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CONTAGION AND SPILLOVER EFFECT FROM DEVELOPED STOCK MARKETS TO THE EAST AFRICAN SECURITIES MARKETS

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Abstract: This paper investigates shock transmission mechanisms in East African securities markets. It models volatility effects between developed stock markets and volatility of the East African securities markets during the global financial downturn of 2007-2009. The United States of America stock markets was used as a proxy for the developed markets and source of the crisis. The study 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. Asymmetric Generalized Auto-regressive Conditional Heteroscedastic (E-GARCH 4,1) model was modified to capture both aspects of contagion and spillovers. 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 period, making up to 956 observations. The study 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 Kenyan and Ugandan markets. No evidence of volatility contagion to the East African markets during the pre-crisis and post-crisis phases however the study found that the Tanzania market experienced volatility contagion from the U.S. market after the main crisis phase. Moreover the study found out that the Kenyan Market has strong influence on the Uganda Securities exchange during volatile periods. Further study on interconnectedness of the East African Exchanges is advised employing Cointegration and Granger causality models.

Key Words: Contagion, Crisis, EGARCH, Influences, Volatility, Sub-prime, Spillovers

I. Introduction

The history of financial crises has raised concerns over the intensity and extent to which shocks emanating from one market are transmitted internationally across the markets. Considering the number of crises that have hit the global financial markets since the Second World War, the 2007/09 U.S credit crisis is viewed as the only crisis that meets the canons of a Global Financial Crisis, consequently marking the beginning of the Second Great Contraction (Reinhart & Rogoff, 2011).

Empirical studies on volatility of stock markets agree that market shocks resulting from unfavourable events such as financial meltdowns, political crises and 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 (Huynh, Kreinovich, Sriboonchitta, & Suriya, 2014). Furthermore, due to the inherent shock transmission channels, the same effect is propagated across borders, an effect termed as financial contagion (Chorafas, 2013).

Financial contagion concept 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 from 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 group of markets.

Previously, shock propagation was understood to be explained only by fundamental linkages such as bilateral trading (Vester, 2006). However the Asian crisis of 1998 presented a paradigm shift. Several stock markets across the Asian region that were not intrinsically linked through economic linkages were affected 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 may as well explain the wider spread of shocks across markets. As a result a distinction is made between volatility that is transmitted through fundamental or financial linkages that is Spillovers/inter-dependence and volatility explained by behaviour of investors that is contagion (Vester, 2006). This study will use the classification by (Forbes and Rigobon 2001).

The financial contagion theories suggest 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 in the East African region, financial linkages with developed stock markets such as of the U.S.A, U.K and the European regions exist. This is explained by the existing trade and financial linkages between these markets; foreign firms operating in the region and exposure to U.S. dollar fluctuations in the international transactions. These linkages according to the financial contagion theories form channels for interdependence or spillovers across markets (Kolb, 2011).

Moreover, 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 (Council & Bank, 2013). This and other foreign investor's activities may cause panic resulting to increased volatilities in the markets a phenomena referred to as contagion.

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 websites, 2015). About 40% of the companies listed in Uganda and Tanzania exchanges are Ken-

yan 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 TanzaniaInvest (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.

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% (AfricaReporters Mod, 2014), thus becoming one of the most attractive markets in the region.

II. Research Problem

The impact of the 2007/09 US credit crisis on the analysed major world stock markets and sub-regions was evident as reported across various studies; the 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, while the Japan's Nikkei 225 dropped by 42% during the same period (Bianco, 2008) and (Adair, Berry, Haran, Lloyd, & McGreal, 2009). 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 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. Empirical evidence 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.

Studies on the Kenyan NSE as a standalone market in the region distinctly focused on either economic variables or traditional theories, this presents general findings that fails to distinguish between spillovers and contagion effect. Moreover the actual effect of external and internal shocks has not been dissected for appropriate policy responses. This study therefore examines these aspects and advices whether the markets as block or individually are efficient to provide a good platform in Africa for global asset diversification during market shocks.

III. Review of Literature

Empirical studies on contagion effect have been carried out on different dimensions 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.

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 Cointegra-

tion 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 reported the existence of contagion effect from the US to the OECD stock markets. The findings are similar to Dash and Mallick (2009) study on the correlation between the US markets and Indian equity markets. The scope of analysis in these markets was fairly conclusive, though wider coverage may make it difficult to capture all market specific events adequately.

Intuitively, within the US financial markets, the effect of the crisis was predictable. Frank and Hesse (2009), using a multivariate GARCH model, tested the transmission of liquidity shocks in the USA markets. The study proved that linkages between markets and funding liquidity risks increased sharply during the crisis across the financial markets. Even though studies on contagion predominantly make use of Stock indices data and GARCH methodologies even those taking different approaches report analogous findings. For instance Longstaff (2010) used ABX subprime indices, DasGupta and Kaligounder (2012) network topology models on balance sheet data and Milunovich and Trück (2013) REITs indices.

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.

IV. Data and Methodology

The study employed causal research design to help disclose the functional relationship between the explanatory variable and its predicted impact on the dependent variable under investigation. The study used 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 divided into 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 to capture the moderating internal effect on the Kenyan market, another sub-sample period covering Post-Election Violence period, the Dec 2007 to March 2008 was considered for the Kenyan market to capture the actual impact of the violence event.

The data was obtained from Bloomberg Data services (Tickers KNSMIDX, DARSDSEI, UGSINDX and SPX). 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 DARSDSEI index (commenced on 2006).

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:

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

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.

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.

In modelling volatility of the three East African Markets, the study used the modified Exponential Generalised Autoregressive Conditionally Heteroscedastic model in line with (Baur,2003) suggestions to capture both effects of volatility and contagion. The full model under EGARCH system was estimated as follows:

Mean Equation:

$$\mathbf{r_{i,t} = \beta_o + \beta_1 r_{us,t-n} + \beta_2 r_{us,t-n} D_{crisis,t-n} + \varepsilon_t} \quad \mathbf{3.4}$$

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

Variance Equation:

$$\mathbf{\ln h_{EA,t} = \alpha_0 + \beta_3 z_{t-q} + \beta_4 [|z_{t-n}| - E(|z_{t-n}|)] + C_1 \ln(h_{EA,t-P}) + d_1 r^2_{us,t-n} + d_2 r^2_{us,t-n} D_{crisis,t-n} + d_3 r^2_{Ke,t-n} D_{crisis,t-n}} \quad \mathbf{3.5}$$

- $\mathbf{\ln h_{EA,t}}$ =Logged Conditional variance of an East Africa market i at time t
  1 $= \boldsymbol{kenya}$ **2** $= \boldsymbol{Uganda}$ **3** $= \boldsymbol{Tanzania}$
- $\mathbf{z_{t-q}}$= 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 $\boldsymbol{\beta_3}$**).**
- $[|\mathbf{z_{t-n}}| - \mathbf{E}(|\mathbf{z_{t-n}}|)]$ = Difference between absolute residuals and expectation of absolute residuals; the $\boldsymbol{\beta_4}$ 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.)
- $\mathbf{\ln(h_{EA,t-p})}$ = The lagged dependent variable (GARCH P) the parameter $\mathbf{C_1}$ in conjunction with $\boldsymbol{\beta_3}$, $\mathbf{(\beta_3 + C_1)}$ measured by magnitude and significance of sum of the parameters explains whether the shocks to the markets are persistent or are short lived.
- $\mathbf{r^2_{us,t-n}}$ = First exogenous US squared returns; parameter $\mathbf{d_1}$ explains the volatility spillover effect from the US markets to the East African Market *i*.
- $\mathbf{r^2_{us,t-n} D_{crisis,t-n}}$ = Interactive second exogenous US squared returns variable; depicts volatility contagion during the crisis period ($D_{crisis,t-n}$=1 during the crisis moment and 0 otherwise), $\mathbf{d_2}$ explains the contagion effect from the crisis source country.
- $\mathbf{r^2_{Ke,t-n} D_{crisis,t-n}}$ = Moderating effect of the Kenyan market. $\mathbf{d_3}$ 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 during the crisis moment and 0 otherwise).
- Subscripts : **t** refers to time t and **q**, $\boldsymbol{q}$ **and** $\boldsymbol{n}$ refers to the number of lags

V. Results and Findings

The table below presents summary of descriptive statistics on indices in the four markets during the three stages of the crisis.

Table 1: Descriptive Statistics

PRE-CRISIS	NSE	TSI	USEI	S&P500
Mean	0.001145283	0.008766593	0.067390657	0.018130337
Median	0.001152712	0	0.003638944	0.080183166
Maximum	0.236555	0.656421426	13.39621022	2.87895789
Minimum	-0.0412586	-1.28137653	-13.3962102	-3.53426921
Std. Dev.	0.018126941	0.146249945	2.682115199	0.996257438
Skewness	8.447605749	-2.14520113	-0.01905949	-0.55583956
Kurtosis	111.7772084	28.62581382	11.36391122	4.692210646
Jarque-Bera	130267.7394	7341.602503	754.9468396	45.26428926
Probability	0	0	0	1.48E-10
Sum	0.295483092	2.288080747	17.45418022	4.804539268
Sum Sq. Dev.	0.084446604	5.561152096	1855.985421	262.0276251
Observations	258	261	259	265

IN-CRISIS	NSE	TSI	USEI	S&P500
Mean	-0.00188919	0.061025933	-0.13634583	-0.20064333
Median	-0.00303464	0	-0.52866228	0.018323913
Maximum	0.069475841	12.72768036	230.3234027	10.2457328
Minimum	-0.05017616	-2.45204835	-233.093345	-9.46951447
Std. Dev.	0.015700086	0.795166915	19.03573795	2.590338256
Skewness	1.053755214	13.30609484	-0.1915432	-0.09264284
Kurtosis	6.415168068	214.0662579	145.4094122	5.655258769
Jarque-Bera	203.9963264	573257.5358	256887.4408	89.73991229
Probability	0	0	0	0.00E+00
Sum	-0.57431285	18.5518836	-41.4491338	-60.9955734
Sum Sq. Dev.	0.074687288	191.5839981	109794.8737	2033.085241
Observations	304	304	304	304

POST-CRISIS	NSE	TSI	USEI	S&P500
Mean	0.001069094	-0.0148714	0.189964191	0.001063193
Median	0.00070925	0	0.149855818	0.001174409
Maximum	0.103653665	4.755196145	228.7197322	0.043034725
Minimum	-0.10090838	-2.82681244	-222.770786	-0.04373225
Std. Dev.	0.010476723	0.32415972	19.45107809	0.012258576
Skewness	0.193913918	6.392070106	0.42602879	-0.20767232
Kurtosis	45.16222388	148.2113034	134.0149455	4.362812787
Jarque-Bera	31704.163	322287.9792	195259.1772	36.19756257
Probability	0	0	0	1.38E-08
Sum	0.457572085	-5.41318844	51.86022406	0.455046551
Sum Sq. Dev.	0.046868256	38.14386713	102909.6874	0.064166433
Observations	428	364	273	428

FULL SAMPLE	NSE	TSI	USEI	S&P500
Mean	0.000180548	0.016334195	0.033331663	-0.01071853
Median	-0.00016068	0	-0.03640011	0.089762206
Maximum	0.236555	12.72768036	230.3234027	10.2457328
Minimum	-0.10090838	-2.82681244	-233.093345	-9.46951447
Std. Dev.	0.01449809	0.503536583	16.03052093	1.722117562
Skewness	4.693401453	17.85073815	0.129188075	-0.33571937
Kurtosis	79.75918672	447.7138245	199.1072756	9.493143817
Jarque-Bera	246678.4986	7737873.642	1339624.873	1770.162973
Probability	0	0	0	0.00E+00
Sum	0.178742326	15.23980417	27.86527049	-10.686379
Sum Sq. Dev.	0.20788246	236.3077521	214576.297	2953.82614
Observations	990	933	836	997

The means for all indices were positive in the pre-crisis period, (**Table 1 above**) however during the crisis phase the Kenyan Market (NSE), Ugandan (USEI) and the United States S&P500 showed negative means. Contrary, the Tanzanian (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.

Table 2: Volatility linkages Pre-crisis Phase

		KENYA	UGANDA	TANZANIA
Parameters	**Conditional Mean Equation**			
β_0	Constant	0.000181	-0.026886	-0.00000875
		[0.000202]	[0.021478]	[0.000877]
β_1	Mean Spillovers	0.000342**	0.041877**	-0.001564***
		[0.00016]	[0.012852]	[0.000438]
β_2	Mean Contagion pre-crisis	-0.000725**	-0.052874***	0.001582
		[0.000403]	[0.012396]	[0.001525]
	Conditonal Variance Equation			
α_0	Constant	-3.044885***	0.058924	-0.679884***
		[0.52395]	[0.099824]	[0.070579]
β_3	Internal Influences	0.785911***	0.532108***	0.037648***
		[0.088228]	[0.074932]	[0.003493]
d_1	Volatility Spillovers	0.01325	-0.013107	-0.025145**
		[0.007371]	[0.057933]	[0.001574]
d_2	Volatility Contagion pre-crisis	-0.020866	0.039412	-0.057727**
		[0.058147]	[0.126669]	[0.023502]
	Residual Diagnostic (Model Fit Test)			
J-B	Normality Test	J-B- 454546.5	J-B- 4313742	J-B- 31953833
		P-Value :0.000	P-Value :0.000	P-Value :0.000
Ljung Box	Serial Correlation	**QLB310**	**QLB279**	**QLB311**
		Ho: True	**Ho: True**	**Ho: True**
ARCH test	ARCH Effect test	R-Squared-0.01346	R-Squared-0.00414	R-Squared-0.00112
		P-Value-0.9075	P-Value-0.9487	P-Value- 0.9734

*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*

Table 2 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 ($\boldsymbol{\beta_1}$) 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 ($\boldsymbol{\beta_2}$ 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 ($\boldsymbol{\beta_3}$) 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 findings on volatility contagion and spillovers ($\mathbf{d_1}$ and $\mathbf{d_2}$ 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.

Table 3: Volatility linkages In-crisis Phase

		KENYA	UGANDA	TANZANIA
Parameters	**Conditional Mean Equation**			
β_0	Constant	0.000654*** [0.000239]	0.07478 [0.041047]	-0.0000425 [0.003026]
β_1	Mean Spillovers	0.000153 [0.000153]	-0.040771 [0.033837]	0.0000032 [0.003175]
β_2	Mean Contagion	0.000467** [0.000217]	-0.033104 [0.045957]	-0.000215 [0.003227]
	Conditonal Variance Equation			
α_0	Constant	-2.627398*** [0.283692]	-0.276866*** [0.030416]	-1.050427*** [0.087131]
β_3	Internal Influences	0.856532*** [0.069767]	0.729061*** [0.024751]	0.075321*** [0.004928]
d_1	Volatility Spillovers	0.010564** [0.005079]	0.10341*** [0.017299]	-0.027209*** [0.007157]
d_2	Volatility Contagion	-0.02265 [0.032165]	-0.201791*** [0.021325]	0.001101 [0.006649]
	Residual Diagnostic (Model Fit Test)			
J-B	Normality Test	J-B- 12480.79 P-Value :0.000	J-B- 4729266 P-Value :0.000	J-B- 10430677 P-Value :0.000
Ljung Box	Serial Correlation	**QLB310** **Ho: True**	**QLB279** **Ho: True**	**QLB311** **Ho: True**
ARCH test	ARCH Effect test	R-Squared-0.24719 P-Value-0.06191	R-Squared-0.00344 P-Value-0.9532	R-Squared-0.000197 P-Value- 0.9888

*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 estimation results from **Table 3** above depicts findings for the in-crisis period; Jan 2008 to Mar 2009. The parameters of particular interest are Mean spillovers ($\boldsymbol{\beta_1}$) and Mean Contagion ($\boldsymbol{\beta_2}$) 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 ($\boldsymbol{\beta_3}$) 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. Volatility spillovers coefficient ($\boldsymbol{D_1}$) was statistically significant for Kenya and Uganda markets clearly implicating the markets for volatility spillovers from the U.S. markets Volatility contagion coefficient ($\boldsymbol{D_2}$) 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.

Table 3: Volatility linkages Post-crisis Phase

		KENYA	UGANDA	TANZANIA
Parameters	**Conditional Mean Equation**			
β_0	Constant	0.0000269	0.005771	-0.00000814
		[0.0002]	[0.014011]	[0.002456]
β_1	Mean Spillovers	0.00019	0.060352***	-0.003464***
		[0.000142]	[0.002126]	[0.0005]
β_2	Mean Contagion post-crisis	-0.000028	0.189921***	0.003454
		[0.000166]	[0.015145]	[0.002766]
	Conditonal Variance Equation			
α_0	Constant	-3.426557***	-0.0103	-1.165838***
		[0.5449]	[0.082717]	[0.06594]
β_3	Internal Influences	0.802655***	0.492343***	0.044297***
		[0.097923]	[0.084678]	[0.005488]
d_1	Volatility Spillovers	0.014829	-0.000061	-0.034916***
		[0.007825]	[0.054671]	[0.00107]
d_2	Volatility Contagion post-crisis	-0.070375***	-0.144426	0.331281***
		[0.030261]	[0.15193]	[0.046669]
	Residual Diagnostic (Model Fit Test)			
J-B	Normality Test	J-B- 181187	J-B- 427114	J-B- 28242098
		P-Value :0.000	P-Value :0.000	P-Value :0.000
Ljung Box	Serial Correlation	**QLB310**	**QLB279**	**QLB311**
		Ho: True	**Ho: True**	**Ho: True**
ARCH test	ARCH Effect test	R-Squared-0.01864	R-Squared-0.004371	R-Squared-0.001023
		P-Value-0.8914	P-Value-0.9473	P-Value- 0.9745

*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 3 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 ($\boldsymbol{\beta_1}$) coefficients). Positive mean contagion ($\boldsymbol{\beta_2}$ co-efficient) 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 $\boldsymbol{\beta_3}$ (internal influences) for all the markets are positive and highly significant. The Significance of $\boldsymbol{\beta_3}$ coefficients indicates that markets were influenced by internal or domestic activities. The $\mathbf{d_1}$ coefficient (volatility spillovers) is negative and significant for the Tanzania market implying no effect from the U.S. markets. Similarly, $\mathbf{d_2}$ (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.

Table 4: Moderating effect of the Kenyan Market to other East African Markets

		UGANDA	TANZANIA
Parameters	**Conditional Mean Equation**		
β_o	Constant	-0.038143***	0.00000516
		[0.018492]	[0.002904]
β_1	Mean Spillovers	9.593416***	0.000137
		[1.177506]	[0.171622]
β_2	Mean Contagion PEV-crisis	-24.94717***	-0.008444
		[1.177506]	[0.712067]
	Conditonal Variance Equation		
α_0	Constant	-0.08415	-0.762685***
		[0.061583]	[0.060149]
β_3	Internal Influences	0.401143***	0.038018***
		[0.064156]	[0.004125]
d_1	Volatility Spillovers	96.13764**	-327.7206***
		[44.89569]	[15.97147]
d_2	Volatility Contagion PEV-crisis	265.0977	27.09179
		[320.4396]	[149.5694]
	Residual Diagnostic (Model Fit Test)		
J-B	Normality Test	J-B- 4391152	J-B- 29428062
		P-Value :0.000	P-Value :0.000
Ljung Box	Serial Correlation	**QLB279**	**QLB311**
		Ho: True	**Ho: True**
ARCH test	ARCH Effect test	R-Squared-0.002357	R-Squared-0.001120
		P-Value-0.9613	P-Value- 0.9733

*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*

This section examines 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, we pursued the same concept. In the same line, the Kenyan market experienced internal political shocks (post-election violence) 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.

The Post-election (PEV) mean contagion ($\mathbf{B_2}$) and PEV volatility contagion ($\mathbf{d_2}$) variables depict the Kenyan scenario during the post-election crisis and $\mathbf{B_1}$ and $\mathbf{d_1}$ represents the expected or normal influence as a result of the fundamental inter-linkages within the region. The spillovers coefficient $\mathbf{B_1}$ shows proof of mean spill-overs from the Kenyan market to the Ugandan market. The mean contagion ($\mathbf{B_2}$) 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 volatility spillovers $\mathbf{d_1}$ coefficient report a large significant positive value for the Ugandan Market. The parameter is considerably higher compared to the model outcomes presented in the three phases of the crisis 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 $\mathbf{d_1}$ coefficient. Further, $\mathbf{d_2}$values gives no evidence of volatility contagion from the Kenyan market during the post-election crisis. Hence in regard to the Kenyan volatile moments during the political crisis, the study found no evidence of volatility or mean influence to the neighbouring markets.

VI. Summary of Findings

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 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. 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.

VII. Conclusions

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, the 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.

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.

VIII. Implications of the Study

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 researchers' 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.

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.

IX Areas for Further Research

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.

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