International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2021, 11(2), 35-39.

Modelling Exchange Rate Volatility of Somali Shilling Against US Dollar by Utilizing GARCH Models

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Received: 14 April 2020 **Accepted:** 25 December 2020 **DOI:** https://doi.org/10.32479/ijefi.9788

ABSTRACT

The main aim of this investigation was to model the volatility of Somali shilling against US dollar by using monthly data covering from 1950 to 2010. Further to that, this finding has adopted both symmetric and asymmetric generalized autoregressive conditional heteroscedastic (GARCH) family models in order to capture volatility clustering and leverage effect as the most stylized facts of exchange rate returns. Result from ARCH indicates presence of conditional heteroscedasticity in the residual series of exchange rate. Symmetric GARCH(1,1) model shows presence of volatility clustering and persistent coefficients of <1 indicating that volatility is an explosive process. Results from asymmetric TCHARCH(1,1) and EGARCH(1,1) indicates presence of leverage effect in the series of exchange rate meaning positive news have large effect on volatility than bad news of same magnitude. This study has an important implication to investors and risk managers. Nevertheless, this study suggests monetary authority to print new currency and de-dollarize the economy in order to be able influence exchange rate volatility. The outcome from this finding also suggests that GARCH family models sufficiently capture the volatility of Somali shilling against US dollar.

Keywords: Exchange Rate, Somali Shilling, US Dollar, Conditional Heteroscedasticity, Volatility Clustering and Leverage Effect
JEL Classifications: F31, O24

1. INTRODUCTION

Exchange rate is the rate at which one currency is converted or exchanged into another. Therefore, there are two categories of exchange rate regime in which every country has to adopt a particular one. The first one is floating exchange rate regime where a value of a currency is allowed to fluctuate against other currencies in response of market forces. The Other category is pegged exchange rate which is also know fixed exchange rate, this type the value of a certain currency is fixed against either basket of another currencies or any other measure of value such as gold.

After the end of Bretton wood monetary system decisions regarding which exchange regime to apply become more challenging in this modern economy as trade and capital markets become more integrated in the world as stated by (Berg and Borensztein, 2001). Despite that exchange rate has gained much attention due to its strong link with most of the macroeconomic variables. (Bahmani-Oskooee and Mohammadian, 2016) study showed that exchange rate volatility affects domestic production, therefore following this work exchange rate will gain attention as any country want make policy concerning domestic production. Further to that, there are significant relationship among exchange rate and macroeconomic variables as confirmed by (Su, 2012). Therefore, following this evidence exchange rate become an important element in macroeconomic analysis and economic decision making.

Since floating exchange rate become prominent across the world countries after the end of Bretton wood system modelling exchange rate by measuring its fluctuation (risk) become vital. (Abdalla, 2012) conducted finding to model exchange rate of nineteen Arab countries while using GARCH models find out the existence leverage effect which indicates that negative effect have large effect on volatility than positive change of same magnitude. There is presence of volatility clustering and leverage effect on USD against Kenyan shilling as confirmed by the work of (Omari et al., 2017). (Epaphra, 2016) find that current exchange rate volatility depends on its previous fluctuation and presence of leverage effect although positive shocks have more effect on volatility than negative shocks of same size as he elaborated by using Tanzania shilling against USD. Both (Abdalla, 2012; Mohsin, 2018) of these investigation find the presence of leverage effect where negative shocks have greater influence on volatility than positives shocks. Despite of the research outcome all of the cited findings has adopted GARCH models.

Somali economy is characterized by high dollarization and unregulated exchange rate as the central bank of the nation become ineffective due to collapse of Somali republic back in 1991. Moreover, no study has considered modelling time series data of S.SH against USD apart from the work of (Nor et al., 2020) which focused macroeconomic determinants of exchange rate. therefore this study fill this gap by modelling exchange rate (S.SH/USD) while adopting GARCH model due to its relevant in capturing volatility as applied by almost all the findings regarding this matter.

Although Somalia's economy is highly dollarized economy, there are still the use of Somali shilling in the market. However the biggest and smallest is 1000 Somali shilling which can easily faked in other way supplied in the market illegally by individuals as confirmed by (Yusuf and Abdurrahman, 2019).

2. DATA AND METHODOLOGY

2.1. Data

In order to model volatility of exchange rate (SOS/USD) as the research objective of this investigation, this article deployed monthly exchange rate of Somali shilling against US dollar data covering period from 1950 to 2010. Further to that time series data of exchange rate (SOS/USD) was sourced from Federal Reserve Bank of St. Louis.

2.2. Methodology

2.2.1. Unit root test

Most macroeconomic and financial time series are reflect trending which is indication of non-stationary. As non-stationary time series analysis lead ordinary least square (OLS) procedures to produce misleading or incorrect results (spurious regression). To avoid the problem of spurious regression this finding conducted united root test by deploying Augmented dickey-fuller test using developed by (Dickey and Fuller, 1979).

$$\Delta y_t = \alpha_0 + \beta_t + \theta y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta y_{t-1} + \varepsilon_t$$

where y_t stands for shows the tested time series, t is the sign of time trend, Δ stands for change of first difference and k is the lag order of the autoregressive process.

The null hypothesis (H_0) which says there is unit root or the exchange rate series is not stationary is reject and alternative hypothesis (H_1) is accepted if the t-statistic is greater the critical value as stated by (Dickey and Fuller, 1979).

2.2.2. Modelling volatility

To model volatility of exchange rate (SOS/USG) this study adopts ARCH and GARCH family models to ensure if large changes is followed by large change and small changes is followed by small changes (volatility clustering).

2.2.3. GARCH family models

GARCH family models are splitted in to symmetric and asymmetric. Conditional variance depends on the magnitude of the change rather than the sign in symmetric models while changes of same magnitude have different effect on future volatility under asymmetric models.

GARCH and GARCH-in-Mean are considered to be symmetric models of GARCH family. as far as this study is concerned GARCH model will be focused. Autoregressive conditionally heteroscedastic (ARCH) was first developed by (Engle, 1982) and after that Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model by (Bollerslev, 1986).

Ordinary least square (OLS) regression assumes that variance of error term is constant (homoscedasticity) although it is not the case of financial time series which exhibit non constant variance (heteroscedasticity). In this case the existence of heretoscedastic in SOS/USD series leads autoregressive conditionally heteroscedastic (ARCH) model for the variance of errors. ARCH model was first developed by (Engle, 1982) by stating that the variance of residuals at time t depends squared residuals of error time in the past periods. Therefore by allowing the dependence of variance on lagged period of squared residuals (Engle, 1982) specified as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2$$

If test statistic (TxR2/the number of observations multiplied by the coefficient of multiple correlation) is significant we reject the null hypothesis of homoscedasticity (variance of error term is constant) and conclude that ARCH effects are present. In the instance where ARCH effects are present in SOS/USD series we proceed to check volatility clustering by adopting GARCH model.

As stated by (Narsoo, 2015) it is difficult to significantly capture the dynamic behaviour of volatility by ARCH model demands high ARCH order. Bollerslev's model GARCH dealt the weakness by allowing the conditional variance to depend its own previous lags. GARCH(1,1) which similar to ARIMA(1,1) can be specified in general form as:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i u_{t-1}^2 + \sum_{i=1}^{q} \beta_j \sigma_{t-j}^2$$

Where:

σ_t^2 stands for the estimated conditional variance.

u_{t-1}^2 stands for the past squared residuals.

σ_{t-j}^2 lagged conditional variance.

Generalized autoregressive conditional heteroscedasticity (GARCH) model is considered to be more parsimonious and less likely to breach non-negativity compared to autoregressive conditional heteroscedasticity (ARCH) as stated Model by (Bollerslev, 1986).

After GARCH model was developed, various extension and variants has been proposed considering to asymmetric models and most prominent are GARCH-M, TGARCH and EGARCH models. In addition to that these asymmetric models was developed as symmetric models violated non-negativity constraints and cannot account for leverage effect as confirmed by (Narsoo, 2015). From the asymmetric models this finding will only consider TGARCH and EGARCH.

Threshold generalized autoregressive conditional heteroscedasticity (TGARCH) model introduces multiplicative dummy variable in to the variance equation to check if positive and negative shocks of same magnitude have different effect on volatility. Further to that TGARCH model is specified as:

$$h_t = y_0 + \delta_1 h_{t-1} + y_1 u_{t-1}^2 + \theta u_{t-1}^2 d_{t-1}$$

Where d takes the value of 1 for $u_t < 0$ and 0 otherwise.

So good news has an impact of y while bad news has an impact of $y + \theta$. If $\theta > 0$ we conclude that there is asymmetry while if $\theta = 0$ we say the news is symmetric.

The variance equation of exponential Generalized autoregressive conditional heteroscedasticity (EGARCH) developed by (Nelson, 1991) is specified as:

$$\log\left(\sigma_t^2\right) = \Delta + \Delta \log\left(\sigma_{t-1}^2\right) + \gamma \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \alpha \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right]$$

Even if the parameters are negative, σ_t^2 will be positive because since we model the $\log\left(\sigma_t^2\right)$.

3. EMPIRICAL RESULT AND DISCUSSION

3.1. Descriptive Statistics and Unit Root Test

The information presented in table shows that the mean of exchange rate is positive. As presented in Table 1 the skewness of 1.8 indicates that exchange rate has long right tail with positive skewness. Since the kurtosis of 6, 2 is greater than standard univariate normal distribution of 3 the exchange rate series is leptokurtic which means the distribution graph of exchange rate (SOS/USD) high and thin. Since P-value of Jarque-Bera test is <1% significant level we reject the null hypothesis of normal distribution which indicates that SOS/USD series is not normally distributed.

This investigation adopted Augmented dickey-fuller unit root test to ensure the stationarity of exchange rate series. As presented in Table 2 exchange rate series is not stationary at level. Therefore to transform the SOS/USD time series date into stationary this is done by differentiating twice EXRATE as indicated in Table 3 meaning exchange rate is integrated order one I(2). T-statistic of augment dickey fuller is less than the critical values at 1% significance level we reject the null hypothesis that there is unit root and conclude that SOS/USD series is now stationary at I(2). In this case we can proceed to test the presence of ARCH effect in exchange rate series.

3.2. Heteroskedasticity Test

The result presented in Table 4 shows that P-value of 0.0000 is <5% significance level we reject the null hypothesis no ARCH effect. This means existence of ARCH effect in exchange rate (S.SH/USD) series. In the present case this finding will estimate ARCH family models.

The exchange rate of Somalia shilling against US dollar was regulated by monetary authority but after the collapse of Somali state in 1991 the system remains unregulated until date. As Figure 1 presents exchange rate seems variable stable from 1950 till 1987 but right after that S.SH/USD was getting more volatile and reflected volatility clustering.

Table 1: Summary statistics of exchange rate (S.SH/USD)

Mean	4004.881
Median	7.142860
Maximum	31900.00
Minimum	6.281500
Std. Dev.	6921.123
Skewness	1.887834
Kurtosis	6.215822
Sum	2931573.
Sum Sq. dev.	3.50E+10
Observations	732
Jarque-Bera	750.2140
Probability	0.000000

Table 2: Augmented dickey-fuller test of EXRATE (S.SH/USD)

		t-statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.551456	0.9994
Test critical values:	1% level	−3.439217	
	5% level	−2.865344	
	10% level	−2.568852	

Table 3: Augmented dickey-fuller unit root test of DEXRATE

		t-statistic	Prob.
Augmented Dickey-Fuller test statistic		−26.54391	0.0000
Test critical values:	1% level	−3.439217	
	5% level	−2.865344	
	10% level	−2.568852	

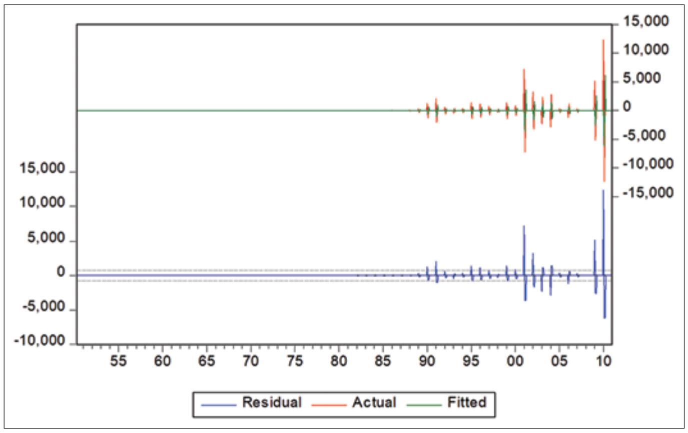
Table 4: Heteroskedasticity test: ARCH

F-statistic	58.17523	Prob. F(1,726)	0.0000
Obs*R-squared	54.00778	Prob. Chi-square(1)	0.0000

Table 5: Results of GARCH, TGARCH AND EGARCH

Model	GARCH (1,1)		TGARCH (1,1)		EGARCH (1,1)	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Constant (ω)	−0.0000157	0.0000	−0.0000399	0.0000	6.282103	0.0000
ARCH effect (β)	0.290290	0.0000	0.038938	0.0086	0.512478	0.0000
Leverage effect (γ)	-------------	--------	--------------	-------	0.122238	0.0484
Symmetry (threshold)	-------------	--------	0.401645	0.0000	----------------	------
GARCH effect (α)	0.997125	0.0000	0.997776	0.0000	0.168591	0.0005
DLEXRATE	−0.526345	0.0004	−0.550733	0.0000	−0.362912	0.0000
Log likelihood	−1910.700		−1928.219		−5728.825	

Figure 1: exchange rate (S.SH/USD) volatility



3.3. Estimation Results of GARCH, TGARCH and EGARCH

Results from GARCH(1,1) in Table 5 shows that coefficients both ARCH (β) and GARCH (α) are positive except Constant (ω) which is negative but all the three coefficients are statistically significant at 1% significance level. The significance of α reveals the presence of volatility clust3ering in GARCH(1,1). The value of α + ∝ (persistence volatility shocks) which is <1 suggest that conditional variance is an explosive process meaning that the effect of today's shock remains in the forecast of variance for numerous periods in the future.

The result from TGARCH(1,1) presented in Table 5 indicates that the coefficient of asymmetry is positive and significant at 1% significance level which means presence of asymmetry in exchange rate series therefore there is difference of 0.4 between bad and good news. In this case modelling the news is significant determinant of exchange rate volatility. Moreover, as the result of EGARCH(1,1) in Table 5 illustrates the coefficient of leverage effect is positive and significant at 5% which indicates that good news have larger effect on volatility of SOS/USD series than bad news of same magnitude. The implication of this result is that good news (appreciation of SOS/USD) creates more risk in the market compared to bad new (depreciation of SOS/USD). This happens because Somalia's economy is heavily dollarized as banks only accept dollar as a currency and daily transactions heavily involve US dollar. When Somali shilling depreciates people, banks, companies and businesses with huge amount of dollar than Somali shilling will encounter exchange rate risk and through that way appreciation of SOS/USD create more risk in the market.

4. CONCLUSION

This study adopted GARCH, TGARCH and EGARCH model with the intention to model Somali shilling against US dollar while monthly time series data covering period from January 1950 to December 2010.

The result from this investigation find that SOS/USD is not normally distributed and presence of autoregressive in conditional heteroscedasticity in the residual series. Result from GARCH indicates existence of ARCH effect in the residual series and volatility clustering as well. The result from TGARCH showed significant presence difference between good and bad news of same magnitude (asymmetry) while the outcome from EGARCH model reveals presence of leverage effect which indicating that positive news have large effect on volatility then bad news of same magnitude.

The findings from this study provide a relevant implication concerning market timing, portfolio selection and measuring risk to investor and risk managers in Somalia. despite of that this study suggest to investor and business owners to pay close attention to exchange rate risk and set better risk management strategies to deal with exchange rate risk. Further to that, this finding recommend to government of Somalia to introduce new currency and de-dollarize the economy to be able to influence exchange rate fluctuation and transform. Lastly, this article concludes that GARCH family models sufficiently capture the volatility of Somali shilling against US dollar.

5. ACKNOWLEDGEMENT

I prepared this work with curiosity without getting fund from any agency. I acknowledge that this work fills a real gap as this finding is about modelling the volatility of Somali shilling against US dollar which is not considered by any other study prior.

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