Modelling Exchange Rate Volatility and Global Shocks in South Africa

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Abstract: This paper models the volatility of South Africa's exchange rate amidst global shocks. Using the symmetric GARCH (p,q) and asymmetric EGARCH (p,q) and the theoretical model of Omolo (2014), it is established that the asymmetric EGARCH (p,q) model outperforms the symmetric GARCH (p,q) model and can be recommended to policymakers in South Africa. The study results show that South Africa's exchange rates are significantly affected by global shocks. It is, therefore, recommended that the South Africa's government should consider the impact of global shocks when formulating and implementing economic policies, especially exchange rates policies.

Keywords: Modelling; Exchange Rate Volatility; GARCH; EGARCH Models

JEL Classification: E3; E5; F4

1. Introduction

The South African rand is determined by the interaction of demand and supply in a freely floating exchange rate system[3]. The market demand for a currency in relation to supply, determines its value relative to other currencies. In theory, demand for a currency and its value change due to many factors. These may include structural problems facing an economy such as changes in demand for a country's goods and services. This may be associated with shocks and uncertainty in the markets of the country's main trading partners. Another shock that is closely associated with the impact of monetary policy is the oil price shock[4]. This paper attempts to understand how these and other shocks interplay with exchange rate volatility, using South Africa as a case study.

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[3] See (Mtonga, 2011).

[4] See (Kutu & Ngalawa, 2016).

To the best of researchers' knowledge, this is the first study to model exchange rate volatility amidst global shocks in South Africa. In addition, no study that we are aware of has simultaneously employed the symmetric GARCH (p,q) and asymmetric EGARCH (p,q) models to analyze exchange rate volatility in South Africa as well as to determine the impact of global shocks on the domestic currency. Furthermore, this study provides an up-to-date analysis on how to model the volatility of exchange rates amidst global shocks in South Africa.

It is important to note that the volatility in the South African rand per US dollar (ZAR/USD) exchange rate has been more than most currencies in the world. During the Asian currency crisis, the South Africa's rand was greatly affected, appreciating by 41.5% from 4.53 rand per US dollar in 1997: 06 to 6.41 rand per US dollar in 1998: 08. During the global financial crisis, the rand also depreciated by 39.15% against the US dollar from 7.33 rands per US dollar in 2008: 07 to 10.20 rands per US dollar in 2009: 01. In addition, as at the fourth quarter of 2015 to third quarter of 2016, the ZAR/USD had lost 24.3% of its value and traded at 14.36 rands per US dollar[1]. This instability in the domestic currency, therefore, is the primary motivation for undertaking this study.

2. Exchange Rate Regime in South Africa

Exchange rates determination can either be left to the forces of demand and supply or can be managed by the authorities. In one extreme, a country can implement a freely floating exchange rate system where the value of the currency is determined by the market forces of demand and supply. Under this system, the authorities do not interfere in the foreign exchange market. This system (of a freely floating exchange rate system) is not practiced by any country in the world (Van der Merwe, 1996). In the other extreme, monetary authorities may adopt a fixed exchange rate system. The fixed exchange rate system is still being practiced in some countries like Argentina and Estonia.

In South Africa, there have been four major distinctive exchange rate regimes and monetary policy frameworks since the end of the Bretton Woods System (Van der Merwe, 2005) early in the 1970s. These include (1) a stage of direct monetary controls and the desire to sustain the stability of the rand exchange rate during the 1970s; (2) a shift to more market-oriented measures and the adoption of money supply targets in the 1980s; (3) the era of informal inflation targeting and managed floating of the rand in the 1990s; and (4) The official adoption of inflation targeting and a floating exchange rate regime in February 2000.

The first phase is the period that was linked to the Bretton Woods System of fixed exchange rates in the 1970s. Initially, the SARB devalued the rand and pegged it against the US dollar since the domestic market could not support a free-floating

[1] See (Hsing, 2016).

exchange rate system due to the underdeveloped nature of the foreign exchange market (Steyn, 2004). Nonetheless, an "independent managed floating" exchange rate system was adopted in June 1974 to mirror the changes in the market rate of the ZAR/USD exchange, the essential balance of payments and domestic economic conditions. Sadly, there were speculative attacks on the rand, which forced the authorities to change the exchange rate policy in June 1975 in favour of a ZAR/USD exchange rate that would be kept constant for long periods. Indeed, the rand moved with the dollar for long periods under restrictive control measures. A heavy reliance was placed on exchange controls, which deterred the inflow of foreign capital. Authorities saw this as an ineffective way of allocating the available foreign exchange, which led to the abandonment of this policy framework.

Subsequently, the authorities decided to implement more market-oriented measures and monetary targeting. This second phase started in 1980 when the monetary authorities allowed interest rates to become more flexible with the moderation and simplification of exchange rate controls. During the same period, the international community imposed financial and trade sanction on the country, which forced monetary authorities to revert back to restrictive control measures in 1985 (Van der Merwe, 2005). In 1986, the De Kock Commission of Inquiry was set up to harmonize monetary policy in the country, among others. The commission recommended a flexible rand and a competitive foreign exchange market in South Africa, subject to Reserve Bank intervention. The flexibility created in the determination of the exchange rate permitted the monetary authority to introduce an informal inflation targeting and managed floating of the rand in the 1990s as a third phase of the exchange rate regime.

The third phase of the exchange rate regime is the period of informal inflation targeting. This was announced during a difficult era characterized by social unrest, a decline in gold prices, and in the prices of other commodities in the country (Van der Merwe, 2005). It is during the 1990s when international actions were directed at bringing an end to the apartheid regime. There were trade boycotts, a disinvestment drive and the removal of external loans from the country. In this period, South Africa's economic growth rate declined, the balance of payments came under severe strain, foreign reserves declined to low levels, demands on the budget increased, and the deficit before borrowing widened. In order to mitigate against the crisis, policy measures were placed on short-term demand management to make sure that foreign debts were paid, that fiscal expenditure was reduced, that employment did not decline and to provide for the safety of internal and external security.

The situation changed dramatically after the formation of the government of national unity in 1994, and the country became reintegrated in the world economy and in the global financial market. Accordingly, the monetary authorities begun to remove virtually all exchange rate restrictions. This policy was largely successful and hence paved way for the official adoption of inflation targeting and floating exchange rate system in February 2000.

Increasing food prices due to declining agricultural output, decreasing manufacturing output, volatility in the exchange rate of the ZAR/USD, and low domestic growth, among others, pose serious challenges on monetary policy actions. Coupled with the performance of the informal inflation targeting prior to February 2000, this forced the monetary authorities to adopt inflation targeting to further tighten monetary policy. The authorities targeted 3-6% Consumer Price Index (CPIX) inflation to be achieved by the end of 2002. This policy has been largely successful and the monetary authorities have decided to continue to applying the framework consistent with their mandate of price stability and a stable exchange rate system. This is the fourth and final monetary policy framework.

3. Exchange Rate Theory and Policy Decisions

This study utilizes the Marshall-Learner Condition to build a framework of exchange rate determination. The Marshall-Learner Condition is an extension of Marshall's theory of the price elasticity of demand for international trade that can be related to South Africa's agenda of collaborating for development, integration and industrialization as a member of the BRICS countries[1]. From the perspective of the theory, Oladipupo (2011) explains the Marshall-Learner Condition as the sum of the absolute long-term price-elasticities for exports and imports, which has to be greater than unity for it to cause a balance of trade improvement or if a declining price-competitiveness can ultimately affect the external balance. The Marshall-Learner Condition can be expressed as:

$$\Delta\forall = ABX(\alpha_{1n} + \alpha_{2n-1}) \quad (1)$$

where:

$\Delta\forall$ is the total variation in the balance of trade;

A is the percentage of devaluation;

BX is the value of exports expressed in terms of foreign currency;

α_{1n} is the first devaluing country's elasticity of demand for imports;

α_{2n} is the second country's elasticity of demand for exports from the devaluing country.

[1] see (Chun, 2013; 2014).

Consequently, for the Marshall-Learner condition to be satisfied, $\alpha_{1n} + \alpha_{2n} > 1$. This method provides a condition on which variations in exchange rates will have certain effect on balance of trade and restore equilibrium.

An additional expression for the re-establishment of the balance of payments equilibrium position can also be given as:

$$B = P_x X(s) - P_m^* sM(s) \quad (2)$$

Where:

B is the balance of payments;

P_x is the price of exports as expressed in the home currency;

P_m^* is the price of imports in foreign currency.

In equation (2), if

$P_m^* = P_x = 1$; we have $B = X(s) - sM(s)$

Then

$$\frac{dB}{ds} = \frac{ds}{ds} - s\frac{dM}{ds} - M \quad (3)$$

Equation 3 can be re-written in relation to the home country's import demand elasticity (s_m) and external demand elasticity for the home country's export (s_x) where:

$$s_m = -\frac{dM}{ds}\frac{s}{M} \quad (4)$$

$$s_x = -\frac{dX}{ds}\frac{s}{X} \quad (5)$$

If we get $\frac{dB}{ds} > 0$, devaluation increases the balance of payments if $\frac{X}{sM}s_x + s_m - 1 > 0$.

In addition, if trade is balanced ($\frac{X}{SM} = 1$), trade increases if the price elasticity is greater than one, e.g. $s_x + s_m > 1$. Nonetheless, if the balance of payments is originally in deficit, then the trade elasticity with respect to s must be greater than one.

4. Methodology

This section presents an outline of the model as well as dataset used for analysis of the ZAR/USD exchange rate volatility in the wake of global shocks. The study is carried out using different volatility models, namely the symmetric GARCH and asymmetric EGARCH, as well as conditional distributions such as Normal Gaussian, Student-t and Generalized Error Distribution (GED).

4.1. Scope of the Study and Variables

The objective of this study is model the volatility of South African exchange rates amidst global shocks, and to determine the differences (if any) in the two estimations (symmetric and asymmetric models). The study employs monthly data spanning the period between $1994{:}\,01$ and $2013{:}\,12$. The study period is dictated by data availability. Four variables are employed to model the exchange rates, and these can be classified into domestic and foreign variables. The domestic variables are exchange rates (EX) and the lag of exchange rates (EX(-1)) whereas the foreign variables are global oil prices (OP) and international interest rates (proxied by Federal Funds Rate (FFR)). This methodology and the variables employed are consistent with Ebaidalla (2013) and are in line with the empirical literature for modelling exchange rates[1]. To the best of the researchers' knowledge, there is no extensive study of this magnitude that has been undertaken on the South Africa's economy in terms of the model used, the number of variables employed and the methodology used in the analysis.

4.2. Definition of Variables and Data Source

The data employed in this study are obtained from the South African Reserve Bank (SARB), International Monetary Fund (IMF), and World Bank's World Development Indicators (WDI). Following Nortey *et al.* (2015), we employ monthly time series data spanning a period of twenty years from 1994:1 to 2013:12.

The Exchange Rate (EX) is the value of the domestic currency per US dollar. The variable is used to capture the trade relationship between South Africa and the rest of the world whereas the lagged exchange rate (EX(-1)) is employed to take into account inertia in the exchange rate[2]. The Global Oil Price (OP), on the other hand, is the global commodity price for oil while the Federal Funds Rate (FFR) (a proxy for international interest rates) is the US's short-term interest rate at which depository institutions in the country borrow and lend money to each other, usually overnight. Both oil prices and international interest rates are external variables

[1] see (Kamal et al., 2012; Omolo, 2014; AL-Najjar, 2016).

[2] see (Khosa et al., 2015).

included to capture the impact of global shocks on exchange rate in South Africa. A number of studies have followed this line of thought[1] (***Model specification***

In order to analyze and model the volatility of exchange rates in South Africa, this study employed the symmetric Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and the asymmetric Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) models. These two alternative methods are employed to offer a robust way to model exchange rate volatility amidst global shocks in South Africa; and to determine the differences (if any) between the two estimations. Related to Adeniyi (2011), Ebaidalla (2013) and Kin and Courage (2014), the building of our GARCH and EGARCH models follow the conventional method where variance changes over time. Suppose the model is given by:

$$EX_t = \beta_0 + \beta_1 EX_{t-1} + \beta_2 FFR_t + \beta_3 OP_t + \varepsilon_{t.} \quad (6)$$

where $\varepsilon_{t \sim N\,(O,\, h_t)}$

$$h_t = C_0 + \alpha_1 h_{t-1} + \alpha_2 e_{t-1}^2 + \alpha_3 FFR_t + \alpha_4 OP_t + \mu_t \quad (7)$$

Equation 7 above shows that conditional variance (h_t) is a function of four terms: C_0 is a constant term, e_{t-1}^2 is an ARCH term capturing the earlier period's squared residual from the average equation, h_{t-1} is the GARCH term that captures the variance of the past period's residual and the two external variables are FFR and OP. $\alpha_1 - \alpha_4$ are coefficients.

4.3. The GARCH (p,q) model

The literature has shown that the GARCH (*p*,*q*) process is suitable for modelling characteristics of time series data[2]. Among others, it permits the conditional average to be determined by its own conditional variance. In addition, empirical evidence has shown that a high ARCH order has to be developed to derive the dynamics of conditional variance. The GARCH (p,q) model introduced by Bollerslev (1986) tends to address this issue. Following Thorlie *et al*. (2014), the standard GARCH (p,q) model can be expressed as:

$$y_t = x_t^{\theta} + \varepsilon_t,\, t = 1,2 \ldots \ldots . . T, \varepsilon_t\,, N(0, \sigma_t^2)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-1} + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2$$

where $\omega > 0, \alpha \geq 0, \beta \geq 0$, and ε_t is highly "stationary if and only if" $\alpha + \beta > 1$.

[1] see (Liu et al., 2015; Benita & Lauterbach, 2007; Elboune, 2008; Afandi, 2005; Maturu, 2007).

[2] see (Hansen & Lunde, 2001).

ε_t is an error term that is uncorrelated with its past values while σ_t^2 is a conditional variance that varies over time as a function of the previous errors[1]. ω is a constant term, ε_{t-1} is an ARCH term and σ_{t-j}^2 is a GARCH term. This GARCH (p,q) model has been extensively used in modelling exchange rates.[2]

4.4. The EGARCH (p,q) Model

The commonly used EGARCH (p,q) method for modelling exchange rates can be presented as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \left[\frac{\mu_{t-1}}{\sigma_{t-1}}\right] + \beta_1 \sigma_{t-1}^2 + \gamma \frac{\mu_{t-1}}{\sigma_{t-1}}$$

EGARCH was developed by Nelson (1991) for an asymmetric reaction to exchange rate volatility. The γ term accounts for the existence of leverage effects where negative returns are expected to lead to high volatility than positive returns of the same magnitude, which makes the model asymmetric. As soon as the asymmetric model for volatility is employed, it permits the volatility and shocks to react spontaneously when prices are dwindling owing to bad news (information) than with resultant increases owing to good news (Kamal et al., 2012). This shows that the consequential effects of good news (positive lagged residual), may not have the same resulting effects as bad news (negative legged residual).

4.5. Estimation of Models and the Criteria for Models Selection

In line with Bala and Asemota (2013), this study employs three conditional distributions to appropriately estimate the GARCH (p,q) and EGARCH (p,q) models for the South African economy. These include the Normal Gaussian distribution, the Student's t with fixed degrees of freedom (df) and the Generalized Error Distribution (GED). These three conditional distributions can be explained as follows:

4.5.1. The Normal Gaussian Distribution

The normal distribution is broadly used in forecasting and estimating GARCH models. If the error term is expressed in terms of a Gaussian distribution, the log-likelihood function of the standard normal distribution can be explained as follows where the distributional hypotheses to be tested are: (1) there is no serial correlation in the residuals; (2) the residuals are normally distributed; and (3) there is no heteroscedasticity (ARCH effects) in the model:

$$logL = \sum_{t=1}^{N} l_t = -\frac{N}{2}\log(2\pi) - \frac{1}{2}\sum_{t=1}^{N} log\sigma_t^2 - \frac{1}{2}\sum_{t=1}^{N} \frac{\mu_t^2}{\sigma_t^2}$$

[1] see (Engle, 1982; Bollerslev, 1986).

[2] see (Choo et al., 2002; Dukich et al., 2010; Abdalla, 2012; Xu et al., 2012 among others).

where N is the sample size, and thus, can be simplified furthers as:

$$l_t = -\frac{1}{2}\log(2\pi) - \frac{1}{2}\log(\sigma_t^2) - \frac{1}{2}(y_t - x'_{t-1}\gamma)^2/\sigma_t^2$$

4.5.2. The Student's t with Fixed df

The student's t distribution is used for fitting GARCH models in order for the standardized error to properly capture the observed fat tails in the return series[1]. The log probability distribution function is presumed to take the following form:

$$l_t = -\frac{1}{2}\log\left[\frac{\pi\left[(v-2)\Psi\left(\frac{\rho}{2}\right)\right]^2}{\Psi[(\rho+1)/2]^2}\right] - \frac{1}{2}log\sigma_t^2 - \frac{[v+1]}{2}log\left[1 + \frac{[y_t - x'_t\gamma]^2}{\sigma_t^2[v-2]}\right]$$

where σ_t^2 denotes variance at time t, and $2 < v \leq \infty$ and $\Psi(.)$ is the gamma function[2]. The lower the v, the fatter the tails.

4.5.3. The Generalized Error Distribution (GED)

Assume the GED log likelihood distribution is given by:

$$l_t = -\frac{1}{2}log\left[\frac{\rho[1/r]^3}{\rho[3/r][r/2]^2}\right] - \frac{1}{2}log\sigma_t^2 - \left[\frac{\rho[3/r][y_t - x'_t\gamma]^2}{\sigma_t^2\rho[1/r]}\right]^{r/2}$$

where the tail parameter $r > 0$. The GED is normally distributed if $r = 2$ and fat-tailed if $r < 2$. Given, $y_t = x'_t\gamma + \mu_t$, then $\mu_t = (y_t - x'_t\gamma)$ [3]. As a result, all the required consistency conditions are presumed satisfied.

4.6. Test for Stationarity (Unit Roots)

One of the pre-conditions for estimating the GARCH (p,q) and EGARCH (p,q) models is that all the variables must be stationary in order to prevent spurious results. The unit root test is employed to test the data for stationarity (see Heymans *et al.,* 2014). Following Ogundipe *et al* (2014), the study employs the Dickey Fuller (DF), Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests to check for the presence/absence of unit roots in the time series. According to Omolade *et al* (2013), when a variable is stationary in levels, it is said to be integrated to order zero (I(0)). That is, there is no unit root. If, on the other hand, a variable is differentiated once in order for it to be stationary, it is said to be integrated to order 1 (I(1)).

[1] see (Bollerslev, 1986).
[2] see (Thorlie et al., 2014).
[3] see (Bala & Asemota, 2013, p. 96).

4.7. Model Selection Criteria and Diagnostic Tests

The study employs the Akaike information criterion (AIC) and Schwarz information criterion (SIC) to determine the appropriate model[1]. The lower the value of AIC or SIC statistic, the better the model[2]. The normal Gaussian distribution, Student's t distribution and GED values for the GARCH and EGARCH models will be tested for normality, serial correlation and heteroscedasticity for purposes of determining the best model. According to Kutu and Ngalawa (2016), the correlogram square residual (Q-test) is employed to test for serial correlation while the Jarque-Bera and ARCH tests are employed to test for the normality of the residual and conditional heteroscedasticity, respectively.

5. Results and Discussion

5.1. The Test for the Residuals/ARCH Effects

The base line in GARCH (p,q) and EGARCH (p,q) models is to test the residuals of the sequence of exchange rates for evidence of heteroscedasticity and determine whether they show any volatility clustering. Employing the LM-ARCH effect test, the exchange rate residual shows a protracted period of low and high volatility in which the exchange rate remains volatile (see Figure 1). In South Africa, protracted periods of low exchange rate volatility are preceded by protracted periods of low exchange rate volatility and protracted periods of high exchange rate volatility are preceded by protracted periods of high exchange rate volatility. This suggests that the residual shows clustering changes, indicating the existence of heteroskedasticity and ARCH effects in the residual.

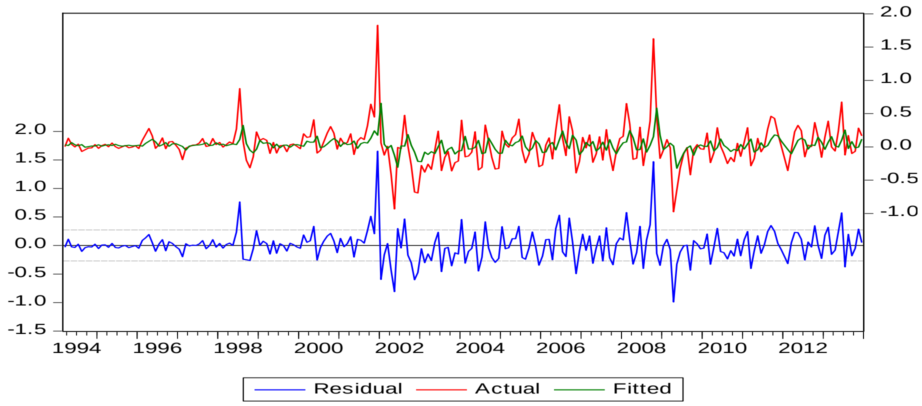

Figure 1. Results of the Residuals/ARCH Effect Test

[1] see (Ishibashi, 2012; Demetriades & Fielding, 2012).
[2] see (Bala & Asemota, 2013).

5.2. The Stationarity Test (Unit Root Test)

As indicated previously, the pre-condition for estimating GARCH (p,q) and EGARCH (p,q) models is for the series to be stationary. As shown in Table 1, the DF, ADF and PP unit roots test results show that all variables are integrated of order 1 except FFR, which is integrated of order zero in the case of the DF test only. These results are in line with Khosa *et al.* (2015).

Table 1. The DF, ADF and PP Stationary Test (Unit Root Tests)

Variables	DF- individual intercept & trend		ADF- individual intercept & trend		PP- individual intercept & trend	
	Order of integration	P-Value	Order of integration	P-Value	Order of integration	P-Value
EX	I(1)	(0.0316)**	I(1)	(0.0000)***	I(1)	(0.0000)***
EX(-1)	I(1)	(0.0317)**	I(1)	(0.0000)***	I(1)	(0.0000)***
FFR	I(0)	(0.0676)*	I(1)	(0.0000)***	I(1)	(0.0000)***
OP	I(1)	(0.0007)***	I(1)	(0.0108)**	I(1)	(0.0484)**

'*', '**' and '***' denote statistical significance at the 10%, 5%, and 1% respectively.

5.3. GARCH (p,q) Model Results

Results of the GARCH (p,q) estimates are reported in Table 2. At 1%, the model reveals that all coefficients are statistically significant in determining exchange rate variations except the ARCH term. The results further show that the lagged exchange rate, the GARCH term, global oil price and the international interest rates are important factors affecting exchange rates in South Africa. The significant impact of global oil prices revealed in this study is in line with Kin and Courage (2014). In addition, the statistical tests conducted to choose the appropriate model reveals that the Student's t distribution is of good fit and performs better in modelling exchange rates in South Africa. Results of the diagnostic tests (see Table 3) conducted on the model reveal that all the models can as well be used to modelling exchange rates and are also good for forecasting and policy formulation.

Table 2. GARCH (p,q) Model Results

Variables	Normal Gaussian distribution		Student's t distribution		GED values	
	coefficient	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*
Average Equation						
C	0.005620	0.7269	0.002577	0.8672	0.002252	0.8726
DEX(-1)	0.319298	0.0000	0.294534	0.0000	0.287747	0.0000
Variance Equation						
γ	0.036772	0.0001	0.035270	0.0003	0.034335	0.0004
ARCH	0.069399	0.2972	0.056837	0.4156	0.051763	0.4132
GARCH	0.439452	0.0000	0.381051	0.0043	0.432927	0.0001
DFFR	-0.103331	0.0000	-0.094475	0.0000	-0.096191	0.0000
DOP	-0.000886	0.0072	-0.000546	0.0190	-0.000784	0.0022
Model Selection						
AIC	0.034847		-0.151104		-0.101181	
SIC	0.136973		0.051022		0.100944	

Table 3. Model Selection Results for GARCH (p,q)

Model Type	Normal Gaussian distribution	Student's t distribution	GED values
Test Specification	*P-Value*	*P-Value*	*P-Value*
Serial Correlation Test	0.7650	0.7980	0.7310
Heteroscedasticity Test	0.7682	0.8006	0.7347
Normality Test	0.0000	0.0000	0.0000

5.4. EGARCH (p,q) Model Results

As shown in Table 4, the EGARCH (p,q) model reveals that parameter estimates of the Normal Gaussian, Student's t distribution and the GED values are statistically significant for all the variables. These findings are in line with the results derived from the GARCH (p,q) models (except the ARCH term that is insignificant under the GARCH model, hence, making the EGARCH a superior model). Furthermore, the asymmetric term (γ) is significant and negative, indicating that news have an important effect on exchange rates in South Africa. The results show that bad news (negative shocks) affect exchange rate volatility more than good news or that negative news lead to a higher subsequent increase in exchange rate volatility than positive news of the same magnitude.

The best model is chosen based on the AIC and SIC statistics. The results reveal that the Student's t distribution outperformed the Normal Gaussian and GED distribution as it recorded the lowest AIC and SIC values. On the other hand, the results of the diagnostic tests based on the standardized residuals show the absence of serial correlation and heteroscedasticity in the model. It can safely be concluded, therefore, that all the models can perform well in modelling exchange rates and for policy formulation.

Table 4. EGARCH (p,q) Model Results

Variables	Normal Gaussian distribution		Student's t distribution		GED values	
	coefficient	*P-Value*	*coefficient*	*P-Value*	*coefficient*	*P-Value*
Average Equation						
C	0.027577	0.0015	0.021328	0.0294	0.022690	0.0053
DEX(-1)	0.329200	0.0000	0.313726	0.0000	0.330872	0.0000
Variance Equation						
γ	-0.606996	0.0000	-0.090047	0.1311	-0.566223	0.0000
|RES|/SQR[GARCH]	0.515309	0.0000	0.052368	0.0027	0.473191	0.0000
RES/SQR[GARCH]	0.274595	0.0000	0.110872	0.0055	0.236661	0.0005
EGARCH	0.929947	0.0000	0.983424	0.0000	0.935444	0.0000
DFFR	-0.598359	0.0049	-0.191482	0.0564	-0.571723	0.0208
DOP	-0.008618	0.0069	0.002460	0.0157	-0.006453	0.0420
Model Selection						
AIC	-0.268726		-0.306771		-0.294199	
SIC	-0.152011		-0.190056		-0.177484	

Table 5. Model Selection Results for EGARCH (p,q)

Model Type	Normal Gaussian distribution	Student's t distribution	GED values
Test Specification	*P-Value*	*P-Value*	*P-Value*
Serial Correlation Test	0.3550	0.3090	0.1980
Heteroscedasticity Test	0.3602	0.3153	0.2025
Normality Test	0.0000	0.0000	0.0000

6. Conclusions

The primary objective of this study was to model exchange rate volatility in the wake of global shocks in South Africa using the symmetric GARCH (p,q) and asymmetric EGARCH (p,q) models. The study results show that in the GARCH (p,q) model, the previous period's exchange rates are an important determinant of the present period's exchange rates in South Africa. The results further show that exchange rate volatility in South Africa is influenced by the GARCH term, global oil prices and international interest rates. The statistical tests reveal that the Student's t distribution is better fitted while the diagnostic tests on all the models show that each of the three models can perform well in modelling exchange rates and is good for forecasting/policy formulation in South Africa.

The study also evaluated the performance of the EGARCH (p,q) in modelling exchange rate volatility amidst global shocks in South Africa. The results show that the parameter estimations of the Normal Gaussian, Student's t and GED distributions are statistically significant for all the variables that affect exchange rate volatility in South Africa. There is also evidence of asymmetric and leverage effects in the model where bad news affects exchange rate volatility more than the good news does, or that negative news leads to a higher subsequent increase in exchange rate volatility than positive news of the same magnitude. Results of the diagnostic tests further show no evidence of serial correlation and heteroscedasticity in the model while the Student's t distribution shows-up as the best fit among the alternatives.

Finally, overall results from the GARCH (p,q) and EGARCH (p,q) suggest that all the variables have a significant impact on exchange rates in South Africa. The results from the EGARCH (p,q) model, however, stand out as the best fit that should be used for policy formulation. The results from both GARCH (p,q) and EGARCH (p,q) models reveal that global shocks have a negative effect on exchange rates. The implication of this is that any rise in oil prices and international interest rates (global shocks) adversely affect exchange rates. It is, therefore, recommended that government in South Africa should consider the impact of global shocks when formulating and implementing economic policies, especially the exchange rates policies.

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