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Monetary Policy, Exchange Rate and Inflation Rate in Nigeria

A Co-integration and Multi-Variate Vector Error Correction Model Approach

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Abstract

Evidences from empirical literature on the nexus among monetary policy, exchange rate and inflation rate have been mixed. Thus this paper attempts to re-examine this issue in Nigeria for the period spanning 1986 to 2010.In contrast to previous studies, this paper employed a Co-integration and Multi-Variate Vector Error Correction Model approach to examine both the long run and the short run nexus among monetary policy, exchange rate and inflation rate. Based on this approach, the paper found that there exist at least a co-integrating vector among the variables and the VECM estimate showed that a uni-directional causation exist from exchange rate and inflation rate to short term interest rate (measure of monetary policy) while a bi-directional causality exist form inflation rate to exchange rate. No evidence of causality was observed in the from short term interest to exchange rate and from interest rate to inflation rate. The theoretical transmission nexus deduced from the VECM estimate further revealed that changes in macroeconomic variables such as exchange rate and inflation rate granger caused a change in monetary policy stance and not otherwise. Based on these findings, this study recommends appropriate control and management of both the exchange rate and inflation rate.

Keywords: monetary policy, exchange rate, inflation rate and VECM.

1. Introduction

Monetary policy has always been seen as a fundamental instrument over the years for the attainment of macroeconomic stability, often viewed as prerequisite to achieving sustainable output growth. Thus, in the pursuit of macroeconomic stability, the managers of monetary policy have often set targets on intermediate variables which include the short term interest rate, growth of money supply and exchange rate. Among these intermediate variables of monetary, the exchange rate is argued to have a greater influence on the economy through its effect on the value of domestic currency, domestic inflation, the external sector, macroeconomic credibility, capital flows and financial stability. Increased exchange rate directly affects the prices of imported commodities and an increase in the price of imported goods and services contributes directly to increase in inflation (CBN, 2008).

The adverse consequence of inflationary pressure from exchange rate depreciation have been a serious concern for the monetary authorities, economists and policy analyst, given that these variables (exchange rate and inflation rate) are the key barometers of economic performance. Consequently assessing the nexus among monetary policy, exchange rate and inflation rate is pertinent because an understanding of the nexus between these variables is prerequisite for the successful conducting and adoption of inflation targeting, which the Nigerian government has also made prime objective in the attainment of its macroeconomic objective. Under inflation targeting, monetary policy stance (through changes in short term interest) affects inflation through a large set of variables including exchange rate (Mukherjee and Bhattacharya, 2011). Base on the above, this study empirically determine link among monetary policy, exchange rate and inflation rate, in line with studies such as (Holod (2000), Kara and Nelson (2002), Berument and

Pasaogullari (2003), Muco et al (2004), Rusitara (2004), An and Sun (2008) and Khan (2008). With respect to Nigeria, studies such as Mete and Michael (2005), Folawewo and Oshinubi (2006), Okhira and Saliu (2008), Omotor (2008), Chuku (2009) and Chimobi and Uche (2010) have investigated the impact of individual effect of monetary policy on exchange rate and inflation rate. These studies failed to take into cognizance the nature of causality among these variables. The causality approach allows us to sidestep the need for a theoretical structural model by treating all endogenous variables in the system as a function of the lagged values of all the endogenous variables in the system (Amarakoon, 2009). This is the gap this study seek to fill in the literature.

The rest of the paper proceed as follows: section two presents a review of literature while section three presents the methodology for the study. In section four, the findings were discussed while section five summarizes the major findings and offers some policy recommendations.

2. Empirical Review

Chimobi and Uche (2010) examined the relationship between money, inflation and output in Nigeria covering the period of 1970 to 2005. Using co-integration and granger-causality test analysis, the study revealed no existence of a co-integrating vector in the series used. Money supply was seen to granger cause both output and inflation. The study also found empirical support in context to the money-prices-output hypothesis for Nigerian economy, M2 have a strong causal effect on the real output as well as on prices. This suggests that monetary stability can contribute towards price stability in the Nigerian economy since the variation in price level is mainly caused by money supply, the study concluded that inflation in Nigeria is to a much extent a monetary phenomenon.

Chuku (2009) examined the effect of monetary policy innovations in Nigeria. The study used a structural vector auto-regression (SVAR) approach to trace the effects of monetary policy shocks on output and prices in Nigeria with a sample data spanning from 1986 to 2008. The study conducted the experiment using three alternative policy instruments i.e. broad money (M2), Minimum Rediscount Rate (MRR) and the real effective exchange rate (REER). The study made the assumption that the Central Bank cannot observe unexpected changes in output and prices within the same period. This places a recursive restriction on the disturbances of the SVAR and helped to generate impulse response functions that tracked the effects of monetary policy innovations on output and prices. The study found evidence that monetary policy innovations have both real and nominal effects on economic parameter depending on the policy variable selected. The study was of the view that price-based nominal anchors (MRR and REER) do not have a significant influence on real economic activity. Whereas, innovations in the quantity-based nominal anchor (M2) affects economic activities modestly. It therefore follows that monetary policy shocks have been a modest driver of business cycle fluctuations in Nigeria. The study concluded that the manipulation of the quantity of money (M2) in the economy is the most influential instrument for monetary policy implementation and recommended that central bankers should place more emphasis on the use of the quantity-based nominal anchor rather than the price-based nominal anchors.

Omotor (2008) examined the impact of price response to exchange rate changes in Nigeria covering the period of 1970 to 2003 and using the vector error correction model (VEC) and slope-dummy methodology. The study showed that exchange rate and money supply aggravated inflation in Nigeria and suggested that a stable, consistent and complementary policy on money supply and exchange rate is required for price stability; the domestic output expansion is needed to meet the ever-growing food demand in Nigeria. The study concluded by giving four recommendations; money affects inflation with a lag. Thus the design of monetary policy should take this into cognizance in monitoring and targeting; exchange rate depreciation can be inflationary; a stable and consistent monetary cum exchange rate policy stance in order to stem inflation is advocated.; sustenance of stringent regulations by the monetary authorities (Central Bank of Nigeria) to check fraudulent transfers of public foreign exchange and round-tripping by commercial banks; and policies that will encourage domestic output expansion are needed to feed the ever-growing food demand in Nigeria.

Okhira and Saliu (2008) examined the impact of exchange rate on inflation rate and the relationship that exist among government expenditure, money supply exchange rate, oil revenue and inflation in Nigeria. The study adopted the Augmented Dickey- Fuller to carry out the unit root test and co-integration with Johansen test. The study observed that variables are correlated, which means the impact of each variable on the rate of inflation in the economy is inseparable. Also, that there was a strong long relationship among the variables, though inflation and exchange rate show no long relationship. The study also found that measure by government to reducing amount of money supplied, government expenditure and control measure on exchange rate could lead to poor productivity in the country. The study concluded by recommending that the policy maker should try to cushion the effect of inflation on the economy when the need arises so that rise in exchange rate will not lead to inflationary pressure in the short run even though inflation and exchange rate have no long term relationship, short term relationship seems to exist.

Folawewo and Oshinubi (2006) examined the efficacy of monetary policy in controlling inflation and exchange rate instability in Nigeria covering the period of 1980:1 to 2000:4 and employing the rational expectation framework and time series analysis. The study observed that the effort of monetary policy at influencing the finance of government fiscal deficit through the determination of the inflation-tax rate affects both the rate of inflation and the real exchange rate, thereby causing volatility in their rates. The study found that inflation affects volatility of its own rate as well as the rate of real exchange and the study concluded that monetary policy should be set in such a way that the objective it is to achieve is well defined.

Mete and Adebayo (2005) examined whether monetary aggregates have useful information for forecasting inflation in the case of Nigeria other than that provided by inflation itself using a sample data spanning from 1990 to 1998. The study adopted two approaches; mean absolute percentage errors (MAPEs) and auto regression model. The study revealed that the Treasury bill rate, domestic debt and M2 (broad money) provide the most important information about price movements. Treasury bill rate provided the best information, since it has the lowest MAPE. Conversely, the least important variables were the deposit rate; dollar exchange rate and M1 (narrow money). M2 provides more information about inflation than M1 in the sample period. They also estimated an inflation equation and determined alternately whether M2 enter the equation significantly and they found that M2 is not significant. Exchange rate levels, and contemporaneous value of the domestic debt, are significant in the model. The results obtained were robust across the two methods used and they concluded that although the monetary variables contained some information about inflation, exchange rate and domestic debt may be more useful in predicting inflation in Nigeria.

3. Methodology

3.1 Model Specification

To analyze the nexus among monetary policy (int), exchange rate (ext) and inflation rate (inf), this study employ the causality approach developed by Granger (1969). Unlike past studies which employed pairwise bivariate granger causality test, this study employed the causality approach based on multivariate error correction model. This is because: first, the multivariate error correction model approach allows us to examine both the short run and long run causality among variables. Secondly, the use of simple traditional granger causality test has been identified (Engel & Granger, 1987; Shan & Morris, 2002) as inappropriate when variables are I(1) series. This is because the simple F-test statistics does not have a standard distribution (Jordaan & Eita, 2007). Therefore, proper statistical inference can only be obtained by analyzing the causality test on the basis of vector error correction model (Yucel, 2009; Nwosa, Agbeluyi and Saibu, 2011).

3.2 Mode Specification

In order to analyze the extent of the causal nexus among monetary policy, exchange rate and inflation rate, this study employs a VAR model of the form:

$$INT_t = \sum_{m} \alpha 11\, INT \quad + \sum_{n} \alpha 12\, EXT_{t-i} + \sum_{r} \alpha 13\, INF_{t-i} + U_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$EXT_t = \sum_{m} \alpha 21\, EXT_{t-i} + \sum_{n} \alpha 22\, INT_{t-i} + \sum_{r} \alpha 23\, INF_{t-i} + U_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$INF_t = \sum_{i=1} \alpha 31\, INF_{t-i} + \sum_{i=1} \alpha 32\, INT_{t-i} + \sum_{i=i} \alpha 33\, EXT_{t-t} + U_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where: *INT* is short term interest rate (a proxy for monetary policy stance), *EXT* is exchange rate and *INF* is inflation rate (proxy by consumer price index). U_{1t}, U_{2t} and U_{2t} are the disturbances term are assumed to be uncorrelated with white noise properties $N(0,\sigma^2)$. Equation (1) to (3) can be expressed in a reduced form as:

$$X_t = \alpha + B_1 X_{t-1} + B_2 X_{t-2} + B_3 X_{t-3} + \ldots\ldots + B_q X_{t-k} + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where: $X_t = [INT \quad EXT \quad INF]^1$

Equation (3) can be written more compactly as:

$$X_t = \alpha + B_1 \sum_{i=1}^{k} X_{t=j} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

X_t is a 3 *x1* – dimensional Vector of endogenous variables of the model, α is a 3 *x1* - dimensional vector of constant and B_1 is 3 *x 3* dimensional autoregressive coefficient matrices of estimable parameter and ε_t is *k*-dimensional vector of the stochastic error term normally distributed with white noise properties $N(0,\sigma^2)$.

The estimation of equation (5) requires appropriate estimation techniques to ensure proper VAR model specification. Therefore, it is necessary to examine the properties of the data for estimation and the co-integration, prior to the granger causality analysis.

4. Empirical Result

4.1 Unit Root Test

This study commence it empirical analysis by first testing the properties of the time series, used for analysis. This is important because most macroeconomic time series exhibit non-stationarity behaviour in their level form, which often poses a serious problem to econometric analysis, leading to spurious result if appropriate measures are not taken. To guard against spurious result, this study took caution by checking the properties of the variables via the Augmented Dickey-Fuller (ADF) and Philip Perron (PP) test. Using these tests, table 1 revealed that all the variables were non-stationary at their level form, thereby leading to test at first differences, which revealed that all the variables are stationary at first difference, that is, integrated of order one I(1). After establishing stationarity, next is the examination of the co-integration relationship among the variables.

4.2 Co-integration Rank Test

To have confirmed the stationary of the variables at 1(1), the study proceeds to examine the existence of co-integration among the variables. The Johansen multivariate co-integration technique was adopted rather than the Engel-Granger techniques. This was based on two reasons. First, the variables for analysis are I(1) series, which is a pre-condition for the adoption of the Johansen technique and secondly, the models are multi-variate models as specified in equation (2) and (4) above, consequently there is the possibility of having more than one co-integrating vector in the model. This is against the Engel-granger technique which is only suitable for testing co-integration between two variables. The results obtained from the Johansen multivariate co-integration method were summarized in table 2. It was observed from table 2, the null hypothesis of no co-integration, that is, r=0 was rejected in both the trace statistics and the maximum eigen-value statistics. The statistical values of these tests were greater than their critical values. However, the null hypothesis of no co-integration, that is $r \leq 1$ could not be rejected in both the trace statistics and the maximum eigen-value statistics, because their values were less than the critical values, implying that there are at least one co-integrating vector among the series.

4.3 Causality Test

The VECM causality result presented in table 3 revealed the causal nexus among monetary policy, exchange rate and inflation rate (proxy by consumer price index). The result showed that the error correction term for co-integrating equation with short term interest rate *(INT)* as a dependent variable is significant at one percent, but the sign is positive (not correct). In addition, interest rate revealed an evidence of causality with exchange rate and inflation rate in the short run.

The coefficient of error correction term with exchange rate as a dependent variable is observed to be statistically significant at five percent, implying that there exists a strong long run relationship running from interest rate and inflation rate to exchange rate. More so, inflation rate revealed an evidence of causation with exchange rate in the short run while no evidence of causality was observed in the short run from interest rate to exchange rate. With respect to inflation as a dependent variable, the error correction term was observed to be insignificant, implying that no existence of long run causality was observed from inflation rate to the short term interest rate and exchange rate. However, in the short run, it was revealed that a unidirectional causation runs from exchange rate to inflation rate while no causality was observed from the interest rate to exchange rate.

An important observation from the VECM result is that the finding was in support of the co-integration result, that only one co-integrating equation exists in the long run. Apart from the above, a theoretical transmission mechanism of the causal nexus among monetary policy *(INT)*, exchange rate *(EXT)* and inflation rate *(INF)* could be inferred from table 3. Figure 1 below presents a theoretical schema for the nexus on monetary policy *(INT)*, exchange rate *(EXT)* and inflation rate *(INF)*. The causal linkage below showed that it is changes in exchange rate and inflation rate that cause changes in short term interest rate and not otherwise. Furthermore, a bi-directional causality was observed between exchange rate and inflation rate. The implication of the observation from figure1 is that changes in exchange rate influences inflation rate which ultimately causes a change in monetary policy stance. Similarly, changes in inflation rate influences the exchange rate which ultimately prompts a reaction from the monetary authority by changing monetary policy stance. An important implication that can be drawn from theoretical schema below is that it is changes in macroeconomic variables such as exchange rate and inflation rate that causes a change in monetary policy stance and not otherwise.

5. Conclusion and Policy Recommendation

This study examined the nexus among monetary policy, exchange rate and inflation rate in Nigeria for the period spanning 1970 to 2010. Although studies have investigated the impact of individual effect of monetary policy on exchange rate and inflation rate, however these studies failed to take into cognizance the nature of causality among these variables. The result from the VECM estimate showed that in the short run, a uni-directional causation exist from exchange rate and inflation rate to interest rate while a bi-directional causality exist form inflation rate to exchange rate. In addition, no evidence of causality was observed in the short run from short term interest to exchange rate and from interest rate to inflation rate. The theoretical transmission nexus deduced from the VECM estimate further revealed that changes in macroeconomic variables such as exchange rate and inflation rate that causes a change in monetary policy stance and not otherwise. Based on these findings, this study recommends appropriate control and management of both the exchange rate and inflation rate.

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Table 1: Unit Root Test

Augmented Dickey-Fuller (ADF) Test				Phillip-Perron (PP) Test		
Variables	Level	1st Difference	Status	Level	1st Difference	Status
Int	-2.0219	-8.2221*	I(1)	-1.8063	-8.7375*	I(1)
Ext	0.5675	-5.7789*	I(1)	0.5448	-5.7778*	I(1)
Inf	-0.6340	-4.3870*	I(I)	-0.2907	-4.3613*	I(1)
Lms	0.1795	-4.2816*	I(1)	0.1113	-4.2547*	I(1)
Lgdp	-2.3272	-5.8304*	I(1)	-1.4238	-5.8463*	I(1)

Source: Authors computation. Note: * implies stationarity at one percent level.

Notes: ext = exchange rate inf = inflation rate
lgdp = Log of gross domestic product int = interest rate
lms = Log of money supply.

Table 2: Summary of the Co-integration Tests

Trace Test				Maximum Eigen value Test			
Null	alternative	Statistics	95% critical values	Null	alternative	Statistics	95% critical values
r=0	r≥1	35.427	31.797	r=0	r=1	28.713	24.13
r≤1	r≥2	26.715	27.495	r≤1	r=2	19.467	20.23
r≤2	r≥3	7.248	10.841	r≤2	r=3	7.247	10.84

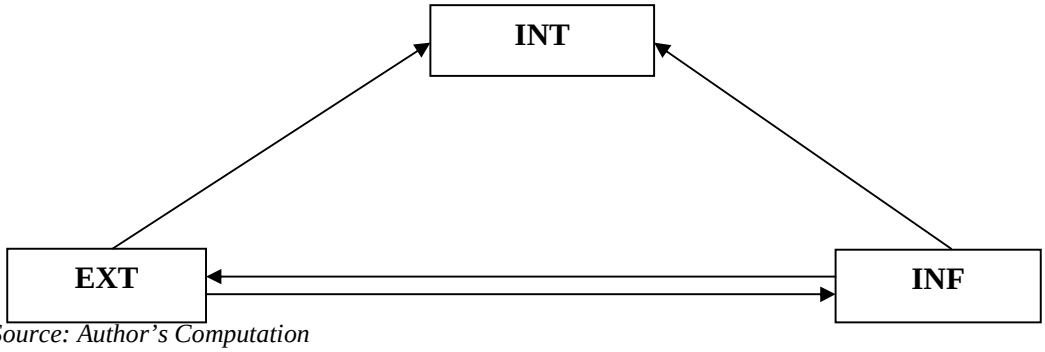
Source: Author's Computation.

Table 3: Multivariate Granger Causality Test based on VECM

Independent Variables	***Dependent variables***		
	INT	***EXT***	***INT***
INT	-	-0.8114 [-0.4878]	0.0457 [0.6552]
EXT	-1.2325 [-5.3760]**	-	-0.0564 [-8.5556]
INF	21.8614 [4.3207]	-17.7374 [-5.1193]	-
ECT	0.6766 [3.2605]**	-0.3575 [-3.1388]**	0.0169 [0.8539]

Source: Author's Computation

Figure 1: Theoretical Transmission Nexus on Monetary Policy, Exchange Rate and Inflation Rate from Causality Results



Source: Author's Computation