

**EXCHANGE RATE VOLATILITY AND AGRICULTURAL  
EXPORT IN A SMALL OPEN ECONOMY**

**IDRIS, Ahmed Sani**

Department of Economics, Kogi State University, Anyigba Nigeria.

Sanii7712@gmail.com.

**08062065126**

**YUSUF Dan-suma, Lawal**

Department of Economics, Kogi State University, Anyigba Nigeria.

***Abstract***

*The concern of this paper is to examine the impact of real exchange rate volatility on Agricultural product export flow in Nigeria for the period 1986 -2018. ARCH and GARCH Models were used to measure current volatility of exchange rate relationship and Johansen co-integration test with vector error correction model (VECM) was used to investigate the impact of exchange rate volatility on agricultural export. The findings suggest that, there exist statistically significant relationship between agricultural exports and exchange rate volatility in Nigeria. The study recommends the combination of monetary and fiscal policy to address the impact of exchange rate volatility instead of sole concentration on monetary policy alone.*

**Keywords:** Exchange rate volatility, agricultural export, ARCH, GARCH, VECM.

**Introduction**

After the collapse of the Bretton-Woods system of fixed exchange rates collapsed in 1973, the relative prices of currencies began to fluctuate as a result of countries embracing flexible exchange rate. Since the emergence of floating exchange rate, there has been extensive debate about the impact of exchange rate volatility on international trade. The liberalization of capital flows and the higher than ever movements of cross-economies financial transactions have also led to amplify the extent of the volatility of exchange rates among countries. This increased volatility of exchange rates is believed to have negative impact on an economy, especially for developing

countries with underdeveloped capital markets and lack of stable economic policies.

These fluctuations brought increased uncertainty to investors; this risk may influence the volume of international trade. Since the beginning of the current floating exchange rate system, numerous theoretical papers have been written to explicate the effects of increased exchange rate volatility on trade, and even more empirical submission have been put forward to estimate these ideas. Adversaries of the floating exchange rates are of the opinion that such rates introduce uncertainty into the foreign exchange market, which could discourage trade flows. However, a theoretical argument is put forward by proponents of flexible rate to show that uncertainty could also boost trade flows if traders increase their trade volume to offset any decrease in future revenue due to exchange rate volatility. They emphasized that indeed, an increase in exchange rate volatility can create profit opportunity for firms if they can protect themselves from negative effects by hedging or if they have ability to take advantage of such fluctuations in exchange rate.

Theoretically, scholars like, Hooper and Kohlhagen(1978), Côte, (1994), Arize, Malindretos, and Slottje (2008), Brada and Mendez (1988) and Chowdhury (1993) in their theoretically studies submitted that volatility depresses trade. If exchange rate schedule are not fully expected, an increase in exchange rate volatility may lead risk adverse agents to reduce their international trading actions. In addition, they emphasized that exchange rate volatility can lead to the deformation of the relative prices of domestic tradable, non-tradable and international goods.

This distortion will cause misallocation of resources which will adversely affect domestic investment and production through reduced efficiency. Under these conditions combined with the dependence on exports as a driving force for their economic growth, the impact of exchange rate volatility has been an important issue for developing and emerging economies. In addition, the dependence on imported capital goods and the specialization of commodity exports can also instigate distinct impacts of exchange rate volatility on the economic activity of developing and emerging economies.

Empirically, investigations analyzing the relationship of exchange rate volatility and agricultural produce export are bound but inconclusive on the directions of the relationship and also the magnitude of the relationship. This disparity cannot be far from the differences in the methods of analysis, sample size and even the nature of the economy under study. For instance, Shehu and Youtang (2012) posited that exchange rate volatility has a negative relationship with export of agricultural product in less developed countries but has a positive relationship in the less developed economies. Golinelli and Parigi (2014) in their quest to monitor movement of global international trade opined that depreciation of local currency of a developing country discourage export of her agricultural product. They emphasized that quality of their product will drop thereby damping their marketability at the international level.

In his own contribution, Abdur (2015) analyzes term of trade of countries and submit that trade farewell in economy that experience less exchange rate volatility. Similarly Chia and Alba (2006) maintained that in small open economy export generally drop as a result of exchange rate volatility they experience. These scholars are of the view that when exchange rate becomes volatile, productivity generally drop as there would be drop in demand. Furthermore, Obadan (2012) and Ikpeze (2012) observing the trend of Nigeria export after the implementation of structural adjustment programme, submitted that at a higher exchange rate of the Nigeria's Naira to the USD, export of agricultural product is always challenged. In support of their position, they observed that agrochemical used in enhancing the quality and quantity of product would become dear to obtain by the mechanized farmers that are responsible for the chunk of the export.

In addition, scholars like Ethier (1973), McKenzie (1999), and Schneider (2005) in their respective submissions show that raise in exchange rate volatility can increase the output and thus volume of trade if the firm can amend its output according to price level. However, in their own contribution, Broll and Eckwert (1999) and Dell'Ariccia (1999) make obvious submission that an international firm with huge domestic market base has the capacity to benefit from the exchange rate movements by reallocating their products between domestic and foreign market. Thus, higher volatility increases the potential profit from global trade and makes

production more beneficial. In addition, they maintained that exchange rate volatility and increased risk associated with volatility induce risk averse agents to direct their resources to less risky economic activity.

### **Models specification, Estimation and results**

Different approaches have been used in explaining the relationship between exchange rate volatility and international trade. In all, these postulation gears towards analysis of existence of a long-run relationships. In the various analysis, long-run export demand equation which specifies export as a function of foreign income, relative price of exports, exchange rate and exchange rate volatility (Bailey, 1988; Brada & Mendez, 1988; De Vita, 2004). These scholars are of the position that exchange rate volatility impact on agricultural exports can be modeled via international trade.

This present study analyzes annual time-series data of export of agriculture product. The sample period for investigations is 1986-2014 which is obtained from Nigeria bureau of statistic and the central bank of Nigeria. In this study, it is assumed that export and import flows of agriculture product fluctuate in response to exchange rate volatility. Volatilities are randomly distributed over the time span under investigation. Exchange rate volatility is assumed to be randomly distributed around an anticipated stochastic steady state trend.

The study follows and adapt the previous scholars like Arize, and Osang (2003), De Vita (2004) and Todani and Munyara (2005) methods of a common specification of export demand equation as presented by Equation [1]

$$[1] \quad ERV_t = \alpha_0 + \beta_1 EXP_t + \beta_2 GGDP_t + \beta_3 RP_t + \varepsilon_t$$

where  $ERV_{tf}$  denotes the relative volatile price of domestic goods in term of foreign goods and it captures both effective relative price currencies, goods, the rate of volatility can thus be captured as in Equation [2]

$$[2] \quad ERV_t = \left( ERx \frac{CPI_f}{CPI_t} \right)$$

where  $CPI_f$  is inflation in a foreign country and  $CPI_t$  is Nigeria's inflation and  $ER$  is the Naira USD exchange rate.

where  $EXP_f$  denotes the logarithm of agricultural exports of Nigeria, that are constructed as nominal agricultural exports deflated by consumer price index ( $CPI$ ) as follows in Equation [3]

$$[3] \quad EXP_t = \ln\left(\frac{NEX_f}{CPI_t}\right)$$

Where,  $NEX_f$  is nominal agricultural exports and  $CPI_f$  is the consumer price index.

Also  $RP_t$  is the measure of exchange rate risk and its intent to capture the uncertainty faced by exporters due to unpredictable fluctuations in the exchange rates. Similarly,  $GGDP_t$  is the global GDP for the correction of Nigeria export ratio in terms of her agricultural product contribution at the global level. Obviously,  $\varepsilon_t$  is an unobservable variable and thus its measure is a matter of serious contention. Recent literature, however, seems to be increasingly adopting the use of Bollerslev (1986) generalized autoregressive conditional heteroskedasticity (GARCH) models by measuring it as a disturbance term. Exchange rate volatility. Various statistical measures of the variability have been suggested in the literature. The approach followed in this study takes into account that it is uncertainty or unpredictable component of a variable's movement rather than variability, which matters most to economic agents, conditional standard deviation measures are used in this study. First, as Engle (1982) summaries that conditional variance is of more relevance to economic agents planning than their behaviors; therefore exchange rate is proxied by the Engle (1982) model (ARCH model). In this model, variance of a variable is specified as a linear function of the expected squares of the lagged value of the error term from an auxiliary regression determining the mean of the variable of interest. Suppose that the exchange rate is generated by the following autoregressive process in Equation [4]. Before presentation of the empirical results, it is necessary to derive an operational measure of  $\Delta ER_t$ ,

$$[4] \quad \Delta ER_t = \alpha_0 + \sum \Delta \beta_1 ER_t + \mu_t$$

Where  $\alpha_0$  is a constant,  $\beta_1$  is the coefficient and  $\mu_t | \Omega_{t-1} \sim N(0, \delta^2)$ . That is, the error term  $\mu_t$  is normally distributed with mean zero and variance  $\mu^2$ .

The set of available information at time  $t-1$  is denoted by  $\Omega_{t-1}$ . Engel

(1982) allowed for the variance to vary over time and the idea behind the ARCH model is to characterize how this variance change over time. The ARCH model assumes that the variance can be captured by the following autoregressive process as in Equation

$$[5] \quad \delta_t^2 = \lambda_0 + \sum_{i=1}^p \phi_i \mu_{t-i}^2$$

Where  $\delta_t^2$  is the conditional variance of the exchange rate,  $\delta_{t-1}^2$  represents the squared residuals consequent from Equation [4] and  $\phi_i$ 's are parameters to be estimated. To ensure that the predicted variance is forever positive, the constraint that  $\phi_i \geq 0$  is necessary. Notice here that in Equation [4] the current levels of volatility is influenced by the previous levels of volatility and thus high or low periods of volatility will tend to persevere. Bollerslev (1986) introduced the GARCH ( $p, q$ ) process, which is just extension of the ARCH in which  $\delta_t^2$  becomes a function not only of  $\mu_{t-1}^2$  but also of the lagged values of itself. The conditional variance in this case is estimated as in Equation [6]

$$[6] \quad \delta_t^2 = \lambda_0 + \sum_{i=1}^p \phi_i \mu_{t-i}^2 + \sum_{i=1}^q \delta_i \sigma_{t-i}^2$$

All coefficients in equation (6) need to be positive to make sure that we have a positive variance. The most common form of Equation [6] is the GARCH (1, 1), which can be represented as follows in Equation [7]

$$[7] \quad \delta_t^2 = \lambda_0 + \phi_1 \mu_{t-1}^2 + \delta_1 \sigma_{t-1}^2$$

Equation [7] is the basis for estimation exchange rate volatility in this study. The results in Table 4 indicated there is a positive relationship between current ERV and its conditional volatility in the period ahead. The relationship is statistically significant based on the z-statistic and probability of the GARCH term results and the squared residual results. Conditional variance and previous information as measured by the squared residual both have a positive coefficient and highly statistically significant probability value at five percent level of significance indicated that previous forecast error affect the present the present forecast error positively. Thus, the present ERV has a positive impact on its conditional volatility in other periods ahead. Also, the estimated mean equation shows that volatility shocks are highly persistent implying that the presence of clustering along the mean. This indicated that a period of large (small) change in ERV is accompanied by a large (small) change in ERV over a long period. This

result also buttressed the point that current ERV influences its conditional volatility in periods ahead.

Like in every time series econometric analysis, the stationary properties of the data series is tested to avoid spurious results. To determine whether each data set is non-stationary and integrated of the same order, the augmented Dickey-Fuller (ADF) test is used to test for the unit root of the series.

The results of unit root test are presented in Table 2. The results for each variable at levels indicate that null hypothesis of a unit root could not be rejected of any variables. Thus, implies that all of the variables are non-stationary. However, at first differences for each variable, the null hypothesis is rejected for all the variables are stationary at five percent level of significance.

This indicates that all the data series are integrated to order one. Therefore, in the next stage we adapt the Johansen's approach of Co-integration tests to determine whether co-integrating vectors existed which would imply non-spurious long-run relationships among the variables. If we have  $N$  endogenous variable  $I(1)$ , there can exist 0 to  $N-1$  linearly independent co-integrating vector that represent long-run equilibrium relationships (Johansen, 1991). The number of these equations is called the "co-integrating rank" and the Johansen tests can determinate the number of co-integrating equations.

Therefore in this study, agricultural exports is computed in a vector autoregressive (VAR) model in the framework of Johansen (1991) integration order to determine the short-run and long-run causes of agricultural exports in Nigeria. Starting with the VAR ( $q$ ), we define  $AEXP_t$  as the unrestricted vector of variables integrated of order one ( $I(1)$ ) as in Equation [8]

$$[8] \quad AEXP_t = \alpha_t + \alpha_1 ERV + \alpha_2 RP_{t-1} + \alpha_3 GGDP_{t-1} + \varepsilon_t$$

The vector error correction model (VECM) is formulated by estimating the above equation in its first difference form as in Equation [9]

$$[9] \quad \Delta AEXP_t = \alpha_t + \alpha_1 \Delta ERV + \alpha_2 \Delta RP_{t-1} + \alpha_3 \Delta GGDP_{t-1} + \varepsilon_t$$

Where, the definition of variables remained the same as earlier stated. The appropriate lag length of the VECM is chosen according to the Akaike's information criterion. We examine the effect of exogenous shock. The results of the co-integration investigation are reported in Table 3. Test statistics from the maximal Eigen value was consistent in suggesting that

there is two integrating vector among the variables. Consequently, it is concluded that there existed long-run relationships among the agricultural export, foreign incomes, relative price, and volatility of exchange rate.

With estimating of Co-integrating vectors, it is determined that the variables are co-integrated, and this model allow us to scrutinize short-run and long-run effects of changes in volatility of exchange rate and foreign income. However, the data was also test for the optimal Lag length selection criteria as presented in Table 4. From Table 4, the results indicated that all the selection criteria, selected lag length of order two. Based on the result, the study proceed to conduct the vector error correction model (VECM) estimation.

The result of vector of VECM estimation is presented in Table 4. Based on the AIC criterion, the bestl estimated lag length of the underlying vector auto-regression (VAR) was estimated for each variable. According to Table 5, the short-run effects represented by difference terms and lagged terms represented long-run effects. The results of long run estimation show that except ERV, other variables are statistically significant at the five percent level. The coefficient of ERV is positive which implies that it has a positive influence on AEXP even in the long-run even though the influence is not significant.

The coefficient of  $ECT_{t-1}$  shows a negative and statistically significant disequilibrium that can be adjusted in the next year. Also, the coefficient ERV in the short-run is negatively and statistically significant at five percent level of significance. The coefficient of relative price of all has the correct positive sign and is statistically significant in short and long run. Significant positive volatility of long run effects could indicate to existence of new potential for exporter of Nigeria in long run. It could be the case that exporters are aware that limited domestic market cannot absorb all excess supply that may arise if trading becomes more risky due to increased exchange rate volatility in long-run. To avoid any reduction in revenues arising from increased risk they therefore, may export more agricultural products in the long-run.

## **Conclusion**



This study was an attempt to analyze the impact of exchange rate volatility on Nigeria's agricultural exports. A VECM procedure was used. The results indicated that ERV has a negative and significant impact on Nigeria's agricultural export flows in short run but it had a positive impact in long run though not significant, that it makes a possibility for exporter to be discouraged from exporting in short run due to uncertainty in exchange rate. This pressure gradually subsides in the long-run as a result of some palliative measures consciously put in place by the government. The study submits that government in Nigeria should put in place both fiscal and monetary measures that will discourage ERV. Also, a conducive climate for investors to operate should be created via both legislature that is favorable for doing business for the investors.

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Table 1

*EGARCH Test Result*

Variable	Coefficient	Std. Error	z-statistic	Prob.
<i>C</i>	19819.06	247966	0.000	0.999
<i>AR(1)</i>	1.000	0.040	24.595	0.000*
Variance Equation				
<i>C</i>	1.578	0.580	2.719	0.006*
<i>RESID(-1)^2</i>	0.959	0.196	4.883	0.000*
<i>GARCH(-1)</i>	0.376	0.048	7.803	0.000*

Note:\* denotes significant at five percent.

Table 2

*Stationarity Test Results*

Variables	ADF At level	ADF 1 <sup>st</sup> Difference
<i>ERV</i>	-2.504	-3.653*
<i>AEXP</i>	-2.051	-3.651*
<i>RP</i>	-1.340	-3.653*
<i>GGDP</i>	-1.132	-3.654*

Note \* denotes rejection of the hypothesis at five percent significance level.

Table 3

*Johansen's Co-integration Test Results*

Hypothesized No. of CE(s)	Eigenvalue	Likelihood Ratio	Five Percent Value	Critical
None *	0.662	60.490	47.213	
At most 1 *	0.607	34.456	29.681	
At most 2	0.349	12.028	15.410	
At most 3	0.068	1.7113	3.764	

\* denotes rejection of the hypothesis at five percent significance level.

Table 4

*VAR Lag Length Selection*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-					
1	2262.824	NA	6.61e+08	40.173	40.342	40.242
2	1119.061	2125.577	19.544	20.797	22.149	21.346
3	905.022	371.252*	10.113*	17.876*	20.410*	18.904*
	876.093	46.593	0.202	18.231	21.948	19.740

Note: \* indicates lag order selected by the criterion, LR: Sequential modified LR test statistic (each test at 5% level of significance), FPE: Final predictor error,AIC: Akaike information criterion, SC: Schwarz information criterion and HQ: Hannan-Quinn information criterion respectively.

Table 5

*Long Run Relationship Estimation*

Variables	Coefficient	Standard	t-statistics	Prob**
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		Error		
<i>L(ERV)</i>	1.049	0.483	-2.171	0.143
<i>L(RP)</i>	0.008	0.014	0.562	0.043*
<i>L(GGDP)</i>	-0.02	0.204	-2.139	0.041*

Note: \* denote five percent level of significance.

Table 6  
*Short Run Relationship Estimation*

Variables	Coefficient	Standard Error	<i>t</i> -statistics	Prob**
<i>DLOGAEXP (-1)</i>	0.436	0.116	3.758	0.032**
<i>DERV(-1)</i>	-0.018	0.009	-2.000	0.065**
<i>DFP(-1)</i>	0.000	0.027	0.033	0.107
<i>DGGDP(-1)</i>	0.011	0.041	0.276	0.272
<i>ECT<sub>t-1</sub></i>	-0.196	0.062	-3.142	0.027*

Note: \* denote five percent level of significance.