Real Exchange Rate Movement-Misalignment and Volatility- and the Agricultural Sector: Evidence from Nigeria

Anigbogu, Theresa. U, PhD
Department of Cooperative Economics and Management
Nnamdi Azikiwe University (NAU)
Awka, Nigeria

Okoye, P.V.C
Department of Accountancy
Nnamdi Azikiwe University (NAU)
Awka, Nigeria

Anyanwu, Nnadozie K.
Departent of Economics
Nnamdi Azikiwe University (NAU)
Awka, Anambra State
Nigeria

Okoli, Moses I.
Department of Cooperative Economics and Management
Nnamdi Azikiwe University (NAU)
Awka, Nigeria

Abstract

The Nigeria agricultural sector has been less impervious to external influences and most actors in the sector are near-incapacitated towards hedging against adverse shocks and uncertainty that affect the sector, especially unpredictable swings associated with price and exchange rate movements. This study X-rays the impact of real exchange rate (RER) misalignment and its volatility on the Nigerian agricultural sector from 1960 to 2010. Estimating a single-regression model via the ordinary least squares (consequently because of the poor coefficients got from the VECM model), the findings were robust and suggesting that RER misalignment and RER volatility impact negatively on agricultural production value. Moreover, appreciation of the RER inhibits the sector's performance, while, on the contrary, financial intermediation to the sector (proxy as the ratio of agricultural bank credit to total bank credit) serves as a positive impetus to the sector. The policy implications it engenders canvasses for hedging the sector from RER movements' risks through ensuring stability of the rate and attainment of long-run equilibrium of RER, as well as producers taking advantage of the subsidized agricultural insurance instigated by the government.

1. Introduction

As world globalization intensifies coupled with the collapse of the Bretton Wood system in the 70's, international and developmental economists and analysts have been actively preoccupied with the issue of global trade imbalances and its possible causes and consequences, as the benefits of world integration have been asymmetrically distributed among economies at vary times, therefore creating classes of losers and winners in the international arena. In the literature explaining trade imbalance and deficits, keen research interest focusing on uncertainty and volatility of the real exchange rate tops the possible causes. The current trade feud between the U.S and China is not unconnected with the exchange rate between both countries.

International trade and capital flows have been adversely affected by uncertainty and instability in real exchange rate. This fact is glaringly crystal after the collapse of the modified Gold Standard fixed exchange rate system instigated by the Bretton Wood institutions and the introduction of floating, or flexible rate, system.

Hooper, Johnson and Marquez (1998) and Chinn (2004, 2005) find that trade flows were significantly affected by real exchanges rates beginning from the mid-70s. Many economies, after the movement to floating, or managed float, exchange rate regime experienced intense vicissitudes, positive and negative, in real exchange rate (hereafter, RER), with its concomitant risks that affect trade negatively. Exchange rate risk proxies the volatility and erratic movement of RER. Adubi and Okumadewa (1999) argue that the more volatile the rate is, the higher the risk associated with the variable. They posit that producers of exports are not only concerned with tradeable prices they receive; they also bother about the stability of such prices as it affects their incomes. Moreover, RER volatility leads to resource allocation inefficiencies, change the production and employment structure, and distort the domestic economy. An International Monetary Fund (IMF) (1984) study cites arguments that exchange rate variability would also tend to induce macroeconomic phenomena that are undesirable, for example inflation and protectionism. However, this view has been refuted by some scholars positing that countries with flexible exchange rate grow faster (De Grauwe, 1998; Caballero and Corbo,1989; Edwards and Levy-Yeyati, 2003; Eichengrean and Leblang, 2003; Gulde and Wolf, 2003).

Mckinnon and Schnabl (2003) argue for the small open East Asian economies that the fluctuations of the Japanese yen against the U.S. dollars affected the growth performance of the whole region positively. They identified trade with Japan as crucial transmission channel. Other thoughts assert that if firms hedge against exchange rate volatility risks by taking advantage of future or forward exchange rate market the strong negative effect on trade could be reversed. This requires a well-developed foreign exchange market, which is near non-existent in most economies in sub-Sahara Africa. However, the International Monetary Fund (1984: No.28) argues that future market works effectively in hedging nominal exchange rate in the short run at small cost. But export oriented activities would be exposed to higher and possibly unhedgeable risks.

Further, in the literature, exchange rate misalignment is a facet of exchange rate movement gathering prominence. Stability and proper alignment of the exchange rates are absolutely essential to the restoration of growth in the tradeable and non-tradeable goods sector and, indeed, the aggregate economy (Oluremi, 1998). Edward (1988, 1989) in his expository RER determinant and misalignment said no one equilibrium exist, but a path of equilibrium through time. He identified equilibrium and non-equilibrium movement in RER. Misalignment is non-equilibrium movement of RER occasioned by inconsistent domestic macroeconomic policies. According to Edward (1988) this inconsistent policy-induce RER misalignment and disequilibrium-could be quantitative trade restrictions such as import tariffs, subsidies, quotas, exchange capital controls; and the composition of government expenditure. Eliminating the inconsistent policies is a way of returning the RER to equilibrium (Oluremi, 1998).

Exchange rate management in Nigeria has evolved through various regimes. During the first decade of independence and for the early years of 1970s', the IMF modified fixed exchange rate was adopted. After its collapse, the country moved to the adjustable peg regime, which pegged the naira to series of international currencies (1973-85). The flexible and managed float regime was instigated under the SAP in 1986. The exchange rate was left to float freely and determined by market forces, with the monetary authorities intervening intermittently in the FOREX market to ensure stability of the rate. The country returned back to a fixed regime from 1994 to 1998, where the naira was fixed at ₦21 to a dollar. The democratic dispensation of 1999 re-ushered the flexible and managed float regime, and has remained the system till present. Pinto (1987) and Ogun (1995) have criticized the first two regimes for generating greater exchange rate misalignment, and the regime after the adoption of SAP (excluding the reintroduction of the fixed regime in 1994) for fuelling volatility of the rate.

The fixed and adjustable pegged regimes were characterized by consistent appreciation of the naira relative to her trading partners. This was a deliberate act to support the import substitution strategy (ISS) of the 1960/1970s. The goal was to outsource imported equipment and machineries to support the protected domestic industries. The combination of these policies was inimical to the economy, as the country witness balance of payment deficits, terms of trade deterioration, and depletion of external reserves. The adversities in the economy worsened when the oil price collapsed in late 70s. From a sectoral perspective, the agricultural sector was the most hit during this period. As Obadan (2006) noted, the agricultural sector collapsed while the large industries flourished due to large scale import of plant inputs made possible by the real appreciation of naira value that encouraged import and capital flight. Output of major cash crops plummeted both in value and quantity. For instance, cocoa, rubber, cotton and groundnut fell by 42, 29, 65 and 64, respectively during between 1970 and 1985 (Osaka et al, 2003).

The agricultural sector, despite its relative importance in the economy, was neglected and its potentials to sustain and fuel pro-poor growth were undermined, as the sector loses its relative competitive flavor owing to appreciation of the naira.

In order to correct the structural rigidities, diversify the productive base of the economy and resuscitate the agricultural sector by promoting its international competitiveness, the country adopted the floating exchange rate system. This system facilitated the depreciation of the effective exchange rate, thus encouraging export. As observed by empirical studies (Oyejide, 1986; Ihimodu, 1993; Osuntogun et al., 1993; World Bank, 1994), the depreciating naira promoted Nigeria's agricultural exports, increased agricultural exports prices and improved the income of small rural farmers who account for 90% of the sector (See Table 1 and 2 on agricultural output and producer prices: Pre and Post-SAP). Confirming this, Adubi et al (1999) observed that the depreciation of the naira and abolition of the commodity boards were significant in bringing about increases in production of exports. They noted a major increase in five major agricultural export crops that had been on the decline since the 1970s.

However, the flexible exchange rate regime was not without negativity on the agricultural sector. This period marked unprecedented volatility, uncertainty and high risks associated with the exchange rate. Variability of the rate caused unproductive changes in relative prices of agricultural commodities, thus leading to imperfect allocation of resources in the sector as well as declining farmer's income. As opined by Adubi et al (1999), even with the presence of future rate market, exchange rate volatility tends to increase the risk and uncertainty in international transactions which adversely affect trade and investment flows.

Table 1: Output of Export Crops: Pre and Post SAP (Cumulative, 000 tons)

Export Crops			
Year	**Pre-SAP**	**Year**	**Post-SAP**
1982	**1346**	**1986**	**1770**
1983	**1435**	**1987**	**1364**
1984	**1137**	**1988**	**2415**
1985	**1437**	**1989**	**2616**
Average	**1339**		**2084**

Source*: Adubi et al (1999)*

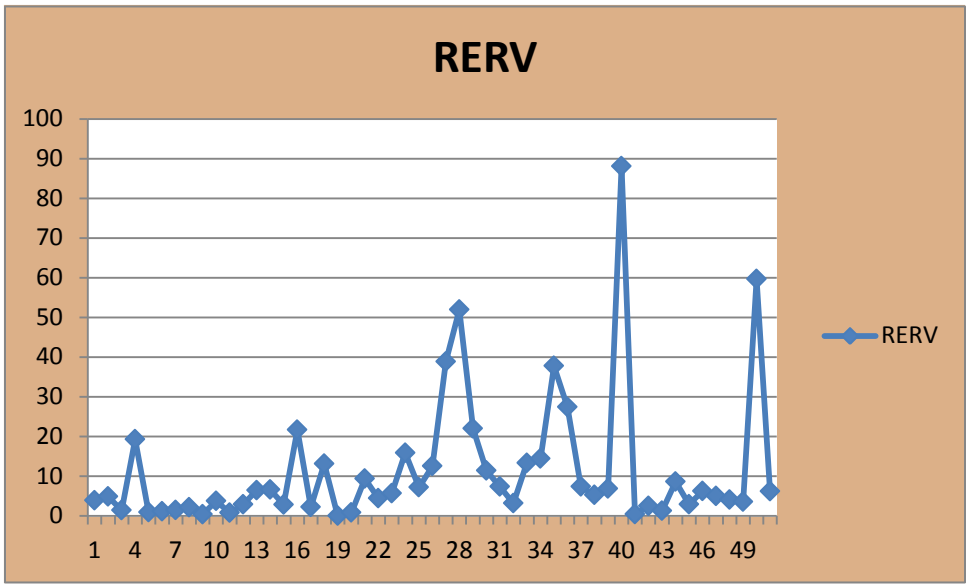
Table 2: **Producer Incomes from Agricultural Crops ('000 ₦)**

Year	**Commodities**				
	Cocoa	**Groundnut**	**Cotton**	**Palm Kernel**	**Palm Oil**
1983	**196,000**	**176,200**	**67,200**	**64,170**	**247,500**
1984	**180,000**	**384,150**	**75,600**	**136,000**	**330,000**
1985	**174,000**	**465,750**	**39,100**	**144,000**	**-------**
1986	**602,000**	**640,000**	**30,000**	**140,000**	**650,000**
1987	**1,162,500**	**1,494,200**	**32,000**	**300,050**	**816,000**
1988	**2,200,000**	**1,543,500**	**873,000**	**545,000**	**1,050,000**
1989	**3,210,000**	**5,233,155**	**1,036,000**	**1,500,000**	**910,000**
1990	**2,074,000**	**5,037,120**	**486,200**	**2,380,000**	**846,800**

Source: Adubi et al (1999)

From Tables 1 and 2, it is perceptible that agricultural output and income received performed grandiosely in the post-SAP period than pre-SAP. Average output was higher in post-SAP and incomes increased seismically beginning from1986 for most of the agricultural cash crops.

Figure 1: Real Exchange Rate Volatility (1960-2010)



Source: RERV as computed by the authors

Decomposing the real exchange rate volatility (RERV) into its various exchange rate management regimes as experienced in Nigeria, in spite of the zig-zag trend in RERV, intense volatility was recorded more during flexible rate regimes. Moreover, the fixed rate regime was the only regime with less volatility in RER. Except for 1963 (when a change in the Nigerian parliamentary structure occurred), RER volatility for the period (fixed 1960-1973) was 7%. Remarkably, movement from one regime to another accompanied an explosion in RER volatility. For instance, RERV was 21% a year after moving to the adjustable regime; 35 and 51% in the first two years of the flexible rate regime (1986 and 1987); 37% in 1994, the year when the fixed rate regime was readopted; and 88% in 1999, marking a change of governmental administration and a shift back to the floating rate system.

The literature on exchange rate movement is vast. Some of these empirical studies focus on the impact of exchange rate on the economy (or aggregated variables like export, BOP, etc.) as a whole without due accentuation to sectoral analysis and dynamism of the RER, while others adopt the nominal exchange rate (NER) ignoring the fact that RER offers a better insight to the relative competiveness of an economy and influences on macroeconomic indicators more than the NER (Schuh, 1974; Ihimodu, 1993; Ogiogio, 1993; Osuntogun et al., 1993; Obadan, 1994, Adubi et al, 1999; Nwidobie, 2011; Oyovwi, 2012). This study aims to fill the lapse in the existing literature by empirically tracing the link between RER movements: misalignment and volatility on agricultural export. Oluremi (1998) investigated something similar, but he looked at total export. This study is a sectorial analysis on the country's most important sector (agriculture sector) in terms of its contribution to the GDP; employment engagement and composition of non-oil export. The rest of the paper is structured as follows: section two presents the theoretical framework; the empirical model, measurement framework and data sources are discussed under section three; section four and five cover empirical analysis and conclusion, respectively.

2. The Theoretical Framework

Exchange rate risk models exist in the literature with slight modifications distinguishing them. These models are mostly micro in perspective; however, macro generalization of these micro-risk models is plausible. A common tenet of these models is that they view an exporter as either a risk averse or a less risk adversary. This distinguishable element generates two distinct responses from exporters. In the view of Oluremi (1998), risk averse exporters see adverse exchange rate changes as perpetual, thus in protecting their income levels, may increase export activities. This is an income effect that tends to increase export volume. Conversely, where the exporter is less risk averse, adverse exchange rate movement is usually interpreted in terms of greater risk. Consequently, the exporter would divert resources from export activities into their domestic substitutes. Such a substitution effect would be mirrored in declining export volume. In his model, he considered a farmer who operates both in the foreign and domestic markets. The revenue of the farmer is:

$$\widehat{Y} = \widehat{e}P_f q(X_f) + P_d q(X_d) \ldots 1$$

where a tilde on any variable indicates its random nature; e is exchange rate; P_f is the price of the output sold in the foreign market measured in domestic currency; P_d is the price of the output sold domestically; and $\widehat{e}P_f = P_d$ suggesting an absence of market segmentation. Assuming same technology in production for both markets, then $q(X_f)$ refers to the quantity produced for the foreign market from using X_f amount of resources, and $q(X_d)$ is the quantity produced for the domestic market from using (X_d) amount of resources.

The farmer maximizes expected utility defined over gross revenue so that,

$$\max E\{U(\widehat{Y})\} = E\{U[\widehat{e}P_f q(X_f) + P_d q(X_d)]\} \ldots 2$$

where U is a concave function of Y. In other words, the farmer is assumed to be risk averse.

The first order condition for a maximum is:

$$\Delta E/\Delta X_f = E\{U(Y)[\widehat{e}P_f q(X_f) - P_d q(X_d)]\} \ldots \quad 3$$

This above could take the form:

$$E\{U'(\widehat{Y})\widehat{e}\} = P_d / P_f \,.\, q'(X_d) / q'(X_f) \,.\, U'(Y) \ldots 4$$

To show how an increase in movement of $\widehat{e}$ affects the optimal amount of resources put into export production ***(X_f)***, the model followed De Grauwe (1998) by examining how a "mean-preserving" spread in $\widehat{e}$ effect the LHS of equ. 4. If such an increase raise the LHS of equ. 4, the RHS must also increase, and this takes place when X_f increases. Thus if $\widehat{e}$ increases the marginal utility of gross revenue, such increase boast export.

The issue now centers whether the function $U'(\widehat{Y})\widehat{e}$ is convex or concave in ***è***. If it is convex (concave), then every mean-preserving increase in the spread of ***ë*** will increase (decrease) the expected value of the function $U'(\widehat{Y})\widehat{e}$. The condition under which the function $U'(\widehat{Y})\widehat{e}$ is convex or concave can be found by differentiating it twice with respect to e.

$$D^{2\,U(\widehat{Y})e} / d^2 e = 1/e\,[R(1-R) + R'Y] \ldots 5$$

where $R = U''(Y)/U'(Y)$ is the coefficient of relative risk aversion. If Equation 5 is positive (negative), then the function $U'(Y)$ is convex (concave). It follows therefore that convexity or concavity depends on the degree of risk aversion. If it is assumed conventionally that the coefficient of relative risk aversion R is constant, then $R' = 0$. By implication, convexity holds if $R>1$ and concavity holds if $R<1$.

As a synopsis, if farmers are sufficiently risk averse ***(R>.1)***, an increase in exchange rate risk raises the expected marginal utility of gross revenue and therefore induces them to increase their export activity. However, if farmers are not very risk averse ***(R<1)***, a higher exchange rate reduces the expected marginal utility of gross revenue and therefore leads them to produce less for export.

3. The Empirical Model and Methodology

The Model

In other to trace the impact of RER movement-misalignment and volatility on agricultural production value, we formulate an agricultural production function which states that agricultural export is influenced by RER, RER volatility and misalignment.

Y = f (RER, RERV, RERM and CRED)

Where Y represents agricultural production value, RER, RERV and RERM are real exchange rate, volatility and misalignment. We included the credit availability to sector as one of the regressors, as it is has been observed in the literature to have a strong influence on the sector (Nwobi et al, 2012).

The econometric model is thus:

$$Y = \lambda_1 + \lambda_2 LogRER + \lambda_3 RERV + \lambda_4 RERM + \lambda_5 CRED + \varepsilon$$

Where λ_1 **to** λ_5 are the intercept and slope coefficients and ε is the random residual term. For the hypothesis that exchange rate misalignment and volatility adversely affect agricultural export to be accepted there coefficients (λ_3 and λ_4) are expected to be significantly different from zero.

Methodology, Variable Measurement and Data Sources

The coefficients of the model's parameters were estimated using the Vector Error Correction Model (VECM). The Augmented Dickey-Fuller (ADF) test was used to determine the time series properties (for the presence of a unit root) of the stochastic variables. A variable is said to contain a unit root or is I(1) if it is non-stationary. The use of data characterized by unit roots may lead to serious error in statistical inference (Abiodun et al: 2010:6). The Johansen procedure was used to test for co-integration in the model; the existence of long-run relationship among the variables. If the variables are cointegrated, their long-run relationship will be most efficiently represented by an error-correction model. However, the VECM specification does not facilitate short-run impacts on the regressand but provide analysis on the speed of adjustment to long-run equilibrium.

Conventionally, RER is computed as

$$RER = NER \cdot \frac{P_t^*}{P_t}$$

That is, RER is defined in terms of NER adjusted for relative prices of tradeable and non-tradeable goods (P_t^*/P_t) at a particular period t. P_t^* is the price index for tradeable goods while P_t is the price index for non-tradeables. P_t^* is usually proxied by any price index that reflects more of tradeable goods' prices in its composition (we used the CPI for the USA to proxy this index), while P_t is proxied by the domestic economy consumer price index, which reflect more of non-tradeable goods' prices in its composition.

Real exchange rate volatility measures the trend movement of real exchange rate overtime. This variability is measured by constructing an index. The study employs coefficient of variation (CV) which expresses the dispersion of observed data values as a percent of the mean of a series as a measure of exchange rate volatility.

$$CV = S/\bar{Y} * 100$$

where S and $\bar{Y}$ represent standard deviation and mean of the series, respectively. We use the annual RER values to compute for its volatility.

Misalignment refers to a sustained departure of the actual RER from its long-run equilibrium level (Edwards, 1989). Hence, when the actual RER is below the equilibrium RER, reference is made to over-valuation; otherwise the term, "RER under-valuation" is used (Edwards, 1989). Various methods of computing exchange rate misalignment exist in the literature. This study adopts the PPP methodology, which takes the average of highest RER values to represent equilibrium RER. Cottani et al (1990) posit that the average value for three years is appropriate to represent the equilibrium of RER. RER misalignment is computed as:

$RERM_t = [(a_i maxRER_i/RER_t)/3\text{-}1] * 100$

Where $[(a_i maxRER_i)/3]$ **(where i=1,2,3)** is the average of the three highest values of RER.

Credit availability to the sector (CRED) was proxied by the ratio of agricultural credit to total bank credit in the economy, while agricultural production value was measured as the ratio of real agricultural production to the real GDP.

Data were sourced from different organizations and publications such as the Central Bank of Nigeria; Penn World table; Bureau of Labour Statistics (USA) and the UNCTAD statistical fact sheet. The data covered from 1960 to 2009. This time period is comprehensively accommodative to account for various exchange rate regime instigated in the country.

4. Empirical Analysis

Avoidingly, spuriousness in our regression estimates, the time series properties of our variables were tested for unit root and verifying a long-run relationship among the variable by conducting a test of cointegration. The results of unit root and cointegration tests are presented in Tables 3 and 4 below.

The result of the unit root test confirms that all the variables are integrated at first difference. Though we evaluated the calculated ADF values at 5% level of significance, the values, after first differencing, were also integrated at other levels of significance.

Table 3: Tests of Data Stationarity

Variables	ADF	Critical Values	Order of Integration
Y	**-6.611304**	**-2.9228**	**I(1)**
RER	**-5.699426**	**-2.9228**	**I(1)**
RERV	**-7.428837**	**-2.9228**	**I(1)**
REVM	**-4.754197**	**-2.9228**	**I(1)**
CRED	**-5.053488**	**-2.9228**	**I(1)**

The synopsis of the Johannsen cointegration test reveals the existence of two cointegrating vectors, thus the rejection of the null hypothesis of no cointegration among the variables. Therefore, the explanatory variables are cointegrated and have both short and long run relationships with the dependent variable.

Table 4: Johannsen Cointegration Test

Eigenvalue	Likelihood Ratio	5 percent	1 percent	Hypothesized No. of CE(s)
0.551617	**78.22226**	**68.52**	**76.07**	**None****
0.326376	**40.52321**	**47.21**	**54.46**	**At most 1**
0.184608	**21.95428**	**29.68**	**35.65**	**At most 2**
0.143747	**12.36223**	**15.41**	**20.04**	**At most 3**
0.102226	**5.068341**	**3.76**	**6.65**	**At most 4***

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.
L.R. test indicates 2 cointegrating equation(s) at 5% significance level

The estimated VECM model was unable to establish significant estimates of the regressors in the model. Consequently, we estimated a single-equational model via the ordinary least squares to evaluate the coefficients of the variables. This yielded significant result. The result of single-equational model is presented in Table 5 below. From the result, 33 percent of the variation in agricultural production value is explained jointly by the regressors. Though this seem relatively low, but as opined by Gujarati (2008:222), a low R^2 value should not be of serious concern but accentuation should be given to the significance of the regressors estimates as well as the model in general. The F-stat. value of 5.470670 shows that the model is significant at 1 percent; its probability value is less than 0.01.

Table 5: OLS Model

Variable	Coefficient	Std.Error	t-Statistic	Prob.
RER	**-29.20770**	**11.46386**	**-2.547807**	**0.0144**
RERV	**-0.170833**	**0.101261**	**-1.687065**	**0.0987**
RERM	**-0.258293**	**0.080627**	**-3.203548**	**0.0025**
CRED	**0.405354**	**0.205458**	**1.972927**	**0.0548**
C	**210.5463**	**65.35315**	**3.221671**	**0.0024**

R^2= 0.332146; F-statistic =5.470670 (0.001155); D-W= 0.713476

Remarkably, the coefficients of the model are all significant but at different levels: the intercept term and RERM are significant at 1 percent; RER is at 5 percent; and RERV and CRED are both significant at 10 percent. Also, all variables conform to a priori knowledge (they are correctly signed).

Real exchange rate misalignment and its volatility affect the agricultural production adversely, as observed from the empirical result. They both have negative coefficients buttressing an inverse relation with the agriculture production value. RERM and RERV within the study period increase risk and instability in the sector. This result supports the findings of Oluremi (1998) that both RER misalignment and volatility adversely discourage growth in the non-oil sector, in which the agriculture is the dominant sector. Based on his empirical findings he posits that Nigerian Producers are less risk averse and would react to any adverse exchange rate movement by reducing production.

Furthermore, real exchange rate is negatively related to agricultural production value. This finding supports the orthodox view that appreciation of the real exchange rate reduces the international competiveness of an economy, generates balance of payment deficit through the promotion of import, unemployment and reduced output growth. Recalling (Kombe, 2004:1), RER affects foreign trade flows in the sense that an over-valued RER will tend to favour imports more than exports of goods and services. This leads to poor economic performance.

However, as observed by other researchers, this seems to be a held belief mostly in African economies. Takatoshi and Krueger (1999) on a panel study on economic growth and real exchange rate found a positive correlation between growth and RER appreciation among selected developed countries. They argue that the Asian miracle in late 80s and early 1990s was supported by RER appreciation. However, they were meticulous in their findings to assert that the positive relationship between growth and RER appreciation takes place at a higher level of economic development as well as a structural change in the production setup. Many SSA economies are yet to attain this level. Also, credit to agricultural sector promotes growth of the sector. These financial services help agriculturists to mitigate and provide a hedge over RER movements' risks.

5. Conclusion

Real exchange rate is an important macro-economic variable that if not well managed influences, adversely, other macro variables and distorts sectoral performance towards optimality. Thus, this study investigated the effect of real exchange rate- misalignment and volatility- on the agricultural sector in Nigeria. Estimating a single-equational model from data obtained from various sources from 1960 to 2010, we found that real exchange rate misalignment and volatility negatively affect the agricultural sector. Moreover, our findings reveal that real exchange rate appreciation discourages growth in the agricultural sector. These findings were akin with previous studies (Oyovwi, 2012; Oluremi, 1998; Obadan, 1994). The policy import the study generates is that monetary authorities should ensure stability of the rate by regularly intervening in the foreign exchange market and ensuring long-run equilibrium of the RER. Also farmers should take advantage of the subsidized agricultural insurance of the Federal government, which provides safety nets towards hedging against risks and uncertainties in the sector.

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