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Volatility Modelling using ARCH and GARCH Models (A Case study of Exchange Rate in Sudan) (at the period from 2007-2018)

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Abstract
This study aims to know on the variance volatility to exchange rate in Sudan at the period (2007 – 2018) and estimate the variance of exchange rate in Sudan also, and how to forecasting by exchange rate in Sudan by using ARCH and GARCH model, and also we found that the model is not suffering from the ARCH effect.The approach using in analysis is ARCH and GARCH models (Volatility models or time-varying dynamic time series).
Moreover, the study depended on the searching of the best model representative to exchange rate variable, through the analysis results we found that the best model is ARCH - GARCH (1,1).

Keywords: Exchange rate, ARCH Model, Inflation, heterosckedaciticty, Volatility

Introduction

The exchange rate is an important indicator and a fundamental variable that has a great impacton the prosperity of a particular country and, given its great importance, has made many Opinions differ on what it is?
It was considered a link between the open economy and the rest of the world's economies, and also aims to contribute to the achievement of a group of Economic and financial goals and do not forget that most modern theories have revealed the extent of the impact of the exchange rate on The stability of the economy's economy, and all countries of the world have become searching for a suitable exchange system for their currencies, so some of them chose to stay On the fixed exchange system, but not like the dollar exchange system, which was like the exchange Some countries have pegged their currencies to a basket made up of the currencies of their trading partners or competitors and floated it to the rest of the currencies and the few.The rest are from developed countries that left their currencies floating in the sea of the international

Economy, lifting their sails against storms and wave.

Objective of study

- The aimed from this study to know the variance volatility exchange rate volatility in Sudan at the period (2007 – 2018).
- Estimate the variance of exchange rate in Sudan at the period (2007-2018).
- ARCH affects.
- Forecasting by exchange rate in Sudan by using ARCH.

Methodology

- Instrument used: collection of data (primary of the sources, secondary of the sources).

1. Sources of data

Central Bank of Sudan – Ministry of finance and economic planning - Central Bureau of Statistics

2. Statistical tool used

- The approach using in analysis is ARCH and GARCH models (Volatility models or time-varying dynamic time series).
- The software package used: EVIEWS 1
- Time series: (2007-2018)

Result and Discussion

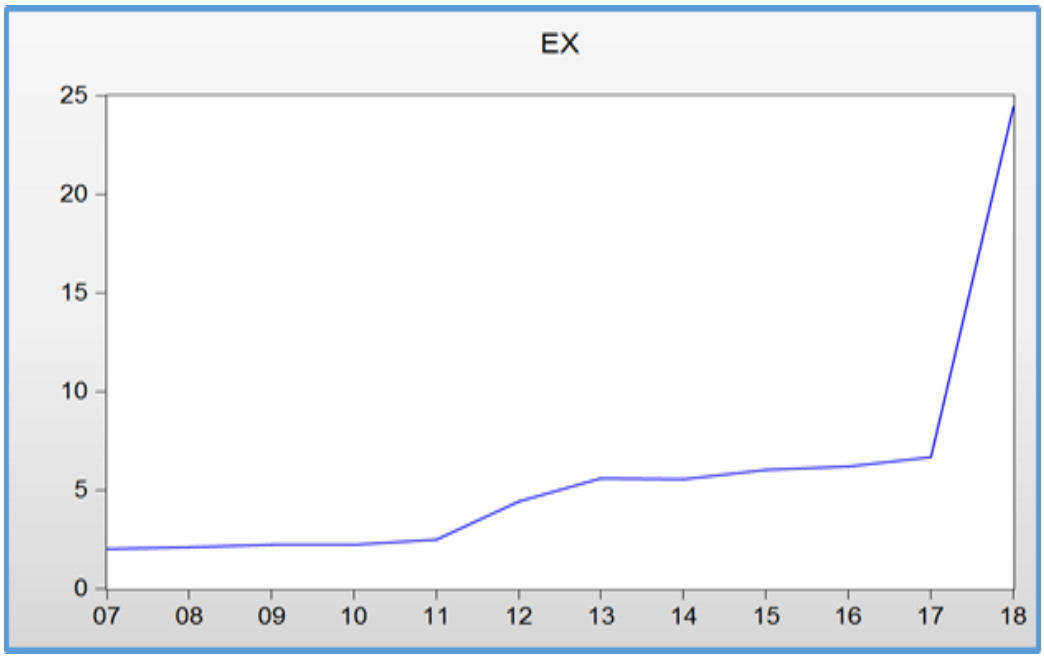

Fig.1: Illustrate the trend of series exchange rate from (2007-2018)

We note that from the above Fig.1 that the series of exchange rate at the period form (2007-2018) is non-stationary(un-constant) or there is high volatility in the variable (exchange rate) this mean that the expected value for error random term it will be greater than or less than through different intervals.

Table. 1: Results of AR (1) model for exchange rate at the period from (2007-2018)

Dependent Variable: EX
Method: Least Squares
Date: 12/19/19 Time: 10:52
Sample (adjusted): 2008 2018
Included observations: 11 after adjustments
Convergence achieved after 16 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.394624	1.770249	1.352704	0.2092
AR(1)	2.170601	0.820546	2.645314	0.0267

R-squared	0.437419	Mean dependent var	6.167895
Adjusted R-squared	0.374910	S.D. dependent var	6.305848
S.E. of regression	4.985571	Akaike info criterion	6.213939
Sum squared resid	223.7033	Schwarz criterion	6.286283
Log likelihood	-32.17666	Hannan-Quinn criter.	6.168336
F-statistic	6.997686	Durbin-Watson stat	1.324070
Prob(F-statistic)	0.026680		

Inverted AR Roots 2.17
Estimated AR process is nonstationary

From the table (1) the results estimation of AR (1) which made clear the parameter significant $\emptyset_1$ that the P-value for t-test regarding with the estimated parameter was is (0.0267) is less than level of significance (α =0.05) this mean that the relation estimated is significant, and also the ($R^2 = 0.44$) this indicator the model is non-significant.

Test to ARCH effect

H_0= there is no ARCH effect

H_1= there is ARCH effect

Table.2: results of ARCH test for the variable (exchange rate)

Dependent Variable: EX
Method: Least Squares
Date: 12/19/19 Time: 12:34
Sample (adjusted): 2008 2018
Included observations: 11 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.505446	0.402925	8.699997	0.0000
RESID1	0.130919	0.008137	16.08860	0.0000

R-squared	0.966398	Mean dependent var	6.167895
Adjusted R-squared	0.962665	S.D. dependent var	6.305848
S.E. of regression	1.218438	Akaike info criterion	3.395981
Sum squared resid	13.36131	Schwarz criterion	3.468326
Log likelihood	-16.67790	Hannan-Quinn criter.	3.350378
F-statistic	258.8431	Durbin-Watson stat	0.845761
Prob(F-statistic)	0.000000		

From table.2 we note that the results of ARCH test the value of R-squared is 0.97, while the p-value is (0.0000) this value is less than the level significant (α =0.05) this mean reject the null hypotheses (H_0) and accept the alternative (H_1) this mean there is ARCH effect in this model.

Diagnostic degree effect of ARCH & GARCH Family

Table.3 Results of diagnostic models for the effect of unconditional variance

Model	AIC	SC	H.Q.C
ARCH(1)	6.488	6.633	6.397
ARCH(2)	6.864	7.616	6.699
GARCH(1)	5.143	5.288	5.052
GARCH(2)	5.613	5.764	5.447
GARCH(4)	6.889	6.959	6.420
ARCH-GARCH (1,4)	6.155	6.438	6.051
ARCH-GARCH (2,4)	6.344	6.668	6.225
ARCH-GARCH (3,4)	6.343	6.797	6.299
ARCH-GARCH (1,3)	5.674	5.917	5.584
ARCH-GARCH (1,2)	5.531	5.733	5.457

From the above table.3 we note that the best model representative effect ARCH by ranking(1) and GARCH by ranking (1), so that has been become the model ARCH-GARCH(1,1) because has been achieved lowest values for the three criterions.

And also the results that appeared in table.4 that regarding by the estimations the best model according on the values three criterions that all the parameters was significant, because the p-value regarding by Z test for each parameter the value was below is less than significance level (α =0.05) this mean the all parameters representative the,model ARCH-GARCH(1,1) is significant.

Table.4: Results of estimating the ML (maximum likelihood) diagnostic model

Dependent Variable: EX
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 12/22/19 Time: 11:57
Sample (adjusted): 2008 2018
Included observations: 11 after adjustments
Convergence achieved after 48 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	12.64295	73.60829	0.171760	0.8636
AR(1)	0.828605	1.245367	0.665350	0.5058
Variance Equation				
C	3.346540	2.607453	1.283452	0.1993
RESID(-1)^2	-1.958061	1.398473	-1.400142	0.1615
GARCH(-1)	1.824367	0.804254	2.268397	0.0233

R-squared	0.261028	Mean dependent var	6.167895
Adjusted R-squared	0.178920	S.D. dependent var	6.305848
S.E. of regression	5.713947	Akaike info criterion	5.319308
Sum squared resid	293.8428	Schwarz criterion	5.500169
Log likelihood	-24.25619	Hannan-Quinn criter.	5.205300
Durbin-Watson stat	1.036301		

The model efficiency test:

Some properties must be achieved to demonstrate the accuracy and efficiency of the choice of the model through three tests for the residuals.

I. The residuals series correlation test

$H_0 =$ *there is no series correlation in the model*

$H_1 =$ *there is correlation in the model*

The results that shown in Fig.2 that demonstrated all the level of confidence for the series correlation for the values of Standard errors within the confines terms, and also the all p-value for this correlations is greater than the level of significant (α =0.05) this mean accept the null hypotheses this indicator there is no series correlation in this model. It is a good adjective of the model and reflects preferential potential over other models.

Date: 12/23/19 Time: 10:27
Sample: 2007 2018
Included observations: 11

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.064	0.064	0.0588	0.808
		2	0.061	0.057	0.1175	0.943
		3	0.005	-0.002	0.1179	0.990
		4	0.016	0.013	0.1232	0.998
		5	-0.081	-0.084	0.2803	0.998
		6	-0.085	-0.078	0.4890	0.998
		7	-0.110	-0.093	0.9234	0.996
		8	-0.120	-0.103	1.6123	0.991
		9	-0.122	-0.102	2.6816	0.976
		10	-0.126	-0.116	4.9694	0.893

Fig.2: Results of correlation tests in the residuals for 11 series of time lags

Impact test of ARCH

This test illustrate whether the final model suffers from the effect of having a family ARCH in residuals series as follow:

$H_0 =$ *there is no ARCH effect*

$H_1 =$ *there is ARCH effect*

The all results is shown in table.5 that demonstrated the P-value for OBS R-squared its was (0.567) is greater than the level of significant ($\alpha = 0.05$) this mean accept for the null hypotheses this indicator to there is no ARCH effect at this model, It is a good characteristic of the model.

Table.5: The results of ARCH impact test for the residual series of the estimated model

Heteroskedasticity Test: ARCH

F-statistic	0.480995	Prob. F(1,8)	0.5076
Obs*R-squared	0.567144	Prob. Chi-Square(1)	0.4514

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/24/19 Time: 09:29
Sample (adjusted): 2009 2018
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.212260	1.567733	1.411121	0.1959
RESID^2(-1)	0.255047	0.367748	0.693538	0.5076

R-squared	0.056714	Mean dependent var	3.170609
Adjusted R-squared	-0.061196	S.D. dependent var	2.273158
S.E. of regression	2.341680	Akaike info criterion	4.716471
Sum squared resid	43.86772	Schwarz criterion	4.776988
Log likelihood	-21.58235	Hannan-Quinn criter.	4.650084
F-statistic	0.480995	Durbin-Watson stat	1.736223
Prob(F-statistic)	0.507605		

Conclusions

From the above results of analysis we note that the all test on the time series for the variable exchange rate annually its demonstrated that is suffering from high effect to heterosckedaciticty, and also demonstrated all the test the model ARCH-GARCH(1,1) is best model to forecasting to series volatility for exchange rate. And also we note that there is no series correlation in this model this good characteristic in this model and there is no impact test of ARCH family at this model and also this good

characteristic, this indicator this model is valid to forecasting

References

1. Ruey S.Ts, Analysis of financial Time series, University of Chicago, second Edition, 2005, P58.
2. Robert Engel, The use of ARCH/GARCH Models in applied Econometrics, Journal of Economic perspective, Volume 15, Number 4, fall 2001.
3. Salah Tomy, principle to Econometrics theory, second edition, part 2, p 163.
4. Mohamed shikhi, the Econometrics methods lectures and applications, Oman, first edition, 2012, p 228.
5. Atban.H, Elgahgoh.H, The impact of liberalization capital market on fluctuate in stock market, the Economic policies and development journal, volume 14.
6. Bera, A. K., and Higgins, M. L. (1993), "ARCH Models: Properties, Estimation and Testing," Journal of Economic Surveys, Vol. 7, No. 4, 307-366.
7. Campbell, J. Y., Lo, A. W., and MacKinlay, A. C. (1997), The conometrics of Financial Markets, Princeton, New Jersey: Princeton University Press.
8. Bera A.K, Higgins M.L (1993)," ARCH models: Properties, Estimation and Testing " Basil Blackwell, and 238 main st, Cameridgema02142, USA.PP.305.
9. Bollerslev T, Engle R.F, Nelson D.B (1994)," Handbook of Econometrics Volume IV Elsevier Science B.V. all Right Reserved, CH.49.
10. BollEerslev T. (1986), " Generalizer Autoregressive conditional Heteroskedasticity " journal OF Econometrics 31 (1986) 307-327. North-Holland.
11. Engle R.F, Focardi S.M, Fabozzi F.J (2007)," ARCH/GARCH Models IN Applied financial Econometrics " JWPR026-Fabozzi C114-NP.