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Inflation Rate, Exchange Rate Volatility and Exchange Rate Pass-Through Nexus: The Nigerian Experience[37]

Evans OSABUOHIEN
College of Business and Social Sciences, Covenant University, Ota, Nigeria
evans.osabuohien@covenantuniversity.edu.ng,pecoseva@gmail.com

Ekene OBIEKWE
College of Business and Social Sciences, Covenant University, Ota, Nigeria
ekene.obiekwe@stu.cu.edu.ng, ekeneobiekwe@yahoo.com

Ese URHIE
College of Business and Social Sciences, Covenant University, Ota, Nigeria
ese.urhie@covenantuniversity.edu.ng urhieese@gmail.com

Romanus OSABOHIEN
College of Business and Social Sciences, Covenant University, Ota, Nigeria
romanus.osabohien@covenantuniversity.edu.ng,romik247@gmail.com

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Abstract

In recent times, the Nigerian economy has been experiencing significant exchange rate fluctuations, particularly depreciation in the foreign exchange market which has been accompanied with inflation. Thus, this paper investigates the degree of pass-through of the official and parallel exchange rates to inflation as well as the relationship between exchange rate volatility and inflation in Nigeria based on monthly time series data (January 2006 to December 2015). In achieving its objectives, the study employs the Generalised Auto Regressive Conditional Heteroscedasticity (GARCH), technique, which was complemented using Co-integration, Vector Error Correction Model, Variance Decomposition and Impulse Response techniques. The results suggest that the parallel exchange rate passes through to inflation in the short run while the official exchange rate passes through to inflation in the long-run exclusively. It also reveals that exchange rate volatility has a positive and significant effect on inflation in the long-run

Keywords: Exchange rate pass-through; exchange rate volatility; inflation; GARCH models; trade

JEL Classification: E31; F31; F37

Introduction

Macroeconomic performance is adjudged by three wide measures - inflation rate, output growth and unemployment rate of an economy (Ugwuanyi 2004). It is no wonder then that the issue of price stability, in addition to being the main aim of fiscal and monetary policy in both developed and developing countries, has also gained a huge amount of attention from economists and policy makers around the world.

Inflation can be defined generally as the persistent rise in the prices of goods and services in an economy. It has positive as well as negative implications. Inflation might be emphatically corresponding with growth at some low levels, but at higher levels inflation is liable to be unfavorable for growth (Doguwa 2012). The Central Bank of Nigeria (CBN) targets about 2% rate of inflation which shows that inflation can be a serious advantage to the economy especially during periods of economic stagnation. Inflation helps in debt settlement, creates employment and boost growth. The negative effects of high inflation, on the other hand, cannot be overemphasised. Examining countries such as Germany in the early 1920s, Hungary in mid 1940s and Zimbabwe in late 2000s, further strengthens this fact (Lopez 2012). Rising level of Inflation reduces the value of a currency which further erodes the purchasing power of money. It is usually associated with higher interest rates which results in low savings and discourages investment and long-term growth. It also erodes export competitiveness and leads to balance of payment deficit.

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Since 1980, inflation in the developing countries has doubled that of developed countries (Bleaney and Fielding 1999). Average inflation rates in more advanced countries have taken various patterns in recent years, trending downwards after 2012 in developed countries, while remaining constant or expanding further in developing countries (Global Economic Prospects 2014). The trend of inflation in Nigeria has been characteristically positive ranging from creeping to running inflation. Doguwa (2012) finds that inflation is inimical to growth when it approaches 10.5 to 12% in Nigeria. According to CBN's Statistical Bulletin (2005) high inflation was recorded in the early 1970's from 13.8% in 1971 to 16.0% in 1972 which could be explained by the oil boom period and the economic controls and measures that were introduced after the Biafra (civil war) of 1967 to 1970.

The oil glut of the early 1980's which led to high prices of oil in the domestic market marked another period of inflation in Nigeria which recorded 23.2% in 1983 and 39.6% in 1984. This led to the Structural Adjustment Programme (SAP) in 1986 which presented another inflation period in the late 1980's. According to Adelowokan (2012), one major problem in the post SAP era was exchange rate instability which led to high output volatility, higher cost of foodstuffs, lower wages and salaries and high unemployment thereby creating burden on the poor. The early 1990's (1992-96) also recorded high inflation at an average of 57 percent and in 1995 inflation was seen to be as high as 72.8 percent. Nigeria has recorded high volatility in inflation rates and these fluctuations should therefore be a concern and should be checked by the monetary authorities.

The increasing overdependence of the economy of Nigeria on imports makes it essential to frequently check the degree to which exchange rate fluctuations transmits to inflation in Nigeria (Ogundipe and Egbetokun 2013, Osuagwu and Nwokoma 2017, Adeleye *et al.* 2017). By definition, exchange rate connotes the rate at which one currency is traded for one another currency (Taguchi 2002). The modelling of exchange rate volatility has noteworthy ramifications for some monetary and budgetary matters as it alludes to the swings or vacillations in exchange rates over a timeframe (Thorlie, Song, Wang and Amin 2014). It is seen as the risk connected with sudden, unpredictable fluctuations in the level of the exchange rate (Adelowokan 2012).

There are a number of reasons to study the relationship between exchange rate volatility and inflation. Both exchange rate and inflation are important for the macroeconomic goal of price stabilisation. Secondly, when exchange rate changes, particularly depreciation, passes through to consumer prices resulting in inflation, exports will no longer become competitive due to high prices (Ito and Sato 2008). This is due to the fact that the high inflation eliminates export competitiveness that would have resulted from exchange rate depreciation; therefore, exchange rate becomes an ineffective in correcting balance of payment deficits and relieving debt burden. Ogundipe and Egbetokun (2013) gave four main reasons for studying exchange rate volatility in Nigeria: Firstly, Nigeria's economy is driven by the external sector, secondly, there is the need for a stable and strong currency, thirdly, the inflation in Nigeria has become endemic and so there is need to check the extent to which exchange rate volatility contributes to it, and lastly but not least is the need to make the external sector competitive

Prior to 1986, Nigeria had embraced the fixed exchange rate system which was upheld by trade regulations that incited disequilibrium in the economy preceding the presentation of Structural Adjustment Programme-SAP (Adelowokan 2012). The exchange rate had been relatively stable during this period. The SAP programme then introduced a second tier foreign exchange market that introduced the determination of exchange rate by forces of demand and supply thereby introducing the regime of flexible exchange rate which also created uncertainty in the foreign exchange market. Since then, Nigeria experienced significant exchange rate depreciations till date (Osabuohien 2016). For instance, on 19th February 2015, the exchange rate was devalued from 168 to 199 Naira per dollar while the Naira exchange rate reached 213.2 from 196.13 Naira per dollar in the parallel market. Since March the CBN rate has remained almost fixed at about 197 Naira per dollar while creating a huge gap and severe exchange rate volatility in the parallel market due to dollar scarcity. Inflation during this period, however, increased gradually from 8.1 in February to 9.01 in December, which has remained on the increase to the end of 2016 (Ministry of Budget and National Planning 2017). These significant exchange rate depreciations coupled with speculations about 2015 general elections alongside dwindling oil prices and fuel scarcity adversely affected the economy, businesses and investments and led to an endemic inflation in the economy.

Thus, this study differs from other studies by separating the pass-through effects of the official and parallel exchange rates and establishing the effects of their volatility on inflation based on monthly time series data. The study has four sections; after this introductory Section is the brief literature review. Section Two covers the theoretical framework and methodology, while Section three is the presentation and discussion of results. Section Four concludes with some recommendations for policy and further research.

1. Insights from the Literature

Exchange rate pass-through denotes the impact of a unit change in the exchange rate on consumer prices; thus, it is domestic inflation that can be ascribed to an initial variation in the nominal exchange rate (Aliyu, Yakubu, Sanni and Duke 2010). Volatility in exchange rate is the unexpected movement either upward or downward of the exchange rate over a given period. Therefore, exchange rate volatility is the risk that occurs when a currency depreciates or appreciates and is a high frequency term referring to short term fluctuations in exchange rate (Oloba and Abogan 2013). From the perspective of policy making, a low exchange rate pass-through reduces the effect of exchange rate fluctuations or exchange rate volatility on domestic demand and enables the exchange rate to absorb external shocks without destabilising price or output (Global Economic Prospects 2014). Presenting the case of oil-exporting countries, Snudden (2016) gave the caveat that in making efforts to stabilise the volatility macroeconomic variables, budget-balance is preferable to other fiscal policy instruments. The above differ slightly from the submission of Bodenstein and Guerrieri (2008) that economic policies respond to volatility in inflation and output gap, after momentary shock in energy prices, and percolate diverse impacts. Therefore, one can surmise that a low degree of pass-through would limit the degree to which exchange rate volatility transmits into inflation rate in the economy.

The need for adjustments to structural disequilibria in advanced countries sequel to the Great Depression led to development of vast researches on exchange rate pass-through so as to determine a nominal anchor for inflation (Aliyu *et al.* 2010). However, although many authors highlight the connection between exchange rate volatility and exchange rate pass-through, the literature on the effect of exchange rate volatility is not as comprehensive as the one available on exchange rate pass-through (Albuquerque and Portugal 2005). Consequently, many authors have found out that pass-through rates have been diminishing over time. Burstein, Eichenbaum and Rebelo (2007) investigated the reason why the prices of non-tradable goods and services responded by so little after large devaluations motivated by the devaluations in the UK (1992), Korea (1997) and Uruguay (2002). The author found that in Korea, inflation stayed stable after the devaluation.

On the other hand, inflation climbed considerably in Uruguay after the devaluation. The devaluation in UK was generally little and was trailed by a gentle expansion and stable inflation. The model attributed this result to two situations: First, is a sticky non-tradable goods price and second, is the effect of real shocks connected with large devaluations which prompted a decrease in the price of non-tradable goods compared to traded goods. Gagnon and Ihrig (2004) investigated declining pass-through rates over-time in twenty industrial countries and found out that exchange rate pass-through to domestic prices has been declining since the 1980s and asserted the monetary policy may be the reason for the declining rate of exchange rate pass-through. This is closely related to a study on G-7 countries where the nexus between exchange rate pass-through and domestic prices particularly the prices of producer and consumer goods was articulated (Jiménez-Rodríguez and Morales-Zumaquero 2016).

Frankel, Parsley and Wei (2012), investigated slow pass-through in 76 countries using VAR analysis and found out that low pass-through rates were no longer unique to advanced countries as conventionally perceived as developing countries have recently been experiencing rapid downward trends in the level of short-run pass-through, and in the speed of adjustment. Campa and Goldberg (2005) also discovered that levels of pass-through are largely uncorrelated with country size, among others based on 25 Organisation of Economic Cooperation and Development (OECD) countries and that there is partial exchange rate pass-through in the short-run, however over the long-run, pass-through is complete and common in imported goods. This is similar to the recent observation made by Goldberg and Tille (2016) regarding Canadian international trade and how it influences exchange rate given rigidities in prices.

Existing studies on exchange rate volatility on the other hand, have produced diverse results. Albuquerque and Portugal (2005) in order to investigate the relationship between exchange rate volatility and inflation in Brazil from 1999 found out that the relationship between exchange rate volatility and inflation is semi concave. Using bivariate Generalised Auto Regressive Conditional Heteroscedastic (GARCH) technique, the results from his results revealed that when volatility is very high, inflation response is low and the impacts are little, and therefore assumed that firms adopted a “wait and see” strategy when volatility is high in the short-run. This also aligns with the findings of Oloba and Abogan (2013) and Bobai, Ubangida and Umar (2013) in Nigeria. On the contrary, Adeniji (2013) investigated this relationship and found positive and significant relationship between exchange rate volatility and inflation from 1986 to 2012 in Nigeria using the Vector Error Correction Mechanism (VECM). Exchange rate volatility also has negative implications for other aspects of the economy. In a more recent study, Asalelye, Okodua, Oloni and Oguntobi (2017) using the VAR approach posit that high rate of inflation and

exchange rate fluctuations can hamper employment generation in Nigeria, and recommend the need for the government to use interest and exchange rates effectiveness in enhancing trade competitiveness and improving economic growth in Nigeria.

Arize, Osang and Slottje (2008) examined the effect of exchange rate volatility on export movements in eight Latin American countries from 1973 to 2004 using Co-integration and VECM and found out that the real exchange rate volatility affects the demand for exports negatively in these countries in the short-run and long-run. Egwaikhide and Udoh (2008) estimated exchange rate volatility and fluctuations in inflation rate using GARCH between 1970 and 2005 and investigated its effect on Foreign Direct Investment (FDI) in Nigeria. Their results revealed that exchange rate volatility and inflation uncertainty has an adverse effect on FDI in Nigeria. In the case of Ethiopia, Berga (2012) using structural VAR submits that exchange rate pass-through (ERPT) between 1991 and 2011 was substantial, modest and consistent with respect to the price of import but not so with the price of consumer goods.

Another line of reasoning stems from the fact that in order to achieve a stable output, low inflation and exchange rate stability would be traded off. This is consistent with the findings of Bleaney and Fielding (1999) that there is the existence of a trade-off in choosing an exchange-rate system between inflation or exchange rate volatility and output volatility and that inflation tends to be 10 percent higher in a country that adopts floating exchange rate regime than a country that adopts the regime of fixed exchange rate. However, Devereux and Engel (2002) used a two-sector dependent-economy model to compare the properties of a series of different monetary rules and argued that the trade-off differs according to regime and that a flexible exchange rate policy that stabilises output can do so without high inflation and exchange rate volatility. Following this same line of thought, Adeniran, Yusuf and Adeyemi (2014) studied the effect of exchange rate volatility on economic growth (1986-2013) using OLS method. The results support previous studies which state that developing countries are comparatively well off in choosing flexible exchange rate regimes and reveals that the relationship between exchange rate and economic growth is positive but insignificant. Conversely, Akpan and Atan (2012) did not find significant connection between exchange rate movements and economic growth using gross domestic products (GDP) based on quarterly time series data in Nigeria (1986-2010). Therefore, exchange rate management is essential but it is neither adequate nor sufficient condition for reviving an economy.

2. Methodology

The theoretical backing establishing the interactions that exist between exchange rate and inflation is the Purchasing Power Parity (PPP) doctrine. As Dornbusch (1976) has noted, PPP posits that the rate at which exchange rate between any two currencies changes over a time frame is determined by the change in the two countries' relative price level. The also stated that the theory has also been referred to as the "Inflation Theory of Exchange Rates" as the theory asserts that the price level between two countries mainly determines exchange rate movements.

It is a common knowledge that the exchange rate parity does not hold across countries at every instant (Parsley 2012). This is because pass-through tends to be incomplete and prices sticky in the domestic country. However, Boyd and Smith (1998) tested PPP in 31 developing countries and found out relative PPP holds almost exactly in the long-run. The result is also consistent with Taylor and Taylor (2004) elucidation of the general perspective of the PPP debate; that in the short-run PPP due to incomplete pass-through does not hold whereas in the long-run PPP may hold as the real exchange rate reverts to its mean. The Purchasing Power Parity theory was adopted in this study. Adeoye and Atanda (2012) analysed the consistency, persistency and severity of volatile exchange rate in Nigeria using the PPP axiom to analyse consistency and ARCH and GARCH models to analyse the sternness of exchange rate volatility (1986-2008). The result indicated the existence of extreme volatility shocks and that both the real and nominal exchange rates are not consistent with basic view of the long-run PPP model.

The model adopted in this study are in two strands namely; The Generalised Auto Regressive Conditional Heteroscedasitic (GARCH 1,1) Model and the Vector Auto Regressive (VAR) Model. The GARCH model is used for the estimation of exchange rate. The GARCH model is preferred over the standard deviation because it is sensitive to outliers and volatility clusters. It consists of a mean equation and a variance equation. The mean equation is specified as follows:

$$INFL_t = \pi_0 + \pi_1 EXOF_{t-1} + \pi_2 EXPARL_{t-1} + \mu t \quad (1)$$

where: $INFL_{t-1}$, $EXOF_{t-1}$ and $EXPARL_{t-1}$ are the current inflation rate, previous session of the official and parallel exchange rate respectively. π_1 is the coefficient of exchange rate while μt is the stochastic term of the

model. The a priori expectation sign is $\pi_1 > 0$ and $\pi_2 > 0$.

The GARCH model permits the conditional variance to depend on its lagged values, therefore the conditional variance in this case is:

$$\delta^2_t = \alpha_1 + \alpha_2\mu^2_{t-1} + \lambda_1\delta^2_{t-1} \quad (2)$$

where: α_1 is the log run average variance which is constant, μ^2_{t-1} is the news about volatility perceived in the previous period (ARCH term), δ^2_{t-1} is the lagged variance of exchange rate (GARCH term), $\delta^2 t$ is known as the conditional variance (*i.e* the variance of the error term derived from equation (1). It is one–period forward forecast variance based on past information and is also known as the exchange rate volatility which would be plugged into VAR model.

Following this model, the econometric model for this study follows insights from Chuba (2015) but with slight modifications. The model consists of two equations in order to analyse the effects of the official and parallel exchange rates separately which is specified as:

$$INFL = f(ERV, MSP, INTR, OILP, EXOF, EXPARL) \quad (3)$$

The explicit form of equation 3 is denoted as follows:

$$INFL_t=\beta_0+\beta_1ERV+\beta_2MSP+\beta_3INTR+\beta_4OILP+\beta_5EXOF+U_t \quad (4)$$

$$INFL_t=\beta_0+\beta_1ERV+\beta_2MSP+\beta_3INTR+\beta_4OILP+\beta_5EXPARL+U_t \quad (5)$$

From equation 4 and 5, the VAR model can be expressed as:

$$INFL_t=\beta_0+\beta_1ERV_{t-l}+\beta_2MSP_{t-l}+\beta_3INTR_{t-l}+\beta_4OILP_{t-i}+\beta_5EXOF_{t-i}+U_t. \quad (6)$$

$$INFL_t=\beta_0+\beta_1ERV_{t-l}+\beta_2MSP_{t-l}+\beta_3INTR_{t-l}+\beta_4OILP_{t-i}+ \beta_5EXPARL_{t-i} + U_t. \quad (7)$$

where $INFL_t$ = Inflation Rate at time t, ERV_t = Exchange Rate Volatility at time t, MSP_t = Broad money supply at time t $INTR_t$ = Interest rate at time t, $OILP_t$ = Oil price at time t, $EXOF_t$ = Official exchange rate at time t, $EXPARL_t$ = Parallel exchange rate at time t and U_t = error term. The apriori expectation is such that $\beta_0 > 0$, $\beta_1 > < 0$, $\beta_2 > 0$, $\beta_3 < 0$, $\beta_4 > 0$, $\beta_5 > 0$.

To test the empirical evidence, the Johansen Co-integration technique was used to determine the long-run relationships among the selected variables. Co-integration ensures that the linear combination of variables are stationary while regression analysis using ordinary least squares (OLS) based on time series data discretely assumes all values to be stationary which may not always be the case. The regression of time series data that is non-stationary will lead to biased regression thereby leading to misleading results. The restricted VAR (or VECM) would also be used to define the short-run relationships among the variables. However, the coefficients from VAR are often difficult to interpret and so further interpreted with estimates from impulse response (IR) function (Gujarati 2003). Therefore, the impulse response (IR) function and the approach of Variance Decomposition (VD) was used to further investigate interrelationships among the variables for this study. A similar approach was done by Osabuohien and Egwakhe (2008) and Olokoyo, Osabuohien and Salami (2009). The econometric software that was used for this study was E-views 7. Monthly time-series data (January 2006 - December 2015) in Nigeria sourced from CBN was used in estimating the stated model above.

3. Results and Discussions

The unit root test was first conducted to test for stationarity of each variable. The GARCH model is used to test for volatility, the Johansen co-integration is used to estimate the long-term relationship among the variables, Vector Error Correction Model (VECM) is used to estimate the speed of adjustment while the IF and VD functions is show the reaction of inflation to shocks from the independent variables.

3.1 Unit Root Test

The Augmented Dickey-Fuller (ADF) test was used for this research. The rule of thumbs for the unit root test is such that; if the absolute value test (ADF test) statistic is higher than the critical value (*e.g.* at 5%), we reject the null hypothesis (H_0) that the variables are non-stationary and if less, we accept the null hypothesis.

Table 1 Unit Root Test Results

Series	ADF Statistic	CV at 5%	Order of Integration	Rank
LINFL	-3.7814	-2.8861	I(1)	Stationary
LERV	-4.5565	-2.8884	I(1)	Stationary
LINTR	-12.5990	-2.8861	I(1)	Stationary
LMSP	-10.3739	-2.8861	I(1)	Stationary
LOILP	-7.3925	-2.8870	I(1)	Stationary
LEXOF	-9.0401	-3.4483	I(1)	Stationary
LEXPARL	-7.6718	-3.4483	I(1)	Stationary

Note: CV is critical value
Source: Authors' computation using E-Views 7.0

When the variables, namely: LINFL, ERV LINTR, LMSP, LOILP, LEXOF and LEXPARL are integrated of order I(1), the ADF test statistics are higher than their critical values at 1 and 5%, respectively, in absolute terms. So, it can be said that they are stationary at first difference. Co-integration hypothesis states that you only attempt a linear combination of series that are integrated of the same order. The study adopts the unit root at first difference; because all variables are stationary of order 1 (at first difference).

3.2. The Estimation of GARCH Model

The Generalised Auto Regressive Conditional Heteroscedastic (GARCH) model was engaged in testing for the impact of exchange rate volatility on Inflation from 2006M1 to 2015M12 and the results as reported in Table 2 shows that both the volatility of the official and parallel exchange rates have negative effects on inflation in the short-run. This implies that a 1% rise in the parallel exchange rate volatility or official exchange rate volatility would lead to a less proportionate decrease in inflation by about 0.003%.

Table 2. GARCH Result

Mean Equation				
Variable	Coefficient	Std. Error	z-Stat	Prob.
DLEXPARL	0.114	0.065	1.751	0.080
DLEXOF	-0.046	0.048	-0.970	0.332
C	-0.003	0.002	-1.196	0.232
Variance Equation				
C	0.000	0.000	1.556	0.120
RESID(-1)^2	0.735	0.221	3.325	0.001
GARCH(-1)	0.067	0.256	0.261	0.794
DLEXPARL	-0.003	0.0014	-2.444	0.0145
DLEXOF	-0.003	0.0036	-0.087	0.9309
R-squared	0.2279	Mean var		-0.006
Adjusted R2	0.0059	S.D. var		0.0412

Note: Dependent Variable is DLINFL GARCH=C(4)+C(5)*RESID(-1)^2+C(6)*GARCH(-1)+C(7)*DLEXPARL +C(8)*DLEXOFF

The mean equation reveals a positive and significant relationship between the parallel exchange rate and inflation in Nigeria at the 10% level however the co-efficient shows that pass- through is low and inelastic in the short-run. It also reveals a negative but not significant relationship between official exchange rate and inflation which means the official exchange rate does not pass-through to inflation that in the short-run. The addition of the ARCH and GARCH components (0.73 and 0.067) is less than one; therefore we can conclude that volatility is not persistent.

Table 3. Unrestricted Co-integrating Rank Tests

TRACE Statistic				
Hypothesised		Trace	5 %	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.3893	119.2191	95.7537	0.0005
At most 1	0.1991	61.5144	69.8189	0.1918
At most 2	0.1531	35.5317	47.8561	0.4203
At most 3	0.0853	16.0826	29.7971	0.7064
At most 4	0.0430	5.6570	15.4947	0.7356
At most 5	0.0043	0.5090	3.8415	0.4756
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				

MAXIMUM EIGENVALUE				
Hypothesised		Max-Eigen	5 %	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.3893	57.7047	40.0776	0.0002
At most 1	0.1991	25.9828	33.8769	0.3218
At most 2	0.1531	19.4490	27.5843	0.3806
At most 3	0.0853	10.4256	21.1316	0.7040
At most 4	0.0430	5.1480	14.2646	0.7230
At most 5	0.0043	0.5090	3.8415	0.4756
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				

Source: Same as Table 1

Based on unit root test, all the variables are integrated of order one I(1), therefore we can then proceed to co-integration. The co-integration test was analysed with a view to determining the nature of the long-run nexus between exchange rate volatility. The result of the co-integration rank test in Table 3 reveals that there is one co-integration equation for both the Trace and the Max-Eigen statistics at the 5% level. The results from the Johansen cointegration test are displayed in Table 4. The test statistics is used to show the significance of the independent variable in the long-run. The rule of the thumb is that if the test (T) statistics is approximately equal to 2 or greater than 2, the variable is statistically significant; however, if the T-statistics is less than 2, the variable is not statistically significant. Another quick way of checking the significance (or not), is to look at the probability value (p-value); where less than 0.01, 0.05 and 0.1 indicate significant at 1, 5, and 10%, respectively.

From the results in Table 4, it is established that there is a positive and significant relationship between exchange rate volatility and inflation rate in the long-run. An increase of 1% in exchange rate volatility leads to a more than proportionate increase in inflation by about 2%. This means that a stable exchange rate is necessary to curb inflation in Nigeria. The result shows that there is a negative relationship between interest rate and inflation. An increase of 1% in interest rate would lead to about 0.06% and 0.6% less proportionate decrease in inflation for model 1 and 2, respectively and vice versa. This is theoretically expected as increased interest rates increases savings rate and decreases current consumption. However, this relationship is insignificant judging by the t-stat of 0.0990 and 0.7282, respectively. There is also a positive and significant relationship between money supply and inflation in the long-run based on the result. This is expected following the quantity theory of money. Thus, when money supply increase by 1%, it will lead to a more than proportionate increase in inflation by about 3% for the official exchange rate equation and 6 percent for the parallel exchange rate equation, and vice versa.

Table 4. Co-integration Result

Normalised co-integrating coefficients T- statistic [ ]					
LINFL	LERV	LINTR	LMSP	LOILP	LEXOF
1	-1.9852	0.0634	-3.1374	0.6036	-3.8314
	[-7.4208]	[0.0990]	[-2.76]	[0.5776]	[-0.9513]
LINFL	LERV	LINTR	LMSP	LOILP	LEXPARL
1	-2.2124	0.6020	-8.0564	5.1675	8.597
	-[6.3079]	[0.7282]	[-6.46]	[3.8243]	[2.2644]

Source: Same as Table 1

The result however reveals a negative relationship between oil price and inflation. A reduction of 1% in oil price would increase inflation less proportionately by about 0.6 percent and more than proportionately by 5 percent for model 1 and 2, respectively and vice versa. This is not theoretically expected but could be attributed to the structure of the Nigerian economy during this period. Since, the Nigerian economy depends mostly on oil for her exports, a decrease in oil price worsens the terms of trade balance and depreciates the exchange rate, thereby making imports more expensive and making consumer prices to rise. This relationship however is insignificant for the official exchange rate equation but significant for the parallel exchange rate equation.

Also, in the long-run, an increase of 1% in the parallel exchange rate would lead to a more than proportionate decrease in inflation by about 9% which is significant while 1% increase in the official exchange rate would lead to more than proportionate increase in inflation by about 4% but is insignificant. This shows that in the long-run, the official exchange rate passes through to inflation while the parallel exchange rate does not.

The presence of co-integration relationship between the variables means that the restricted VAR (VECM) should be used for the estimation. The VECM limits the log run behaviour of dependent variables to incorporate

short-run disequilibria. The short-run deviations are corrected through series of adjustments. To satisfy the stability condition the VECM should have a negative sign, lie between 0 and 1 and be statistically significant.

The co-efficient of the stochastic term is negatively signed and statistically significant for both models. This shows that there a long-run convergence between inflation and the exogenous variables. The co-efficient shows that for model 1 and 2 about 0.46% and 0.3% of errors in the current period will be corrected in the subsequent period respectively which implies a slow speed of adjustment. This slow speed could be attributed to sticky prices *i.e.* prices take time to adjust downwards and so when there is short disequilibrium, it takes a long time before it converges to its long-run equilibrium.

Table 5. Vector Error Correction Results

Equation 1		Equation 2	
Dependent	D(LINFL)	Dependent	D(LINFL
ECM	-0.0046	ECM	-0.003
	[-3.9814]		[-3.5014]
D(LINFL(-1))	0.8621	D(LINFL(-1))	0.825
	[20.5290]		[18.1068]
D(LERV(-1))	-0.0064	D(LERV(-1))	-0.0048
	[-2.5331]		[-1.9846]
D(LINTR(-1))	-0.02786	D(LINTR(-1))	-0.0216
	[-1.4436]		[-1.1072]
D(LMSP(-1))	-0.00486	D(LMSP(-1))	-0.0158
	[-0.1188]		[-0.3857]
D(LOILP(-1))	0.0329	D(LOILP(-1))	0.0393
	[1.6813]		[1.8678]
D(LEXOF(-1))	-0.03628	D(LEXPARL(-1))	0.0067
	[-0.4574]		[0.1112]
C	-0.00018	C	-0.0003
	[-0.10044]		[-0.1815]
R-squared	0.8273	R-squared	0.8230
Adjusted R-squared	0.8162	Adj. R-squared	0.8116
F-statistic	74.5810	F-statistic	72.3860

Source: Same as Table 1

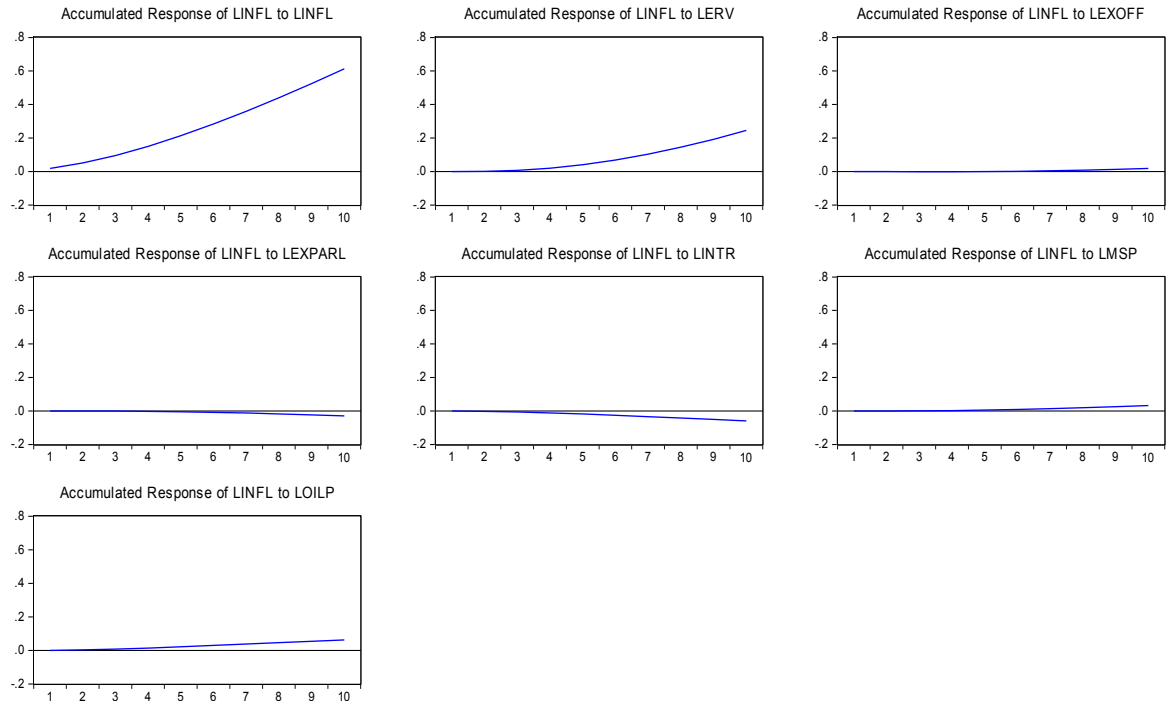
The result of the estimation for the official exchange rate equation shows that the explanatory variables account for about 83% of the variations in inflation and 82% for the parallel exchange rate equation. The results of the estimation give the short-run relationships among the variables. The result reveals that exchange rate volatility is the only significant variable and has a negative relationship with inflation in the short-run. The results of the estimation of the remaining variables follow a priori expectations apart from money supply. The negative relationship between money supply and inflation could be due to the fact that broad money supply includes time and savings deposits which are not yet in circulation and do not contribute to inflation in the short-run.

3.3. Impulse Response and Variance Decomposition Analyses

The impulse response function displays the accrued reaction of inflation to a shock in standard deviation to each of the variables. From the plots in Figure 1, the influence of exchange rate volatility on inflation over the 10 period interval is evident. From the graph below the immediate effect of a shock to LERV at say period 9 is about 24% increase in inflation. The impact of the above shock is pronounced as the interval increases.

The information in Figure 1 shows that there is no relatioship between inflation and shocks to the variables throughout the 1st period. However, from the 2nd to the 10th period inflation showed a postive reponse to shocks from exchange rate volatility and oil price throughout, while the postive response started from the 3rd period for money supply shocks and 6th period for the official exchange rate. The accumlated reaction of inflation to the parallel exchange rate and interest rate is negative throughout the period.

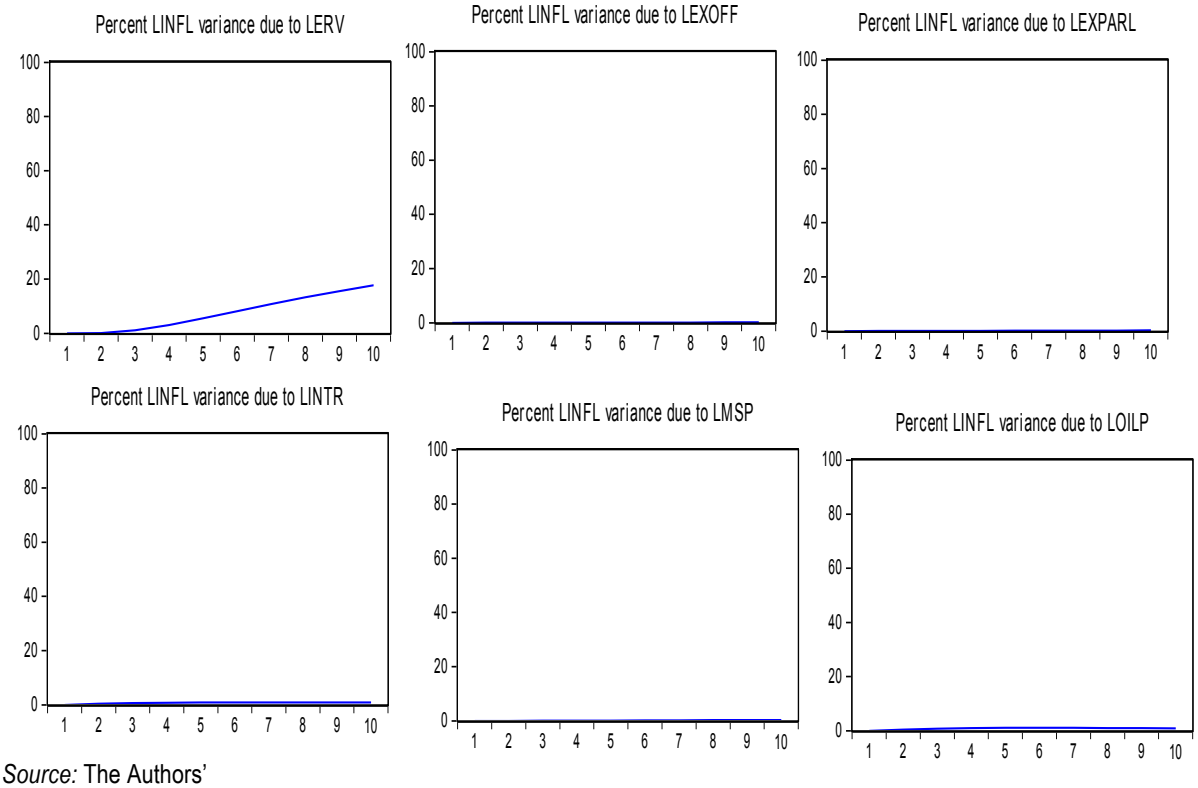
Figure 1. The Accumulative Response of Inflation



Source: The Authors'

Variance decomposition analysis represented in Figure 2 shows the relative contributions of shocks in the independent variables to inflation variance (*i.e*. changes in inflation). The variance decomposition of inflation has shown that in the first period none of the independent variables could explain changes in inflation. While exchange rate volatility caused significantly large changes in inflation, other variables caused relatively smaller changes in inflation. For instance, in the 7th period, exchange rate volatility, interest rate, money supply and oil price account for about 10 uints, 0.87 unit, 0.19 unit. and 1unit changes in inflation, respectively.

Figure 2 Variance Decomposition of Inflation



Source: The Authors'

Conclusion and Recommendation

This study examines the degree of pass-through of the official and parallel exchange rates to inflation as well as the relationship between exchange rate volatility and inflation in Nigeria based on monthly time series data from January 2006 to December 2015). The Generalised Auto Regressive Conditional Heteroscedasticity (GARCH), Cointegration, Vector Auto Regression (VAR) analysis, Impulse Response Function and Variance Decomposition techniques were used in examining the relationship. Inflation is modelled as a function of exchange rate volatility, official and parallel exchange rate, interest rate, money supply and oil price.

The GARCH and VECM results reveal the there is a negative and significant relationship between exchange rate volatility and inflation in the short-run while the co-integration result reveals a positive significant relationship in the long-run. The short-run result supports the work of Albuquerque and Portugal (2005), which showed that when volatility is high, inflation response is reduced as firms adopt a "wait and see" strategy. The impulse response and variance decomposition functions also reveal that exchange rate volatility very significant in determining inflation response and variance. The results also reveal that the parallel exchange rate only passes through to inflation in the short-run while official exchange rate only passes through to inflation in the long-run. This means that the higher official exchange rate would generate a poor inflation response in the short-run and its effects would only be revealed in the long-run. Also, the results in this present study suggest that exchange rate pass through is low in the short-run. This corroborate previous studies such as Frankel, Parsley and Wei (2012), Campa and Goldberg (2005), and Thameur and Daboussi (2014) where it has been established that the notion of sticky prices is expected.

Furthermore, it was found that interest rate is negative but not significant in determining inflation both in the long and short-run. Broad money supply has a negative insignificant relationship with inflation in the short-run due to time deposits but positive and significant in the long-run as theoretically expected. Oil price has a positive insignificant relationship with inflation in the short-run but negative in the long-run due to unfavourable terms of trade balance. Finally, the coefficient of error correction term indicates a rather a slow but significant speed of adjustment from the short-run distortion to long-run equilibrium due to sticky prices in the short-run.

From the results of the empirical study, the following recommendations are proposed to ensure price stability in Nigeria. Firstly, the Central Bank should strengthen the managed float system, such that the parallel exchange rates are left to freely operate through the workings of demand and supply, while the official exchange rate is strictly managed by the central bank so that it is not devalued to reflect the value of the currency operating in the parallel market. This is due the fact that, the increases in the parallel exchange rate would affect inflation or may cause economic hardships only in the short-run but not in the long-run. However, a depreciation or devaluation of the official exchange rate would ultimately increase inflation over the long-run. Secondly, the government should set up proper approaches and procedures that will guarantee the support of an exceptionally stable exchange rate as this is an important determinant of inflation. Thirdly, there is need to provide foreign exchange in order to reduce dollar scarcity and bridge the parallel and official exchange rate. Therefore, the government should direct it's spending to the yielding sectors of the economy including agriculture and manufacturing as this would go far in expanding the production of goods and services thereby stabilising the exchange rate.

This current study is confronted with some limitations as it relies on the dollar exchange rate for the model therefore the relationship may not be the same if other major currencies were added in the model. The scope *(i.e.* January 2006 to December 2015) was also limited by available data. Thus, complementing what has been done in this study, it is recommended future scholars should focus on using other alternate currencies such as the Euro to model the relationship between exchange rate and inflation. In further research, it may also be worthwhile to carry out a panel data analysis across countries to complement our findings.

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