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Modeling the Returns on Nigeria's Agricultural Food Export Price using GARCH Model

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Abstract
The study investigates GARCH Model in modeling of the returns on Nigeria's agricultural food export price, specifically to; determine whether Nigeria agricultural export Prices can be fitted to a volatility model, to test the present ARCH effect in the return volatility of Nigeria agricultural export Prices and determine the impact of price volatility in Nigerian Agricultural export markets.
Using the cotton price to represents Nigeria agricultural export price, the logarithm returns for various months were computed, descriptive statistics of the logarithm returns was calculated and the volatility of the market was estimated using the standard deviation and the addition of the ARCH and GARCH components of the GARCH model was done to the determine persistence of volatility impact . It was found that the Agricultural export market has volatility of 0.514 with 88.3% persistence of volatility impact between 1992 to 2020. This show that the market is highly volatile within period under investigations than the period preceding it. The recommendation is that the depth of instruments in the Agricultural export market should be varied in terms of fixed tradable financial instruments used to raise capital in the Agricultural export market than concentrating on the would be returned to the marketer if all of the assets were wind up and all of the marketer's debts were paid off.

Key words: *Modeling, Returns, Export, Price, GARCH*

1.1 Background to the study

The returns on Nigeria's agricultural export price fluctuations have been attracting increasing attention in recent statistics, econometrics of finance, and economic studies and have been recognized as one of the most important economic phenomena. According to Zheng, Kinnucan, and Thompson, (2008) agricultural food price volatility has been identified as one of the things that reduces welfare and competition by increasing consumer costs. Also, Apergis,and Rezitis(2011) revealed that agricultural export price volatility increases the risk and uncertainty of both producers and consumers. Thus, the volatility of commodity prices has been studied to some extent in recent times, but so much attention has been given to the returns on the price of Nigerian agricultural export products.

The returns of Nigerian Agricultural food export prices, like other financial indicators, are generally known for their continuously volatile nature. The findings of a study by Rashid and Meron (2007) revealed that price volatility in the markets of major cereals crops remains high in Ethiopia. However, studies on Nigeria's agricultural export food price volatility remain an area in which little or no empirical attention has been paid. Therefore, it becomes necessary to devote effort to modeling agricultural food export prices using GARCH models. This is because investigating the pattern of domestic food export price volatility is important in mitigating price instability and risks, food insecurity, food policy decisions and strategic planning, granting of licenses for private firms to import or export food etc.

Therefore, it becomes necessary to devote effort to modeling agricultural food export prices using GARCH models. This is because the pattern of domestic food export price volatility is important in mitigating price instability and risks, food insecurity, food policy decisions and strategic planning, granting of licenses for private firms to import or export food etc. It is against this background that this study models the returns on food export prices using GARCH with the intention to ; determining whether Nigeria agricultural export prices can be fitted to a volatility model, testing the present ARCH effect in the return volatility of Nigeria agricultural food export prices and determining the impact of price volatility in Nigerian agricultural food export markets. This study will be found significant in contributing to knowledge by identifying the pattern of Nigeria's agricultural export price volatility and the ARCH effect in its return volatility for the purpose of making informed policy decisions and in regulating food export prices.

Methodology

3.1 Sources of Data and the software used in the Data Analysis

The study uses Cotton prices which was extracted from the central Bank of Nigeria (CBN) statistical database website (www.cbn.goving). The data spanned from the month of January, 1985 – January 2021. The series All Share Index(ASI) is fitted to conditionally compound monthly return computed as,

$$r_t = log\left(\frac{AEPt}{AEP_{t-1}}\right) X \frac{100}{1} \tag{3.1}$$

For t = 1, 2, …….t-j where ASIRt is the return on Agricultural Export Prices ($AEPt$) at time t, and AEP_{t-1} is return on Agricultural food export Prices at time "$_{t-1}$".

3.2 Model Specification

The volatility model in normal error distribution assumptions used in this study is the Generalized ARCH (GARCH) Model, However, the model is subject to the normal error distribution assumptions (Engle,1982)

3.2.1. Generalized ARCH (GARCH) Model

By definition as specified in Deebom, and Essi (2017), the standard GARCH model used in the estimation of agricultural export price returns, we considered the residual of the ARMA process obtained in model in equation (3.2) and the residual could be written as shown below:

$$\sigma_t = \sigma_t \varepsilon_t \text{ for } \varepsilon_t \sim N(0,1) \text{ and } \sigma_t / f_{t-1} \sim N(0, \sigma_t^2) \quad (3.3)$$

The standard symmetric GARCH (1,1) model can be written as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (3.4)$$

Where $\alpha_0 \geq 0$, $\alpha_1 \geq 0$ and $\beta \geq 0$, i.e. all these parameters must be positive in order to guarantee a positive conditional variance, and where $\alpha_1 + \beta < 1$ represents the persistence of shocks to volatility (Mala, & Reddy, 2007)

3.2.2. Normal Error Distribution Assumptions

In modelling the conditional variance of All share index (ASI) of Nigeria stock markets , there is need to subjects to conditional distributions for the standardized residuals of the returns modernism and the Gaussian (Normal) was considered appropriate(Engle,1982). The Gaussian (Normal) error distribution assumed a log-likelihood contribution is of the form;

$$LogL(\theta_t) = \sum_{t=1}^{T} L(\theta_t) = -\frac{1}{2} Log[2\prod] - \frac{1}{2} \sum_{t=1}^{T} log(\sigma_t^2) - \frac{1}{2} \sum_{t=1}^{T} \frac{(y_t - \gamma y_t)^2}{\sigma_t^2} \quad (3.24)$$

RESULTS

4.1 Preliminary Test

The preliminary test in the study include; time plots, descriptive test for normality, unit root test, ARMA model and heteroskedaticity test using lagranger multiplier

4.1.1 Time Plots

The results on time plots to check for the trend in the series are shown in Figure 4.1 and 4.2

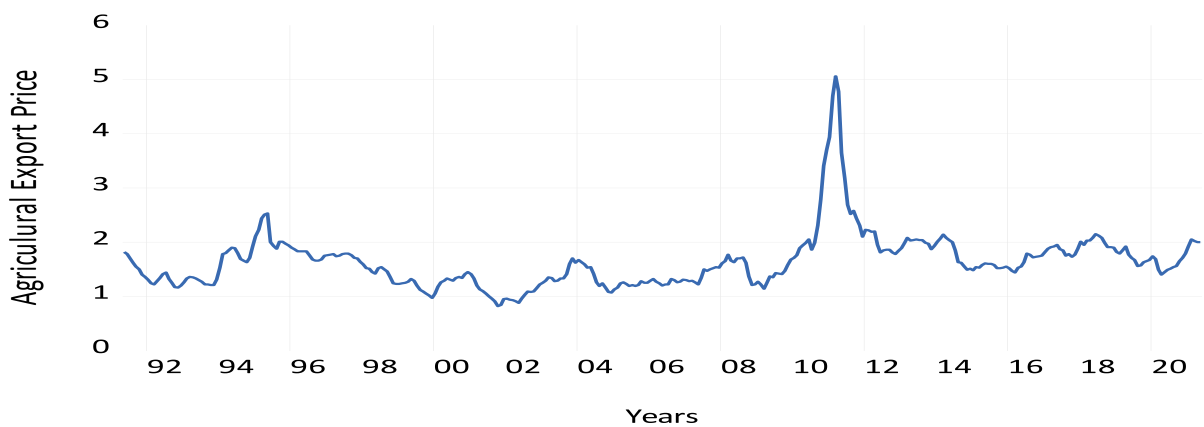

Figure 4.1: Time Plot on Agricultural Export Price at Level

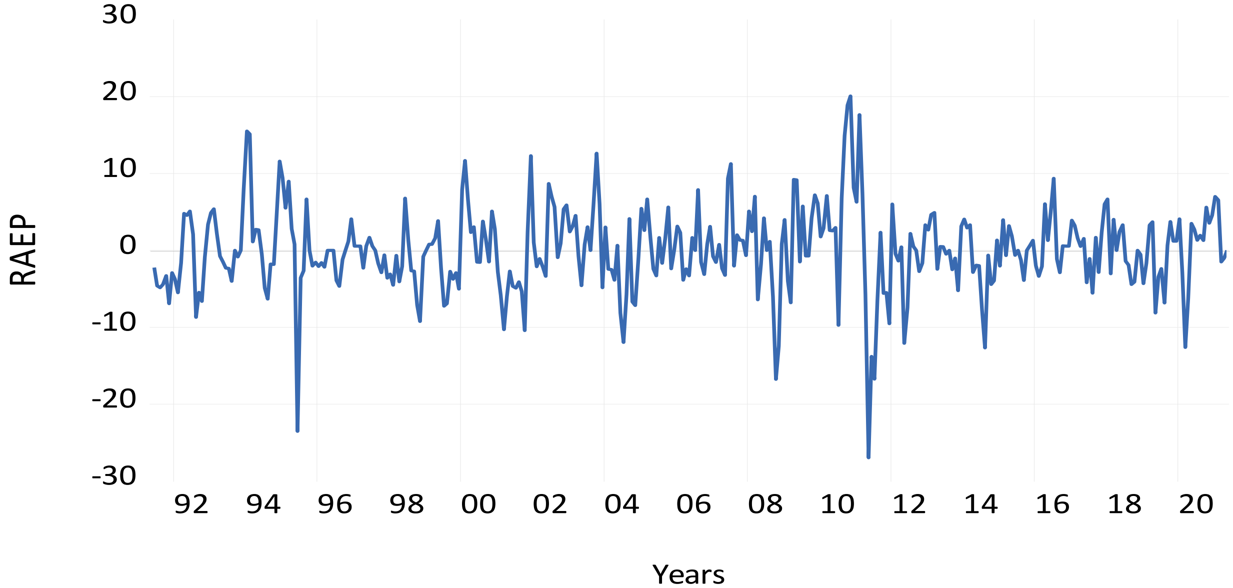

Figure 4.2: Time Plot on Agricultural Export price at first differenced

4.1.1 Descriptive Test for Normality

Table 4.1 is the result for the descriptive test for normality and this test statistic provides basic information about the variables and highlights potential relationship between variable

Table 4.1 Descriptive Statistics on all Variables

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	J-Bera	Sum
Agric Price	1.636	1.580	5.060	0.820	0.514	2.816	16.716	3307.00	590.56

The descriptive statistics was done to determine whether the distribution of the series follow the normal distribution assumption. The result shows that agricultural price is positively skewed as shown in table 4.1 which implies that all the series are skewed to the right. The jarque-bera test statistic are all statistically significant and the probability value of all the variables are also statistically significant (0.000000). Therefore, the null hypothesis of not normally distributed is upheld. Which means that the respective series are not normally distributed

4.1. 2: Unit Root Test

The results for Unit Root Test using Augmented Dickey Fuller and Phillip Perron Test are shown in the table below

Table 4.2: Unit Root Test using Augmented Dickey Fuller and Phillip Perron Test

Variable(s)	Stat Level	Augmented Dickey Fuller Test (ADFT)					Phillip Perron Test (PPT)				
		1%	5%	10%	ADFTS	Remarks	1%	5%	10%	PPTS	Remarks
Cotton	1(0)	-2.57	-1.94	-1.62	-2.52	Not	-	-	-	-2.62	Not Stationary

Price						Stationary	2.57	1.94	1.62		
	1(1)	-2.57	-1.94	-1.62	-10.24	stationary	-2.57	-1.94	-1.62	-9.24	Stationary

Table 4.2 is the result for the unit root test. Most time series are inherently non-stationary and may cause spurious or biased estimation. However, to ascertain the stationarity, the Augmented Dickey-Fuller and the Phillip-Perron unit root tests was adopted. From the results obtained in Table 4.2 of unit root test, Augmented Dickey-Fuller and Phillips-Perron tests showed that at level, agricultural price had unit root (Non-stationary) as the probability value (p-value) is greater than 5% level of significance. At first difference, all the variables had no unit root (stationary) as the probability value (p-value) is less than 5% level of significance.

4.1.3 ARMA model

$$e_t^2 = 0.019 + 0.493\varepsilon_{t-1}^2 \quad (4.1)$$

4.4 Heteroskedaticity Test

This is done to confirmed if the series will be e fitted to a GARCH model and this is estimated using Using Lagranger Multiplier and the results are shown in table 4.2 below.

Table 4.2 Heteroskedaticity Test Using Lagranger Multiplier

Estimators	Lag (1)		P-value	Lag(5)		P-value
F-statistic	4.495335	Prob. F(1,356)	0.0347	2.816673	Prob. F(5,348)	0.0165
Obs*R-squared	4.464218	Prob.Chi Square(1)	0.0346	13.76896	Prob. Chi-Square(5)	0.0171

Table 4.2 contains the answer to research question one and its corresponding test of hypothesis one. The table shows that there is the presence of ARCH effect in the return volatility of Agricultural export prices. Also, since the estimated probability values of the Engle's Lagrange Multiplier ARCH tests are less than 5 percent significance level with up to 5 lags. Therefore, we can fit the series to a GARCH model.

4.2 GARCH Model Estimation

Mean Equation $y_t = -0.140 + 0.445\sigma_{t-1}$ (4.2)

Variance Equation:

$$\sigma_t^2 = 2.827 + 0.147u_{t-1}^2 + 0.736\sigma_{t-1}^2 \quad (4.3)$$

Equation 4.2 contain the estimate of the mean equation while equation 4.3 contain the estimate of standard symmetric GARCH model with normal error distributional assumptions. The equation 4.3 have two parts ARCH and GARCH model components. The addition of the ARCH and GARCH model component show the impact of volatility and so there is 88.3% of persistence of volatility impact.

4.3 Post –test / Diagnostics Check/ Model Diagnostics

In order to ascertain the fact, the selected models are good enough for forecasting, there is the need for further confirmatory test and this shall test for the presence of ARCH effect, Q-Q plots for the residuals using the selected models and forecasting

4.4.1 ARCH effect

This is done in conformity with the residuals of the models as review in the concept of homoscedasticity as account for, in Arch effect model. This was estimated using the ARCH –LM model and the results are shown in Table 4.7contains heteroskedasticity test for the fitted GARCH Model

Table 4.2 Heteroskedaticity Test Using Lagranger Multiplier

Estimators	Lag (1)		P-value	Lag(5)		P-value
F-statistic	0.174638	Prob.F(1,356)	0.6763	0.693024	Prob. F(5,348)	0.6290
Obs*R-squared	0.175533	Prob.Chi Square (1)	0.6752	3.490112	Prob. Chi-Square(5)	0.6249

Table 4.2 also indicates evidence of the absence of ARCH effect. We notice that the number of observations (n) multiplied by the coefficient of regression (R^2), i.e. (nR^2) was higher than the probability value of the chi-square (X^2) distribution. Therefore, it was confirmed that the null hypothesis which states that there is no presence of ARCH effect should be rejected, and the alternative hypothesis that there is ARCH effect, be accepted. The result reported here concerning the test for ARCH effect agreed with Cruicui and Luis (2010) findings in risk modelling in the crude oil market: a comparison of Markov-switching and GARCH models. In Cruicui and Luis (2010), it was found that the coefficient of the regression model multiplied by the number of observations (nR^2) is more significant than the probability value of the chi-square (X^2) distribution satisfying the presence of ARCH effect

4.4.2 Q-Q plots for the residuals

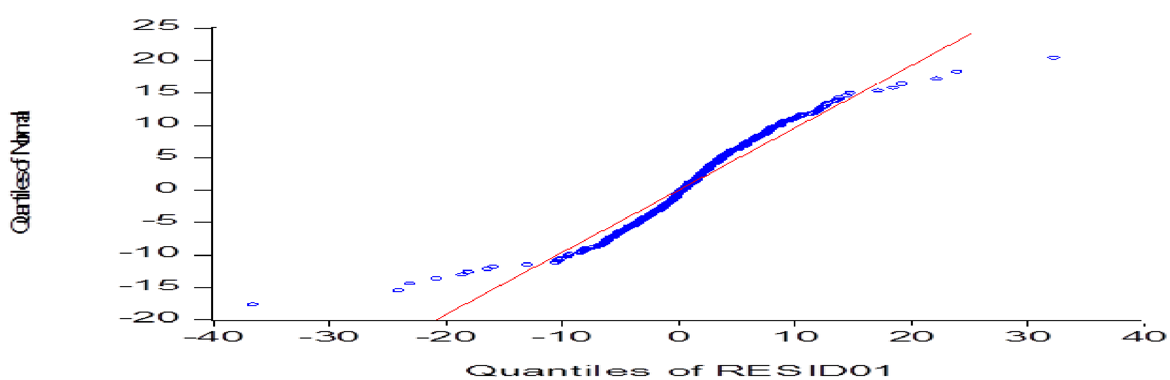

Figure 4.3 contains QQ-plots of the Residuals of the GARCH Model. The graph confirmed that the quantiles of normal points lie straight on the quantiles of residual points which shows that the model is adequate for forecasting and policy formulation. The result obtained for model fitness using QQ-statistics test in this study agree with Atoi (2014) findings using Q-Q – plot.

Similarly, the normal and residual points for the quantile plot above is also in line with Abduikareem and Abdulhakeem,(2016) recommendation in analyzing oil price – macroeconomic Volatility in Nigeria. In Abduikareem and Abdulhakeem,(2016), it was recommended that in examining GARCH models that it is necessary that normal and residual points Plot needs to be validated to be sure that the model is properly fitted.

4.5 Discussion of Results

Table 4.2 contains the answer to research question one and its corresponding test of hypothesis one. This means that the variances of log returns are heteroskedastic and suggests the use of ARCH/GARCH model for capturing the time varying volatility in the log returns. Similarly, equation 4.2 contain the estimate of the mean equation while equation 4.3 contain the estimate of standard symmetric GARCH model in normal error distributional assumptions. Also, equation 4.3 has two parts and they include; ARCH and GARCH model components. The addition of the ARCH and GARCH model components show the impact of volatility. From the results obtained above, there is 88.3% of persistence of volatility impact in Nigeria agricultural export price between 1992 to 2020.

6.2 Conclusion

The conditional variances of all the estimated GARCH model is found to be unstable with high impact volatility and persistence shock. The GARCH (1,1) a showed supportive evidence for the existence of high impact volatility indicating that shocks increase volatility more than positive shocks of the same sign. This result signaled potential loss or gain with higher level of risk and uncertainty in Nigerian export market.

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