

Modeling Asymmetric Effect in African Currency Market: The Case of Kenya

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Abstract
At present, results on asymmetric volatility in the currencies of African economies are at best mixed. Although the bulk of the studies suggested the presence of asymmetric effect, a strand of studies reported 'no asymmetric effect'. The present study seeks to examine empirically the possibility of asymmetry in Kenyan exchange rate volatility in the light of the two recent crises: the global financial crisis of 2008-09 and the election violence of January-February 2008. Two quantitative techniques were employed; the dichotomous-EGARCH specification and the standard method of subsample comparison. Empirical results showed that returns exhibit some skewness and excess kurtosis, giving justification for the generalized error distribution that was applied in the variance equations. EGARCH estimates showed the presence of asymmetry in the volatility of Kenyan shillings in which positive shocks tend to increase volatility more than the negative. In addition, the estimated effect of the crises on conditional variance is about 12.5%. Tests of specification indicated that EGARCH(1,1) fits the daily currency series well. Further, subsample comparisons revealed a significant increase in volatility during the crises. While ARCH effects increased by 39.8%, GARCH effects also went up by 2.5%. Finally, the article recommends some measures that would promote greater exchange rate stability in the economy.
Keywords: Exchange rate volatility, Financial crisis, EGARCH, Election violence, Kenya

1. Introduction

The significance of modeling asymmetry in volatility is well documented by Nelson (1991), Glosten *et al.* (1993), Engle and Ng (1993), Bekaert and Harvey (1997), and Bekaert *et al.* (2003), among others. Specifically, asymmetry behavior in financial asset pricing (stock market returns) was first discussed in Black (1976). Some subsequent studies on the subject include Christie (1982), French *et al.* (1987), Nelson (1991), Schwert (1989) among others. Specifically, the bulk of the studies suggested that negative shocks lead to higher stock return volatility than equivalent positive shocks. A conceivable reason for this is the so-called leverage effect.

Up till the early nineties, the consensus in the currency market is that there is no asymmetric volatility in foreign exchange (FOREX, hereafter). Bollerslev *et al.* (1992), for instance, wrote: "[W]hereas stock returns have been found to exhibit some degree of asymmetry in their conditional variances, the two-sided nature of the foreign exchange market makes such asymmetries less likely." Later, empirical evidences emerged to support the existence of asymmetric effect in same: Byers and Peel (1995) documented evidence of asymmetric volatility in European exchange rates during 1922-1925, Tse and Tsui (1997) in Malaysian ringgit, McKenzie (2002) in Australian dollar, and Adler and Qi (2003) in Mexican peso, all against US dollar.

Studies on asymmetric volatility have been limited to the stock market. In general, empirical studies on asymmetric behavior for FOREX market are relatively few. For African currency market, they are very few. Moreover, the very few existing ones did not capture the asymmetries which may exist in the conditional volatility, notable exceptions being Chipili (2009), Olowe (2011), Bouoiyour and Selmi (2012) and Okyere *et al.* (2013).

Further, result on asymmetric volatility in African FOREX market is at best mixed: While Olowe (2011) reported "no asymmetric volatility" in the Nigerian foreign exchange market, Chipili (2009), Bouoiyour and Selmi (2012) and Okyere *et. al.* (2013) found evidence of asymmetry in the Zambian kwacha, Egyptian pound and Ghanaian cedi, respectively. Recently, Ntwiga (2012) using GARCH(1,1) and GARCH(2,2) models documented asymmetric volatility in the analysis of the effect of election violence shocks on Kenyan FOREX rates. However, according to Nelson (1991), GARCH model is in itself a restrictive model, in the sense that it assumes that only the magnitude and not the positivity or negativity of unanticipated excess returns determines features of the conditional variance. And as such is not appropriate to model asymmetry in volatility. Thus to our knowledge, the possibility of asymmetric volatility is yet to be investigated in the Kenyan currency market and also, the asymmetry associated with African FOREX market, in general, has not been fully examined.

The main objective of the present study is to examine empirically the possibility of asymmetry in Kenyan exchange rate volatility in the light of the recent global financial crisis. The US-originating financial crisis that recently engulfed the world economy offers more reasons to explore the possible asymmetric behavior in the exchange rates of developing countries. The belief is that countries in sub-Saharan Africa are barely integrated into the global financial system, and consequently, would be spared the effects of the global financial crisis. However, results from different surveys have proven otherwise. Ben Ltaifa *et. al.* (2009) for example, in a research on the impact of the crisis on the currencies of sub-Saharan Africa, reported that the currencies of many sub-Saharan African countries, like those of many emerging and developing economies, suffered large depreciations with the onset of the global financial crisis. These large depreciations was attributed to collapsing trade and financial flows which further led to substantial balance of payments gaps, triggering fast depreciations and higher exchange rate volatility. There are several other studies on the impact of the crisis to African countries. See for example, Kilonzo (2008), Anyanwu (2011), among others.

The election violence of 2008 is another major crisis which makes the case of Kenya a peculiar one, worthy of investigation. As Mwega (2010) noted, it will be very difficult to disentangle its effects from those of the global financial crisis. Consequently, the present paper investigates the case of asymmetric volatility in Kenyan shillings in the light of the recent global crisis and the presidential election violence.

Another contribution of the present study is that two methods have been employed; the (i) dichotomous model and (ii) standard statistical analysis of subsamples comparisons. Usually, for studies of this nature, the common approach is the latter, i.e. to divide the entire sample period into subperiods – pre-crises, during crises and post-crises. Then, obtain volatility equations based on the subsamples and compare the results. However, the present study acknowledges that this common approach is rather a mechanical estimation of the volatility model. Such a model may well have different parameters from year to year, and volatility may be triggered by changes in level (i.e. persistent movements in the same direction), in which case the interpretation would be rather different. Thus, it is important to investigate, first, if the change in conditional variance is as a result of the crises. In the light of this, the present paper introduces a dummy variable **C** in the volatility equation which takes value 1 during the crises period and 0 in the non-crises period. Once it has been established that the crises have some impact then the second step is to investigate the extent using volatility equations obtained for subperiods.

The remainder of the paper is organized in the following manner. Section 2 reviews related literature. Section 3 describes developments in the Kenyan foreign exchange market before and during the crisis. Section 4 presents the data and the methodology. Section 5 discusses the results of the empirical tests. Finally, Section 6 contains the conclusion and recommendations.

2. Literature Review

This literature section can be separated in two (but not really distinct) parts. The first one discusses empirical results on asymmetric volatility in FOREX market with emphasis on Africa. The second one analyzes the recent crisis with respect to its effect on fluctuations in exchange rate.

2.1 Asymmetric Volatility in Exchange Rate Market.

Wang and Yang (2006) identified central bank intervention as one of the major causes of asymmetric volatility in currency market: As central banks intervene on one side of the market but not the other, interventions may lead to an asymmetric behavior in exchange rate volatility. Another cause is contrarian and herding investors: In the case of stock markets, Avramov *et al.* (2006) reported that herding trades increase volatility as prices decline while contrarian trades reduce volatility following price increases. Now, Gençay, *et al.* (2003) and Carpenter and Wang (2006) have shown that contrarian trading and herding are present in the foreign exchange markets, thus, one would also expect asymmetric volatility.

Asymmetry in FOREX volatility has been studied extensively for developed markets (See Wang and Yang (2006) for a list of some of these studies). However, it is well known that returns from emerging financial markets have several features that distinguish them from developed markets. There are at least four distinguishing features of emerging market returns: higher sample average returns, low correlations with developed market returns, more predictable returns, and higher volatility (Bekaert and Wu, 2000). These differences may have important implications for decision making by investors and policy makers. Hence, the later part of this section is dedicated to empirical results on asymmetry behavior in the African FOREX markets.

Chipili (2009) examined the sources of conditional volatility in the real and nominal Zambian kwacha exchange rates with respect to the currencies of eight major trading partners from the period 1964 to 2006 using three GARCH-type models namely, GARCH(1,1), TGARCH(1,1) and EGARCH(1,1). He found that (i) EGARCH specification was the best fitting model for most exchange rates. (ii) TGARCH model did not detect asymmetry pattern in all exchange rates considered. However, EGARCH model did detect the presence of asymmetry in all the exchange rate series but one.

The following can be deduced from his findings. Evidence of asymmetry in conditional variance of Zambian kwacha suggests that the symmetric model GARCH usually employed in studying volatility in African currency market is restrictive. Further, the presence of asymmetry in the kwacha exchange rate series is consistent with the findings in most developed markets. Finally, in agreement with various other studies (See for instance Koutmos and Theodossion (1994) and Hu *et. al.* (1997)), EGARCH specification developed by Nelson (1991) is very efficient in capturing asymmetries in financial data.

In contrast to Chipili (2009), Olowe (2011) found no evidence of asymmetry in the Nigerian currency market. His research interest was to investigate the volatility of Naira/Dollar exchange rates using a wide range of asymmetric GARCH models, namely, GARCH (1,1), GJR-GARCH(1,1), EGARCH(1,1), APARCH(1,1), IGARCH(1,1) and TS-GARCH(1,1) models. Using monthly data over the period January 1970 to December 2007, the study rejected the hypothesis that asymmetric effect is present in Nigerian FOREX market. This is in sharp contrast to earlier studies in the developed economies.

Recently, Bouoiyour and Selmi (2012) also documented the existence of asymmetric effect in Egyptian pound. The paper investigated FOREX volatility using five different specifications of GARCH, namely, GARCH, EGARCH, GJR-GARCH, NGARCH and TGARCH. There were two main findings; first, specification tests (Akaike and Schwartz Information Criteria) identified EGARCH as the best fit for Egyptian currency, second, asymmetric effect was present in the Egyptian exchange rate market with positive shock increasing volatility more than the negative of the same magnitude.

Very recently, Okyere *et. al.* (2013) also using GARCH, EGARCH and TARCH to model asymmetries in Ghanaian cedi/US dollar submitted that positive shock implied a higher next period conditional variance.

We have no empirical evidence to rely on for most of the African countries, except for the ones mentioned above. These empirical studies present mixed results on asymmetric volatility in African exchange rate market though bulk of the evidence indicates the presence of asymmetry in volatility. Moreover, the case of Kenya, in particular, is yet to be investigated. Given the peculiarity in each financial market, it is important to examine the consistency of Kenyan Shillings in the context of the above-mentioned stylized facts.

2.2 Exchange Rate Volatility and Financial Crises.

The purpose of this section is to give an overview of theoretical and empirical literatures on exchange rate volatility and financial crises. More detailed descriptions of the recent crisis can be found in Ben Ltaifa *et. al.* (2009) and Melvin and Taylor (2009), among others. Interested reader is also invited to see Forbes and Rigobon (2000) and Glick and Rose (1998) for theories on crises and contagion.

That financial shocks affect exchange rate volatility is well documented in the empirical literature. But we shall review some recent studies.

Baharumshah and Hooi (2007) using EGARCH model reported strong evidence of asymmetry before and after the Asian crisis for most of the currencies (the Korean won, the Philippine peso, the Thai baht, the Malaysian ringgit and the Singapore dollar) they considered. Oga and Polasek (2008) did not consider asymmetry in their research; however, they agreed with earlier studies that the Asian crisis caused volatility structure change in East Asian currencies.

Though quite a number of studies have examined the impact of the previous crises, particularly the Asian crisis, on exchange rate volatility, yet the recent crisis is worth investigating because, according to Kohler (2010), it differs from the previous ones in a number of ways: First, the place of origin; and second, the scale of contagion. The Asian and the Argentinean episodes originated in emerging market economies; while in the most recent crisis the epicentre of the turmoil was the US banking system. Significant contagion was recorded in all the three episodes, in the Asian crisis it was largely confined to the region and that of the Argentinean episode was mainly confined to the neighboring countries, such as Brazil. The latest crisis, by contrast, was truly global.

At the onset of the crisis, there was no agreement (in the existing literature) as to whether African region would be spared the rippling effects of the crisis. Studies such as Horhota and Matei (2009), and Naudé (2009) anticipated very minimal (or no) effect, their reason being that the region is barely integrated into the global financial system. However, the International Monetary Fund (IMF) (2009) argued that Low Income Countries (LICs) (such as Africa) will be exposed to the current global downturn now more than in previous episodes because they are more integrated than before with the world economy through trade, FDI, and remittances. This submission by IMF (2009) is in agreement with the economic globalization index presented in Table 1 which shows that Africa has experienced a steady increase in economic globalization in the last four decades and consequently, is steadily integrating into the world markets.

AfDB (2009) identified two transmission channels of the crisis into Africa: trade flows and capital flows (such as foreign direct investment, private capital flows and remittances). For Kenyan economy in particular, Mwega (2010) highlighted four key mechanisms of transmission which are similar to the transmission channels earlier listed: private capital flows, trade, remittances, and foreign aid.

There are very few empirical studies relating FOREX volatility to the recent financial crisis in the context of African economies. In what follows the paper highlights some of the differences in those studies.

First there is no agreement as to when the crisis started. Ben Ltaifa *et. al.* (2009) defined the crisis period as June 2008 – March 2009. Coudert *et. al.* (2010) selected the larger period July 2007, the time of the bursting of the subprime crisis, to September 2009. Later, Olowe (2011) defined the crisis period as beginning from the time the takeover of Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation) by the American government was officially made public and extending up to March 2009. In line with the chronology of the crisis as documented in Kilonzo (2008) and Ben Ltaifa *et. al.*

(2009), and also incorporating the presidential election violence, this paper defines the crises period for Kenya as January 2008 – March 2009.

Second, in difference with methods, Ben Ltaifa *et. al.* (2009) measured exchange rate volatility as the ratio of the standard deviation of the exchange rate to its annual average; whereas it has been established that the traditional measure of volatility as represented by variance or standard deviation is unconditional and does not recognize that there are patterns in asset volatility e.g. time-varying and clustering properties. Coudert *et al.* (2010) employed both the squared monthly returns of exchange rates (in logarithms) and GARCH model in measuring FOREX volatility of certain emerging economies. While the former method suffers the same drawback as standard deviation the latter is inadequate because the use of GARCH model is restrictive (Nelson, 1991). And besides, if the presence of asymmetric volatility is not accounted for, it will lead to the underestimation of the Value at Risk (Engle, 2004). Finally, Olowe (2011) used both GARCH and GJR-GARCH in his analysis. However, as noted earlier, the dichotomous-GARCH model which he applied could only ascertain the presence of the impact of the crisis but could not provide the in-depth analysis of what went down during the period. The subsample comparison which, in addition, is being applied here is important especially for Kenyan economy as she was faced with election violence crisis about the time of the financial crisis, precisely January-February 2008.

Earlier empirical findings agreed that the crisis had effect on exchange rate volatilities of emerging economies but to what extent? Did the crisis cause volatility to increase or not? Was the effect symmetric? Has volatility returned to the state it was before the crises? To these questions the study attempts to offer answers.

3. Developments in the Kenyan Foreign Exchange Market: Before and During–the–Crises Review.

Since the collapse of the generalized fixed exchange rate regime and the adoption of a generalized floating system by the industrialized countries in 1973, African countries have experimented with various types of exchange rate arrangements, ranging from a peg to a single currency, weighted currency basket, managed floating, independently floating exchange rate system and monetary zone arrangements, such as the CFA Franc Zone and the Common Monetary Area (CMA) of Southern Africa. The experiences of various African countries with exchange rate arrangements and management have, therefore, been diverse and varied as these countries have sought to find an optimal and sustainable exchange rate regime.

For Kenya, the shift from a fixed to a flexible exchange rate regime has been gradual. According to Ndung'u (2000), from independence to 1974, the exchange rate for Kenya shilling was pegged to US dollar, but after discrete devaluations the peg was changed to the Special Drawing Rights (SDR). SDR was later abandoned because it was considered inadequate to maintain competitiveness of the shilling since the weights used did not reflect her trade pattern, which is more diversified. A crawling peg exchange rate regime was adopted until 1990 when it was replaced with a dual exchange rate system. The new regime lasted until October 1993, when, after further devaluations, the official exchange rate was merged with the market rate and the shilling was allowed to float. Following the years after the liberalization of the shilling, the exchange rate went through several phases of depreciations due to a number of factors. (See Mnjama (2011) for details). This made the Central Bank to intervene periodically to smooth out volatility. Speculation on the shilling eased from September 2004 following a positive assessment of the economy by IMF. Hence, from December 2004 to December 2007, its real exchange rate appreciated by 30% representing a major deviation from its past levels. According to Kiptui and Kipyegon (2008), this appreciation of the shilling real exchange rate has attracted public attention especially from exporters who have argued that the strengthening shilling is eroding their competitiveness. However, due to the global financial crisis, NEER declined by 1.1% between 2007 and 2008 and by 16.6% between 2008 and 2009 (CBK Annual Report, 2009).

4. Data and Methodology

4.1 Data

Exchange rate behavior is driven by market microstructure considerations rather than traditional economic fundamentals. As such, time duration between trades is important and might contain useful information about market microstructure (Mende, 2005; Goyal, 2007). In the light of this, high frequency data on daily exchange rates were employed. The entire data period is from January 1, 2006 to July 13, 2012, a total of 1,701 observations.

For the purpose of our analysis, the pre - crises period is from January 1, 2006 to December 31, 2007. Following Ntwiga (2012) the beginning of the election violence was presumed as January 1, 2008. According to Mwega (2010), among others, both the election violence and the financial crisis occurred simultaneously in Kenya, hence we defined the crises period from January 1, 2008 to March 31, 2009. The rest of the data is the "post-crises" period. Datasets on daily exchange rates of US dollar to the Kenyan shillings were obtained from the official website of the Bank of Kenya. The daily exchange rates used in this study are the average of the buying and selling rates.

Exchange rate returns r_t for each of the three periods were calculated using the formula

$$r_t = In\left(\frac{y_t}{y_{t-1}}\right) * 100 \qquad \text{---} \qquad (4.1)$$

Where t is the period (in days), y_t and y_{t-1} represent the exchange rate prices for days t and $t-1$ respectively and r_t is the exchange rate return for day t. The transformation from absolute prices y_t to returns r_t is justified by noting that it is more appropriate to base volatility measures on returns rather than absolute price movements. Level of prices experiences significant changes from time to time (Rahman et al., 2002). Moreover, absolute prices often display unit-root behaviour and thus cannot be modeled as stationary.

4.1.1 Statistical Properties of Data

The summary statistics of the exchange rate returns is given in Table 2. The result indicates that the data under study is skewed to the right, and leptokurtic. This agrees with Maana *et al.* which found evidence of unconditional leptokurtosis in Kenyan shillings. Additionally, result also suggests that Kenyan shillings exhibit some level of volatility, about 59%. Jarque-Bera statistics was highly significant, which implies that the distribution of Kenyan shillings is not normal. Furthermore, the Ljung-Box Q-statistic for both squared and un-squared residuals denoted $Q^2(20)$ and Q(20), respectively are reported in Table 2. Notice that both statistics are highly significant. This suggests that the exchange rate returns depend on past values, i.e. are serially correlated, and that the residuals are strongly heteroscedastic. Using the correlogram as guide the author found that including lags 1, 2, 4, 6, 10 and 14 in the mean equation effectively removed the serial correlation earlier reported. Q(20) and $Q^2(20)$ for the new mean equation are 8.1165 and 895.64 respectively with p-values 0.991 for Q(20) and 0.00 for $Q^2(20)$. The issue of heteroscedasticity will be addressed in the next section using EGARCH.

4.2. Methodology

Conditional heteroskedasticity models have been widely used in the literature to evaluate time-varying volatility; see Bollerslev *et al*. (1992) or Bera and Higgins (1993) for a survey of the literature. Some of the commonly used ones include the Asymmetric GARCH (A-GARCH) of Engle (1990), EGARCH of Nelson (1991), Asymmetric Power ARCH (A-PARCH) of Ding *et al*. (1993), GJR-GARCH of Glosten *et al*. (1993), Threshold GARCH (T-GARCH) of Zakoian (1994), and the Asymmetric Nonlinear Smooth-Transition GARCH (ANST-GARCH) of Anderson *et al*. (1999). EGARCH model is usually preferred in modeling because it provides a specification that allows for asymmetry and volatility changes to be measured simultaneously. In addition, it can capture large shocks of any sign in a financial series, such as the one observed during currency crisis (Baharumshah and Hooi, 2007).

4.2.1. EGARCH Model Specification

For each integer t, let ε_t be the model's prediction error, σ_t^2 is the conditional variance of ε_t, $\omega,\ \alpha_i\ (i = 1,2,\cdots,p)\ and\ \beta_j\ (j = 1,2,\cdots,q)$ are parameters, a univariate Generalized Autoregressive Conditional Heteroscedasticity model, GARCH(p,q), model is

$$\left.\begin{array}{l} \varepsilon_t = \sigma_t z_t \quad where \quad z_t \sim \quad i.i.d \quad with \\ E(z_t) = 0, \quad Var(z_t) = 1, \quad and \\ \sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \end{array}\right\} \qquad \text{-------------} \qquad (4.2)$$

In model (4.2), α_i reflects the influence of random deviations in the previous period on σ_t, whereas β_j measures the part of the (realized) variance in the previous period that is carried over into the current period. The sizes of the parameters α_i and β_j determine the short-run dynamics of the resulting volatility time series. Large error coefficients, α_i, mean that volatility reacts intensely to market movements. Large lag coefficients,

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β_j, indicate that shocks to conditional variance take a long time die out, so volatility is persistent.
The conditional variance in the EGARCH model proposed by Nelson (1991) is given following Eviews specification by Quantitative Micro Software (2010),

$$In\left(\sigma_t^2\right) = \omega + \sum_{j=1}^{q} \beta_j In\left(\sigma_{t-j}^2\right) + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \quad \text{--------} \quad (4.3)$$

(In EGARCH, equation (4.3) replaces the last equation in the system (4.2)).

The presence of leverage effect is indicated by inclusion of the term γ_k and the impact on the conditional variance is asymmetric if $\gamma_k \neq 0$. When γ_k < 0, then positive shocks (good news) generate less volatility than negative shocks (bad news). When γ_k > 0, it implies that negative shocks generate less volatility than positive shocks. In other words, A negative value of γ_k implies that negative innovations or news lead to a higher subsequent increase in the volatility of the exchange rate compared with positive news. Hence, an appreciation of the domestic currency relative to the foreign currency tends to induce a higher increase in volatility of the domestic currency than a depreciation of the same magnitude in the subsequent period (Pozo, 1992; Kahya, et al. 1994; and Kočenda and Valachy, 2006).

Under the assumption that the distribution of $z_t = \frac{\varepsilon_t}{\sigma_t}$ followed the Generalized Error Distribution (GED), the log-likelihood function of EGARCH(p,q) model is

$$L_T = \sum_{t=1}^{T} \left(In\left(\frac{\upsilon}{\lambda}\right) - \frac{1}{2}\left|\frac{z_t}{\lambda}\right|^{\upsilon} - \left(1 + \frac{1}{\upsilon}\right) In(2) - In\Gamma\left(\frac{1}{\upsilon}\right) - \frac{1}{2} In\left(\sigma_t^2\right) \right), \quad \text{-------} \quad (4.4)$$

Where

$$\lambda = \left(\frac{2^{\left(-\frac{2}{\upsilon}\right)} \Gamma\left(\frac{1}{\upsilon}\right)}{\Gamma\left(\frac{3}{\upsilon}\right)} \right)^{1/2} \quad \text{--------------------} \quad (4.5)$$

The density of a GED random variable normalized to have a mean of zero and a variance of one is given by:

$$f(z_t) = \frac{\upsilon \exp\left(-\frac{1}{2}\left|\frac{z_t}{\lambda}\right|^{\upsilon} \right)}{\lambda 2^{\left(1+\frac{1}{\upsilon}\right)} \Gamma\left(\frac{1}{\upsilon}\right)} \qquad -\infty < z_t < \infty, \quad 0 < \upsilon \leq \infty, \quad \text{--------------} \quad (4.6)$$

Where $z_t = \frac{\varepsilon_t}{\sigma_t}$, $\Gamma(.)$ is the gamma function, λ is as defined in (4.5), and υ is tail thickness parameter. When $\upsilon = 2$, has a standard normal distribution. For $\upsilon < 2$, the distribution of z_t has a thicker tail than the normal and for $\upsilon > 2$, the distribution of z_t has thinner tails than the normal.
Under sufficient regularity conditions, the maximum likelihood estimator is consistent and asymptotically normal (Nelson, 1991). EGARCH(1,1) specifications are employed despite the existence of higher order GARCH specifications on the strength of empirical evidence such as Hsieh (1989) and Malik (2005) that they are parsimonious and most common specification of GARCH models that sufficiently characterise the behaviour of the exchange rates (Kočenda and Valachy, 2006; and Harrathi and Mokhtar, 2007). The model parameters are estimated using the maximum likelihood procedure described in Berndt et al. (1974). The relevant variance equations are
1) Full sample without dummy variable C

$$In(\sigma_t^2) = \omega + \beta In(\sigma_{t-1}^2) + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad \text{------} \quad (4.7)$$

2) Full sample with dummy variable C

$$In(\sigma_t^2) = \omega + \beta In(\sigma_{t-1}^2) + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \theta C \quad \text{-------} \quad (4.8)$$

3) Pre-crises, crises and post-crises subsamples

$$In(\sigma_t^2) = \omega + \beta In(\sigma_{t-1}^2) + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad \text{-------} \quad (4.7)$$

Where t is the period (in days), θ is the dummy variable coefficient and C the dummy variable which takes value 1 during the crises and 0 otherwise, and β, α, γ *and* θ are parameters to be estimated. Notice that the same variance equation (4.7) is estimated in both subsamples. The only difference is the span of each period.

5. Estimation Results

We have divided this section into two parts for clarity. The first part analyzes the full sample period using dichotomous-EGARCH model while the second part compares the variance equations obtained from the subsamples.

5.1 First Part

The maximum likelihood parameters were computed using Eviews 7. Table 3 lists the parameter estimates for EGARCH(1,1) exchange rate model for 2006 – 2012 with and without the inclusion of variable coefficient θ measuring the presence (or absence) of the effect of both Kenyan election violence and the 2008-09 financial crisis.

Next we examine the empirical issues raised earlier in the section:

i) In agreement with Bouoiyour and Selmi (2012) and Okyere *et. al.* (2013), the asymmetric relation between returns and changes in volatility, as represented by γ , is positive and highly significant. Recall that the positive value of γ indicates that volatility tends to rise (fall) when returns surprises are positive (negative). The estimated values for γ in both models are about 0.0383 and 0.0397 (with a standard error of about 0.015 and 0.017) respectively which is significantly above zero at any standard level.

Figures 1 and 2 plot σ_t^2 (the conditional variance of returns) and the log value of the Kenyan shillings exchange rate returns, respectively. σ_t^2 exhibits variations with lows of less than one-half and highs over ten. Notice that major episodes of high volatility are associated with market rise.

ii) The estimated effect of the crises on conditional variance is partly consistent with the results of Olowe (2011) and Ntwiga (2012). The estimated value of θ is about 0.125 with a standard error of 0.026.

Specification Tests: Correct specification of EGARCH model has implications for the returns (Nelson, 1991). Accordingly, we test for serial correlation in the standardized residuals and the squared standardized residuals at lags one through twenty.

Table 3 also reports the Ljung-Box Q-statistic with 20 lags (denoted Q(20) and $Q^2(20)$) for e_t and and their associated p-values. It also gives the loglikelihood values (denoted LogL) and the ARCH ML test statistic with 20 lags (denoted ML(20)). In the Ljung-Box test, EGARCH model did very well, with probability values of 0.212 and 0.885 for Q(20) and $Q^2(20)$ (respectively) before the inclusion of the dummy variable. The model did even better after the variable was introduced as the Ljung-box test values went up by about 41.04% and 6.78%, respectively. Consequently, the loglikelihood value also increased. Meaning that the serial correlation and ARCH effect found in the datasets before modeling has been removed in both cases; giving justification for the specified model.

5.2 Second Part

This section provides in-depth analysis of the crises, in the sense that the entire period is divided into three subperiods: pre-crises, crises and post-crises. The essential parameters of the volatility equations shall be analyzed for possible changes. Table 4 presents the parameter estimates for the three subsamples.

First, in the three periods, large error coefficients, α, suggested that volatility reacted intensely to market movements. Large lag coefficients, β,also indicated that shocks to conditional variance took a long time to die out, so volatility was persistent. Further, in agreement with Kilonzo (2008) and Ben Ltaifa *et. al.* (2009) among others, volatility increased significantly during the crises compared to the remaining subperiods. Results showed that α coefficient which represents the ARCH effects increased by 39.8% during the crisis and went down thereafter. Moreover GARCH effects also experienced an increase during the period but by only 2.5%. Whereas it increased further by 17.8% in post-crises. Asymmetry parameter (γ), increased (on the absolute) during the crises but decreased thereafter. It is noteworthy that same parameter was positive before and after the crises but negative during the period with standard error of 0.04, 0.06 and 0.02 for the period before, during and after the crises, respectively.

Therefore, results showed that volatility increased during the crises but went down (on the average) thereafter.

6. Conclusion and Recommendations

The study investigates the asymmetric effect of the election violence and the recent global crisis on the exchange rate volatilities of Kenyan shillings using EGARCH-GED model. We found that EGARCH(1,1) specification fits the data well and captures the salient features of the exchange rate volatility in the data. The major findings are: first, we found strong evidence of asymmetries in the exchange rate volatility of Kenyan currency. Second, dichotomous - EGARCH results indicate that the election violence of 2008 and the U.S. global crisis have significant impact on the exchange rate volatilities of Kenya. This provides additional evidence that Africa is not insulated from the rippling effects of the US-triggered crisis. Third, the bulk of evidence points to the fact that the conditional volatility, in the context of ARCH, GARCH and asymmetric effects, has substantially increased during the crises, but went down afterwards.

It is established in the literature (See, for instance, Chowdhury (1993), and Arize (1996)) that exchange rate volatility deters trade flows and that a higher currency risk is not favorable to foreign investments. Policy makers, therefore, should be concerned with the increase in volatility in this post-crisis era. The following are some recommendations: First and foremost, good corporate governance is required to restore market confidence, attract FDI/ Private capital inflows and investments and promote economic growth. This will be achieved by increasing; the accountability of directors, the transparency of corporate structures and financial transactions. Recall that Asian banks escaped significant impact of crisis (largely) due to well capitalized banks, cautious regulation and huge forex reserves (Baharumshah and Hooi, 2007).

Second, international surveillance is equally important. If multilateral organizations especially IMF can play the role of “policing” the global financial system and warn of potential trouble spots and crisis, the impact (if any) would be minimal on Kenya if the surveillance information available is well utilized.

This present lull in the economy provides an opportunity to implement effective economic policies in order to ensure internal short-term and long-term economic growth. Sub-Saharan Africa had experienced relatively substantial economic growth before the global financial crisis, and it is important that it continues to grow in order to meet Millennium Development Goals and further alleviate poverty.

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Table 1: KOF Globalization Index for Africa (Average)

	1970-79	1980-89	1990-99	2000-09
Central Africa	24.07	29.11	32.09	39.93
East Africa	22.22	24.66	33.18	43.07
South Africa	48.86	51.63	54.43	59.10
West Africa	24.16	29.25	35.84	44.16
Sub-Sahara Africa	29.83	33.66	38.88	46.57
World	41.09	44.26	51.33	60.48

Source: konjunkturforschungsstelle (KOF), Swiss Economic Institute Database 2010, ETH, Zurich, Germany.

Table 2: Summary Statistics of Kenyan Exchange Rate Return (January 1, 2006 – July 13, 2012)

	Kenya
Mean	0.009133
Standard Deviation	0.590059
Skewness	0.012617
Kurtosis	17.41909
Jarque-Bera	14111.95 (0.00)
Q(20)	69.886 (0.00)
$Q^2(20)$	998.60 (0.00)

Q(20) and $Q^2(20)$ denote the Ljung-Box Q-statistic with 20 lags for the standardized residuals and the squared standardized residuals, respectively. P-values are in parentheses.

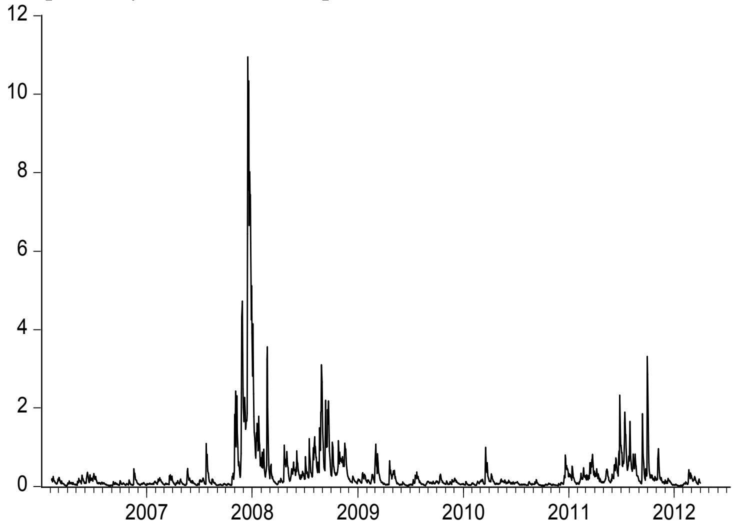

Figure 1: Daily Volatility

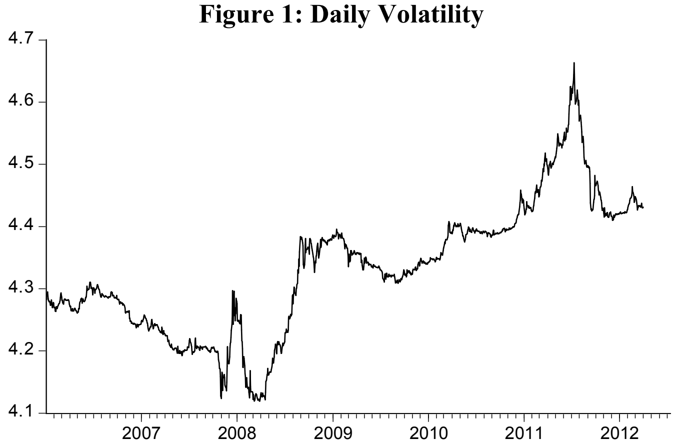

Figure 2: Log of Kenyan shillings exchange rate returns

Table 3: Parameter Estimates of the EGARCH-GED model with and without dummy variable, (January 1, 2006 – July 13, 2012).

Parameter	EGARCH	Augmented EGARCH
ω	-0.390662 (0.00)	-0.519502 (0.00)
α	0.408995 (0.00)	0.459998 (0.00)
γ	0.038309 (0.0116)	0.039657 (0.00)
β	0.950239 (0.00)	0.915630 (0.002)
θ	NA	0.125067 (0.00)
LogL	-722.7345	-714.3860
Q(20)	24.727 (0.212)	22.791 (0.299)
Q^2(20)	12.813 (0.885)	11.070 (0.944)
ML(20)	12.06691 (0.9138)	10.33994 (0.9616)

Q(20) and Q^2(20) denote the Ljung-Box Q-statistic with 20 lags for the standardized residuals and the squared standardized residuals, respectively. LogL is the loglikelihood, ML(20) denotes the ARCH ML test statistic with 20 lags. P-values are in parentheses. NA means Not Applicable.

Table 4: Parameter Estimates of EGARCH-GED model (precrises, crises and post-crises subperiods)

Parameters	Pre-crises	Crises	Post-crises
ω	-0.922175 (0.00)	-0.647778 (0.00)	-0.451504 (0.00)
α	0.530294 (0.00)	0.741219 (0.00)	0.442576 (0.00)
γ	0.000834 (0.98)	-0.180210 (0.003)	0.061778 (0.01)
β	0.780491 (0.00)	0.799635 (0.00)	0.941553 (0.00)

P-values are in parentheses

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