less or no impact on the returns of these markets. Notably, the size of coefficients for the Ugandan market at spillover level is relatively bigger implying a higher market exposure to external shocks.

The estimates for internal influences ($\beta_3$) in all the three markets indicate positive significant influences from domestic events or activities with the Kenyan Market exhibiting largest coefficient. This indicates that volatility in the market was influenced largely by internal happenings prior to the U.S. financial crisis. The sum of the estimated ARCH and GARCH coefficients ($\beta_3 + \delta_1$) (persistence coefficients) in the phase are fairly below unit meaning that volatility in the markets is not highly persistent during the normal periods in both financial markets.

The leverage effect, coefficient $\beta_4$, is negative for both Uganda and Tanzania, indicating that a negative shock to the either markets would result in increased volatility relative to positive shocks of similar magnitude. The findings on volatility contagion and spillovers ($d_1$ and $d_2$ coefficients respectively) for Kenya and Uganda are insignificant but show negative significant coefficients for the Tanzanian market during the pre-crisis phase, indicating that the market risk could be influenced negatively by both economic and non-economic factors from the external market.
4.4.3 Post-crisis Phase

The table below presents findings on the post-crisis phase.

Table 4.7: Estimation of EGARCH (4,1) model Post-crisis Phase

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditional Mean Equation</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.0000269</td>
<td>0.005771</td>
<td>-0.00000814</td>
</tr>
<tr>
<td>$\beta_0$</td>
<td>Constant</td>
<td>[0.0002]</td>
<td>[0.014011]</td>
<td>[0.002456]</td>
</tr>
<tr>
<td></td>
<td>Mean Spillovers</td>
<td>0.000019</td>
<td>0.060352**</td>
<td>-0.003464***</td>
</tr>
<tr>
<td></td>
<td>Mean Contagion</td>
<td>[0.000142]</td>
<td>[0.002126]</td>
<td>[0.0005]</td>
</tr>
<tr>
<td></td>
<td>post-crisis</td>
<td>-0.000028</td>
<td>0.189921***</td>
<td>0.003454</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Conditional Variance Equation</th>
<th>KENYA</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>-3.426557***</td>
<td>-0.0103</td>
<td>-1.165838***</td>
</tr>
<tr>
<td></td>
<td>Internal Influences</td>
<td>0.802655***</td>
<td>0.492343***</td>
<td>0.044297***</td>
</tr>
<tr>
<td></td>
<td>Leverage Effect</td>
<td>0.034179</td>
<td>-0.316833***</td>
<td>0.052682***</td>
</tr>
<tr>
<td></td>
<td>Volatility Persistence</td>
<td>0.589186</td>
<td>0.756824</td>
<td>0.143424</td>
</tr>
<tr>
<td></td>
<td>Volatility Spillovers</td>
<td>0.014829</td>
<td>-0.000061</td>
<td>-0.034916***</td>
</tr>
<tr>
<td></td>
<td>Volatility Contagion</td>
<td>-0.070375***</td>
<td>-0.144426</td>
<td>0.331281***</td>
</tr>
<tr>
<td></td>
<td>post-crisis</td>
<td>[0.030261]</td>
<td>[0.15193]</td>
<td>[0.046669]</td>
</tr>
</tbody>
</table>

Residual Diagnostic (Model Fit Test)

<table>
<thead>
<tr>
<th>J-B</th>
<th>Normality Test</th>
<th>J-B- 181187</th>
<th>J-B- 427114</th>
<th>J-B- 28242098</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-Value:0.000</td>
<td>P-Value:0.000</td>
<td>P-Value:0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>QLB310</td>
<td>QLB279***</td>
<td>QLB311</td>
<td></td>
</tr>
<tr>
<td>Ljung Box</td>
<td>Ho: True</td>
<td>Ho: True</td>
<td>Ho: True</td>
<td></td>
</tr>
<tr>
<td>ARCH test</td>
<td>R-Squared-0.01864</td>
<td>R-Squared-0.004371</td>
<td>R-Squared-0.001023</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P-Value-0.0914</td>
<td>P-Value-0.9473</td>
<td>P-Value-0.9745</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The figures in parentheses are standard errors of the estimators; *, **, *** denote significance at 10%, 5% and 1% Respectively; J-B- the statistic of Jarque and Bera (1980) Normality test; Ljung Box - Test for serial correlation; Ho: There is no Serial correlation; QLB:- Ljung Box at lag k

The results in Table 4.7 above are based on the post-crisis phase period, March 2009 to December 2010. In this phase the results on mean spillovers for the Ugandan and Tanzania markets show similar market behaviour as of the pre-crisis phase (positive and significant mean spillover ($\beta_1$) coefficients). Positive mean contagion ($\beta_2$ coefficient) was detected for Ugandan market indicating that the market returns are exposed to unexpected effect
from the U.S. The findings support the notion by market observers that when the Kenyan exchange experience increased volatility, foreign investors in the market opt for Uganda and Tanzania Exchanges for better returns or diversifications (Odhiambo, 2011). This could explain the resulting behaviour of the Uganda Securities Exchange immediately after the crisis phase. Kenya results show no evidence for both mean spillovers and contagion during the post-crisis phase.

Coefficients $\beta_3$ (internal influences) for all the markets are positive and highly significant. The Significance of $\beta_3$ coefficients indicates that markets were influenced by internal or domestic activities. With respect to the Leverage effect, (the tendency for volatility to rise more following a large price fall than following a price rise of the same magnitude) coefficient for the Ugandan market is negative and significant, meaning that the market exhibits the leverage effect throughout the phases. The degree of persistence in the conditional variance (given by $\beta_3+C_1$) for the estimated period indicate relatively lower volatility persistence compared to other phases, however the Ugandan coefficient is higher relative to other markets.

The $d_1$ coefficient (volatility spillovers) is negative and significant for the Tanzania market implying no effect from the U.S. markets. Similarly, $d_2$ (volatility contagion) is negative and significant for the Kenyan Market. However findings for the Tanzania market show evidence for volatility contagion. Possible reasons being, one cited earlier by (Odhiambo, 2011) that is, owing to the behaviour of investors when the Kenyan market is volatile. Theoretically, the phenomena can be explained by the two stage contagion aspect that is Kenya and Ugandan Markets forming intermediary channels for shock transmission. Moreover physic distance theory suggest that investors, while rebalancing their portfolios in volatile periods tend to reinvest in closely related markets (in relation to distance, similar
economic environment or political environment). The high volatility might have been stimulated further by the Tanzania policy that dictates that foreign investors’ resales must be directed to strictly locals. Though Ugandan market indicated signs for mean contagion only, the findings are not surprising, as Baur (2003) indicates; increased effect of shocks to the mean of a market return does not necessarily increase the impact on the volatility. Similarly increased shocks to the volatility do not necessarily increase the influence on the underlying returns. Hence Uganda and Tanzania market experienced post crisis mean contagion and volatility contagion respectively.

4.4.4 Kenyan Post-Election violence

The table below presents findings on the post- Election crisis phase.

Table 4.8: Estimation of EGARCH (4,1) model Kenya PEV-crisis Phase

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditional Mean Equation</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0  )</td>
<td>Constant</td>
<td>-0.038143***</td>
<td>0.00000516</td>
</tr>
<tr>
<td></td>
<td>[0.018492]</td>
<td>[0.002904]</td>
<td></td>
</tr>
<tr>
<td>( \beta_1  )</td>
<td>Mean Spillovers</td>
<td>9.593416**</td>
<td>0.000137</td>
</tr>
<tr>
<td></td>
<td>[1.177506]</td>
<td>[0.171622]</td>
<td></td>
</tr>
<tr>
<td>( \beta_2  )</td>
<td>Mean Contagion PEV-crisis</td>
<td>-24.94717***</td>
<td>-0.008444</td>
</tr>
<tr>
<td></td>
<td>[1.177506]</td>
<td>[0.712067]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditional Variance Equation</th>
<th>UGANDA</th>
<th>TANZANIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha_0 )</td>
<td>Constant</td>
<td>-0.08415</td>
<td>-0.762685***</td>
</tr>
<tr>
<td></td>
<td>[0.061583]</td>
<td>[0.060149]</td>
<td></td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>Internal Influences</td>
<td>0.401143***</td>
<td>0.038018***</td>
</tr>
<tr>
<td></td>
<td>[0.064156]</td>
<td>[0.004125]</td>
<td></td>
</tr>
<tr>
<td>( \beta_4 )</td>
<td>Leverage Effect</td>
<td>-0.22968***</td>
<td>0.028528***</td>
</tr>
<tr>
<td></td>
<td>[0.056382]</td>
<td>[0.002879]</td>
<td></td>
</tr>
<tr>
<td>( \beta_3 + c_1 )</td>
<td>Volatility Persistence</td>
<td>0.64596</td>
<td>0.190431</td>
</tr>
<tr>
<td>( d_1 )</td>
<td>Volatility Spillovers</td>
<td>96.13764**</td>
<td>-327.7206***</td>
</tr>
<tr>
<td></td>
<td>[44.89569]</td>
<td>[15.97147]</td>
<td></td>
</tr>
<tr>
<td>( d_2 )</td>
<td>Volatility Contagion PEV-crisis</td>
<td>265.0977</td>
<td>27.09179</td>
</tr>
<tr>
<td></td>
<td>[320.4396]</td>
<td>[149.5694]</td>
<td></td>
</tr>
</tbody>
</table>

Residual Diagnostic (Model Fit Test)

<table>
<thead>
<tr>
<th>Test</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>J-B Normality Test</td>
<td>( \chi^2 = 1.3991152 )</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.000</td>
</tr>
<tr>
<td>Serial Correlation Test</td>
<td>QLB279</td>
</tr>
<tr>
<td>Ho: True</td>
<td>True</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.002357</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.9613</td>
</tr>
</tbody>
</table>

Notes: The figures in parentheses are standard errors of the estimators; *, **, *** denote significance at 10%, 5% and 1% Respectively; J-B - the statistic of Jarque and Bera (1980) Normality test; Ljung Box - Test for serial correlation; Ho:- There is no Serial correlation; QL&B:- Ljung Box at lag \( k \)
The Post-election (PEV) mean contagion ($B_2$) and PEV volatility contagion ($d_2$) variables depict the Kenyan scenario during the post-election crisis and $B_1$ and $d_1$ represents the expected or normal influence as a result of the fundamental inter-linkages within the region.

The results are interpreted from Table 4.8 above, $B_1$ shows proof of mean spillovers from the Kenyan market to the Ugandan market. The mean contagion ($B_2$) estimates show no strong evidence for both markets. The internal influences in the respective markets are low as indicated by the significant low positive values of the two markets. The parameter $B_4$ show evidence of leverage effect to the Ugandan market. The $d_1$ coefficient reports a large significant positive value for the Ugandan Market. The parameter is considerably higher compared to the model outcomes presented in Table 4.5, 4.6, and 4.7 where the U.S. market is the exogenous interactive variable for spillovers. The findings give a strong implication of a spillover influence from the Kenyan market rather from the U.S. However the findings gives no support for the volatility spillover effect to the Tanzania market as shown by a large negative $d_1$ coefficient. Further, $d_2$ values gives no evidence of volatility contagion from the Kenyan market during the post-election crisis.

4.4.5 Residual Diagnostics

Three assumptions, namely; no serial correlation, no ARCH effect and residuals are normally distributed are tested to ensure the estimated EGARCH (4, 1) model is suitable for forecasting or hypothesis testing. The P-values for all the estimated Ljung Box statistics were more than 5% hence the null hypothesis of no serial correlation is accepted for all the models. The ARCH effect was tested by the ARCH LM test, the P-values for all the observed R-squared values are more than 5% hence the null hypothesis of ‘no ARCH effect’ is accepted. Lastly the Models were tested for the normality assumption. The null
hypothesis (residuals are normally distributed) was tested by the Jarque Bera statistic, in all the estimated models the null hypothesis is rejected therefore the residuals are not normally distributed. The models scored well on the other two assumptions; no serial correlation and no ARCH effect. Even though the residuals are not normally distributed, the estimators would still be consistent and therefore the researcher can still use the model for hypothesis testing and forecasting (Kirchgässner, Wolters, & Hassler, 2012). Moreover the sample size was big enough in line with the central limit theorem justification (Lee, Lee, & Lee, 2000).

4.5 Hypothesis Testing

The estimated models meet the GARCH family model criteria as explained above. Hence the researcher proceeded to test the study hypotheses. Ideally under the GARCH framework for estimating behaviour of stock market data, it is prudent to evaluate the mean equation hypotheses then of the variance equation. Thus the hypotheses under mean and variance sections are evaluated concurrently under the three phases; Pre-crisis, In-crisis and Post-crisis phases.

4.5.1 Spillovers and Contagion Effect

The general null hypothesis for testing spillover and contagion is that there is no increased transmission of shocks from the U.S. market to the East African market $i$ during crisis phase

$$h: H_{0,i}: \beta_1/\beta_2/\mathbf{d}_1/\mathbf{d}_2 \leq 0$$

against the alternative hypothesis

$$H_{A,i}: \beta_1/\beta_2/\mathbf{d}_1/\mathbf{d}_2 > 0.$$ 

The mean spillovers ($\beta_1$) results during the pre-crisis phase Table 4.6 for Kenya and Uganda were positive and significant therefore the null hypothesis is rejected, meaning that the market returns were influenced by daily or normal activities from the U.S. market before the crisis phase. The pre and post-crisis findings on mean equation for Uganda and Tanzania are similar. Conversely, during the in-crisis phase as indicated in Table 4.5, the findings show insignificant coefficients at all significance levels for all the East African
markets, supporting the null hypothesis of no mean spillovers to the markets. Under the variance equation output, the findings on volatility contagion and spillovers ($d_1$ and $d_2$ coefficients respectively) for all the three markets are insignificant during the pre-crisis period, however during the crisis phase the results are in favour of the alternative hypothesis of volatility spillovers ($d_1$) from the U.S. market to the Kenyan and Ugandan markets. The null hypothesis of no volatility contagion ($d_2$) is not rejected in all the three markets. Nevertheless the P-value for mean contagion ($\beta_2$) shows significant coefficient at 5% for the Kenyan market only, hence the null hypothesis of no mean contagion is rejected. The findings indicate that the Kenyan market was influenced by both mean contagion and volatility spillovers from the U.S. financial crisis and only volatility spillovers for the Ugandan market. The vulnerability of both markets to the shocks as a result of fundamental linkages rules out the possibility of good diversification opportunities in these markets. Possibly what would work well for traders is if they concisely employ a momentum based strategy in their diversification plan. In addition, the findings support the decoupling and recoupling hypothesis that is, business cycles between developed and emerging/developing economies tend to diverge during tranquil periods and later converge during the global meltdown (Cheung & Westermann, 2013). In the Tanzania market, evidence suggests that the market was not affected during the in-crisis and pre-crisis periods. Interestingly, findings on the Tanzania market after the crisis period show evidence of volatility contagion. The suitable justification for this behaviour is explained by the activities of foreign investors, moving from the bearish Kenyan market. Therefore the findings show that the Kenyan market is only vulnerable to mean contagion and the behaviour of its volatility and that of Ugandan market is influenced through linkages in economic variables. The study findings during the in-crisis phase support the alternative hypothesis of mean spillovers ($\beta_1$) from the U.S. Market to Kenya and Uganda, meaning that shock
transmission between the U.S. market to the markets are explained by market fundamental linkages such as international or bilateral trade and effect of common external factors such as the U.S. exchange rate fluctuations and both markets and null hypothesis for Tanzania market.

4.5.2 Internal Influences, Leverage Effect and Volatility Persistence

The significant \( \beta_3 \) coefficients indicate that markets were influenced by internal or domestic activities. The coefficient for both Uganda and Kenya during the crisis period is large and significant supporting the hypothesis of strong internal influences for the markets (Table 4.5). The results are analogous to the pre-crisis findings (Table 4.6), with the Kenyan Market exhibiting a higher value signifying stronger internal influences. These results are similar to (Mattes, 2012) on the Kenyan Market. The domestic influence for Tanzania is mild for all the phases.

The hypothesis for leverage effect states; \( H_0 = \gamma > 0 \); downward movement in the market is not followed by relative higher volatilities against \( H_0 = C_1 \neq 0 \). The leverage effect is evident in the Ugandan market in all the three phases as indicated by the negative significant coefficients (Table 4.5, 4.6 and 4.7). Tanzania market shows evidence for leverage effect during the pre-crisis period only while the contrary holds for Kenya. This indicates that a sharp drop in share price (negative shock) tends to increase volatility than an increase in the price of a share price (positive shock) in the Ugandan and Tanzania Markets.

The volatility persistence is measured by the sum of the ARCH and GARCH terms, a value close to 1 shows the markets exhibit volatility persistence and at unit, indicates that volatility is explosive. During the crisis period the Kenyan and Uganda Markets demonstrated explosive volatility, 1.04 and 1.35, respectively (Table 4.5). The contrary is
observed during the other phases; nevertheless the Ugandan Market indicated relatively larger values throughout the phases. Volatility is persistent if it lasts for months and market volatility is correlated to volatility in market fundamentals such as inflation, interest rates and debt levels in the corporate sector (National Bureau of Economic Research, 1990). The reasoning is consistent with the findings above suggesting that the volatility experienced during the period under study was transmitted through fundamental linkages or behaviour.

4.5.3. Influence of the Kenyan Market to Volatility on other East African Markets

The sixth objective sought to investigate the moderating effect of the Kenyan market in explaining the volatilities in the other east African stock markets. The objective was motivated first by the reasoning advocated by Jithendranathan (2013), that contagion or spillovers from one region to another may follow indirect rather than direct channels such that a shock from a ground zero country first hits a relatively developed market in a vulnerable region and due to close interconnectedness of these markets, the shock spills-over to the neighbouring or closer markets. Since the Kenyan market is relatively developed in the region, the researcher pursues the same concept. In the same line, the Kenyan market experienced internal political shocks in the same period of the Subprime crisis. thus an assumption here is that the experienced volatility in Uganda and Tanzania could have been a result of the increased volatility of the Kenyan market rather than the effect of the US crisis, and the estimated model looks at both scenarios.

From the findings, the researcher found out that during the Kenyan volatile phase, the market had a strong influence of both mean and volatility spillover to the Ugandan Market as indicated by the significant $\beta_1$ and $D_1$ values (Table 4.8). The results show a strong evidence of transmission of spillovers from the Kenyan Market as compared to from the U.S. markets. The results find no evidence for either mean or volatility influence from the
Kenyan market to the Tanzania market during the Kenyan crisis. Therefore the Kenyan post-election crisis had no contagion effect to the neighbouring markets, nevertheless the evidence support an influence based on market fundamental inter-linkages both on Kenyan crisis and U.S. crisis. It is important to note however that the influence through the Kenyan market is quite eye-catching as compared to direct transmission from the U.S. market.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction
This section discusses the final part of this study by presenting the summary of the thesis, conclusion, and recommendations. Also outlines suggested areas for further research.

5.2 Summary
The broad objective of this study was to examine volatility contagion and volatility spillover effect from the U.S. financial Markets to the volatility of the East African regional stock markets. The EGARCH (4, 1) model was employed in line with (Baur, 2003) modifications. The data comprised of daily market indices data covering a period of 956 days. The objectives were analysed from the data in three phase periods, namely Pre-crisis, In-crisis and Post-crisis using the Econometric Views package. The study found the following key findings; that the market volatility in East Africa experienced during the 2007 – 2009 period was influenced both by volatility spillover from the U.S. markets and volatility emanating from the domestic markets, especially for Kenyan and Ugandan markets. No observed volatility contagion to the East African markets during the pre-crisis and post-crisis phases was observed however the study reveals that the Tanzania market experienced volatility contagion from the U.S. market after the main crisis phase, indicating a ripple effect of shock transmission through the Kenyan and Ugandan Markets.

The leverage effect was present in the Ugandan and Tanzania markets. The effect is prevalent in Uganda in all the three phases of the crisis, and pre-crisis phase for the Tanzania market but absent in the Kenyan market in all the three phases. Moreover, volatility persistence was explosive in the two main stock markets (Kenya and Uganda) during the crisis phase. Further, the study found out that during the high volatility moments in the Kenyan market, there is relatively higher and direct influence to the Uganda market.
compared to an influence originating from the U.S. markets. However, the influence to the Tanzania market occurs after investors after overreacted to the negative shocks in both Kenya and Ugandan Market. In general, the results are indicative that the Ugandan market is the most volatile and vulnerable to external shocks in the East African region.

5.3 Conclusion
The first finding concerns two aspects that are volatility spillovers and contagion effect. While no Volatility spillovers are observed during the pre-crisis period for all the markets, research findings found evidence for spillover effect during the crisis phase for Kenya and Uganda markets. No volatility contagion was detected for Uganda and Kenya in all the three phases. Tanzania indicated a presence of volatility contagion during the post-crisis period. The findings rule out the possibility of the East African markets being affected by contagion effect from the U.S. and that the influence on the volatility of the markets is caused by the normal market or fundamental linkages between the markets such as bilateral trade and common external factors such as fluctuations in the foreign exchange.

Secondly, the findings show proof of strong internal influences to market volatility in both Uganda and Kenya during the crisis period. The domestic influence for Kenya was stronger indicating that the market volatility during this period was influenced by both external and internal causes. This indicates that the political turmoil experienced during the 2007 period could have had a moderating effect to the volatility witnessed during the crisis phase. Likewise, volatility in the Ugandan market was caused by both domestic and spillover influences from the U.S. financial markets.

In addition, volatility persistence was found to be explosive in Uganda and Kenya. The Ugandan market exhibited the highest level of persistent, meaning that volatility in the markets takes a longer period before it decays off from the market, the implication being
that when the markets are volatile, there are high chances of speculative attack and investors will have to wait for fairly longer periods before they make a comeback to trading.

Finally, the influence of the Kenyan Market as market leader in the region was probed. From the findings, the researcher found out that during the Kenyan volatile phase, there is strong influence of both mean and volatility spillover to the Ugandan Market. There was good evidence to suggest that Uganda is more prone to external shocks emanating from the Kenyan Market than from the USA financial market. It is also important to note that the influence emanating from the Kenyan market to Uganda is not in isolation of the U.S. shocks as the effect follows a ripple effect originating from the USA financial system. Also it is noted that it takes a relatively longer period before the influence hits the Tanzania market. Therefore diversification in the East African region during the global financial crisis is tenable only for a short period.

5.4 Limitation of the Study and Recommendations
The study faced one challenge; data from the markets exhibited unfavourable effects such as the non-trading period effect as result of market glitches and non-synchronous trading effect. This posed a time challenge as the researcher spent considerable time in cleaning and synchronizing the data for the four markets. Based on the findings the researcher makes the following recommendations; as the results indicate, volatility in the East African markets is caused mainly by fundamental linkages, the possible channels being financial and trade links and exposure to U.S. dollar exchange fluctuations. These channels can be better managed if countries were to adopt faster interventions to adverse currency fluctuations and diversification of bilateral trade agreements that is, the countries should avoid overtrading with single major economies. This will spread the risk in instances of global shocks as the countries would have a wide range of policies to adopt in line with the international policy coordination during global market downturn.
Secondly, even though the aspect of volatility contagion was not out rightly notable in the tested episodes across all the markets, due diligence should be observed on the current developments in the markets such as lessening stock market restrictions for foreign investors. In as much the move is plausible to achieving emerging market status and providing opportunities for raising capital for local firms, elsewhere this move has been counterproductive since it makes the markets prone to external shocks. In the researcher’s insight, the East African Markets have quite several strides to make before it reaches full market freeness to foreigners. Therefore the Ugandan model of market freeness may expose it further to external attacks hence the market should rethink its policy on foreign restrictions. In the same vein, even as the Kenyan market stages forward to have a similar policy for foreign investor trading, the study recommends a calculated design where specific classification of shares is put in place. This groups shares into classes such as those owned exclusively by locals and another class for both locals and foreigners. Further, put a limit on capital inflow by a single investor. This will provide a good cushion for locals by controlling overreactions during global volatile incidences. The strategy has been popular elsewhere where policy makers are keen to shielding their markets from high market volatility such as in Chinese and Saudi stock markets.

Also it was noted that there was high leverage effect among the East African Exchanges, further transmission of shocks from both the USA and the neighbouring Kenyan market to the rest of the markets in the region were observed. The influence of the Kenyan market to other East African markets may stem from the number of the Kenyan companies listed in these markets, that is, Kenyan markets dominating the scene in both Uganda and Tanzania bourses. Based on the two stage contagion hypothesis, this makes the markets vulnerable to any shock emanating from within the Kenyan periphery. The East African counterparts should put in place mechanisms to support locally established companies to list in their
respective markets. This would reduce further the negative influence emanating from financial links.

Finally, sustained level of stock market volatility was witnessed on both the Kenyan and Ugandan Market. This implicates the markets with market inefficiency meaning that it is possible for one to predict the markets' behaviour. This in turn invites speculators to the markets who escalate volatility levels making it unbearable for genuine investors to make a comeback. This study proposes that a policy should be in place to have more foreign institutional investors rather than individual or foreign retail investors, since it is relatively easier to control institutional behaviour as they are bound to international company and commercial laws.

5.5 Suggestion for Further Research
One of the important reasons for studying stock market volatility is to establish diversification opportunities during global market shocks. To further elaborate the understanding on the East African interconnectedness and available diversification opportunities, the study suggests use of additional models such as Cointegration and Granger causality to better clarify on the direction of stock market predictability in the region. Moreover, a study on impact of foreign market restrictions on market volatility should be undertaken so as to disclose whether market restrictions to foreign traders help to curb higher volatility during global market shocks.
REFERENCES


Appendix 1: Summary of the Estimated Model Equations

In-Crisis Phase: Table 4.5

\[ r_{i,t} = \beta_0 + \beta_1 r_{us,t-n} + \beta_2 r_{us,t-n} D_{h,in,t-n} + \epsilon_t \]

\[ \ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-p} + \beta_4 [z_{t-n} - E(|z_{t-n}|)] + c_1 \ln(h_{EA,t-q}) + d_1 r_{us,t-n} + d_2 r_{us,t-n}^2 D_{h,in,t-n} \]  

Mean Equation

- \( r_{i,t} \) = Return of an East African \( i = 1, 2, 3: 1 = \text{Kenya} \quad 2 = \text{Uganda} \quad 3 = \text{Tanzania} \)
- \( \beta_0 \) = The constant term
- \( r_{us,t-n} \) = Lagged U.S. (S&P 500) stock index return
- \( r_{us,t-n} D_{h,in,t-n} \) = Interactive term, US index return with a dummy variable that takes the value 1 during the crisis period and 0 otherwise,
- \( \epsilon_t \) = Error term.

Variance Equation

- \( \ln h_{EA,t} \) = Logged Conditional variance of an East Africa market \( i \) at time \( t \)
  
  \( 1 = \text{Kenya} \quad 2 = \text{Uganda} \quad 3 = \text{Tanzania} \)
- \( z_{t-q} \) = White noise (ARCH q term)
- \( [z_{t-n} - E(|z_{t-n}|)] \) = Difference between absolute residuals and expectation of absolute residuals
- \( \ln(h_{EA,t-p}) \) = The lagged dependent variable (GARCH p)
- \( r_{us,t-n}^2 \) = First exogenous U.S. squared returns
- \( r_{us,t-n}^2 D_{h,in,t-n} \) = Interactive second exogenous U.S squared returns variable; depicts volatility contagion during the crisis period \( (D_{h,in,t-n} = 1 \) during the phase period and 0 otherwise)
- **Subscripts:** \( t \) refers to time \( t \). \( h_{in} \) denotes the in-crisis phase and \( q \), \( q \) and \( n \) states number of lags.
Pre-crisis Phase: Table 4.6

\[ r_{i,t} = \beta_0 + \beta_1 r_{us,t-n} + \beta_2 r_{us,t-n}D_{h,\text{pre},t-n} + \varepsilon_t \]

\[ \ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-p} + \beta_4 (|z_{t-n}| - E(|z_{t-n}|)) + C_1 \ln(h_{EA,t-q}) + d_1 r_{us,t-n}^2 + d_2 r_{us,t-n}^2 D_{h,\text{pre},t-n} \]

Mean Equation

- \( r_{i,t} \) = Return of an East African market at time \( t \): 1 = Kenya, 2 = Uganda, 3 = Tanzania
- \( \beta_0 \) = The constant term
- \( r_{us,t-n} \) = Lagged U.S. (S&P 500) stock index return
- \( r_{us,t-n}D_{h,\text{pre},t-n} \) = Interactive term, U.S. index return with a dummy variable that takes the value 1 during the pre-crisis phase and 0 otherwise.
- \( \varepsilon_t \) = Error term.

Variance Equation

- \( \ln h_{EA,t} \) = Logged Conditional variance of an East Africa market at time \( t \): 1 = Kenya, 2 = Uganda, 3 = Tanzania
- \( z_{t-q} \) = White noise (ARCH q term)
- \( |z_{t-n}| - E(|z_{t-n}|) \) = Difference between absolute residuals and expectation of absolute residuals
- \( \ln(h_{EA,t-p}) \) = The lagged dependent variable (GARCH p)
- \( r_{us,t-n}^2 \) = First exogenous U.S. squared returns
- \( r_{us,t-n}^2 D_{h,\text{pre},t-n} \) = Interactive second exogenous U.S. squared returns variable; depicts volatility contagion during the pre-crisis phase (\( D_{h,\text{pre},t-n} = 1 \) during the phase period and 0 otherwise)
- \( \text{Subscripts: } t \) refers to time \( t \), \( h_{\text{pre}} \) denotes the pre-crisis phase and \( q, q \text{ and } n \) states number of lags
Post - crisis Phase: Table 4.7

\[ r_{it} = \beta_0 + \beta_1 r_{us,t-n} + \beta_2 r_{us,t-n} D_{h,pst,t-n} + \epsilon_t \]

\[ \ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-p} + \beta_4 \left[ \left| z_{t-n} \right| - E(\left| z_{t-n} \right|) \right] + C_1 \ln(h_{EA,t-q}) + d_1 r_{us,t-n}^2 + d_2 r_{us,t-n}^2 D_{h,pst,t-n} \]

(iii)

Mean Equation

- \( r_{it} \) = Return of an East African \( i = 1, 2, 3: 1 = \text{Kenya} \quad 2 = \text{Uganda} \quad 3 = \text{Tanzania} \)
- \( \beta_0 \) = The constant term
- \( r_{us,t-n} \) = Lagged U.S. (S&P 500) stock index return
- \( r_{us,t-n} D_{h,pst,t-n} \) = Interactive term, US index return with a dummy variable that takes the value 1 during the post-crisis phase and 0 otherwise,
- \( \epsilon_t \) = Error term.

Variance Equation

- \( \ln h_{EA,t} \) = Logged Conditional variance of an East Africa market \( i \) at time \( t \)
  
  \[ 1 = \text{Kenya} \quad 2 = \text{Uganda} \quad 3 = \text{Tanzania} \]
- \( z_{t-q} \) = White noise (ARCH q term)
- \( \left[ \left| z_{t-n} \right| - E(\left| z_{t-n} \right|) \right] \) = Difference between absolute residuals and expectation of absolute residuals
- \( \ln(h_{EA,t-p}) \) = The lagged dependent variable (GARCH p)
- \( r_{us,t-n}^2 \) = First exogenous U.S. squared returns
- \( r_{us,t-n}^2 D_{h,pst,t-n} \) = Interactive second exogenous U.S. squared returns variable; depicts volatility contagion during the post-crisis phase \( (D_{h,pst,t-n} = 1 \) during the phase period and 0 otherwise)

- Subscripts: \( t \) refers to time \( t \), \( h_{pst} \) denotes the post-crisis phase and \( q, q \) and \( n \) states number of lags

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Kenyan Post-Election Violence: Table 4.8

\[ r_{it} = \beta_0 + \beta_1 r_{ke,t-n} + \beta_2 r_{ke,t-n} D_{h,pev,t-n} + \epsilon_t \]

\[ \ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-p} + \beta_4 [ |z_{t-n}| - E(|z_{t-n}|)] + C_1 \ln (h_{EA,t-q}) + d_1 r_{ke,t-n}^2 + d_2 r_{ke,t-n}^2 D_{h,pev,t-n} \]

Mean Equation

- \( r_{it} \) = Return of an East African \( i = 1, 2, : \) 1 = Uganda 2 = Tanzania
- \( \beta_0 \) = The constant term
- \( r_{ke,t-n} \) = Lagged Kenyan NSE stock index return
- \( r_{ke,t-n} D_{h,pev,t-n} \) = Interactive term, Kenyan index return with a dummy variable that takes the value 1 during the post-election crisis phase and 0 otherwise,
- \( \epsilon_t \) = Error term.

Variance Equation

- \( \ln h_{EA,t} \) = Logged Conditional variance of an East Africa market \( i \) at time \( t \)
  1 = Uganda 2 = Tanzania
- \( z_{t-q} \) = White noise (ARCH q term)
- \( [ |z_{t-n}| - E(|z_{t-n}|)] \) = Difference between absolute residuals and expectation of absolute residuals
- \( \ln (h_{EA,t-p}) \) = The lagged dependent variable (GARCH p)
- \( r_{h,pev,t-n} \) = First exogenous Kenyan squared returns
- \( r_{us,t-n} D_{h,pev,t-n} \) = Interactive second exogenous Kenyan squared returns variable; depicts volatility contagion during the Kenyan post-election crisis phase \( (D_{h,pev,t-n}=1 \) during the phase period and 0 otherwise)

Subscripts: \( t \) refers to time \( t \), \( h_{pev} \) denotes the post-election crisis phase and \( q, q and n \) states number of lags

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Appendix 2 Summary of Great Ten financial shocks

The Great Ten Financial Bubbles

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1636-37</td>
<td>The Dutch Tulip Bulb Bubble</td>
</tr>
<tr>
<td>1719-20</td>
<td>The South Sea Bubble</td>
</tr>
<tr>
<td>1718-20</td>
<td>The Mississippi Bubble</td>
</tr>
<tr>
<td>1927-29</td>
<td>The stock price bubble</td>
</tr>
<tr>
<td>1970s</td>
<td>The surge in bank loans to Mexico and other developing countries</td>
</tr>
<tr>
<td>1985-89</td>
<td>The bubble in real estate and stocks in Japan</td>
</tr>
<tr>
<td>1985-89</td>
<td>The bubble in real estate and stocks in Finland, Norway, and Sweden</td>
</tr>
<tr>
<td>1990-99</td>
<td>The Asian Bubble in real estate and the surge in foreign investment in Mexico</td>
</tr>
<tr>
<td>1995-00</td>
<td>The bubble in over-the-counter stocks in the United States</td>
</tr>
<tr>
<td>2002-08</td>
<td>Asset bubble in the US, UK, Spain, Ireland, and Iceland &amp; government of Greece debt</td>
</tr>
</tbody>
</table>
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Following your application for authority to carry out research on "Contagion and spillover effect from United States of America Stock Markets and Volatility of East African Securities Markets," I am pleased to inform you that you have been authorized to undertake research in Nairobi County for a period ending 30th October, 2015.

You are advised to report to the County Commissioner and the County Director of Education, Nairobi County before embarking on the research project.

On completion of the research, you are expected to submit two hard copies and one soft copy in pdf of the research report/thesis to our office.

DR. S. K. LANGAT, OGW
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County.

The County Director of Education
Nairobi County.
THIS IS TO CERTIFY THAT,
MR. HERMAN ANGWENYI KENGERE

of KENYATTA UNIVERSITY, 0-605
Nairobi, has been permitted to conduct
research in Nairobi County

on the topic: CONTAGION AND
SPILLOVER EFFECT FROM UNITED
STATES OF AMERICA STOCK MARKETS
AND VOLATILITY OF EAST AFRICAN
SECURITIES MARKETS

for the period ending: 30th October, 2015

Applicant's
Signature

Director General
National Commission for Science,
Technology & Innovation

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the County Education Officer of the area before
embarking on your research. Failure to do that
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2. Government Officers will not be interviewed
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3. No questionnaire will be used unless it has been
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the relevant Government Ministries.

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