Determinants of Exchange Rate Dynamics in Nigeria

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Abstract
Current exchange rate models hardly beat a random walk in terms of their predictive power. This could be as a result of lumping the time frames of different exchange rate regimes when estimating exchange rate models. This e-study examined the determinants of exchange rate dynamics in Nigeria under the various exchange rate sub-regimes between the periods 1986-2020 using the monetary theory of exchange rate determination and expressing the interest variables in their relative forms rather than their absolute forms. The variables used are naira per dollar exchange rates, relative money supply, relative real gross domestic product, interest rate differential, relative inflation rates, oil price, trade openness and government capital expenditure. While the ARDL technique was employed to estimate the various exchange rate sub-regime models, the structural VAR model was employed to estimate the responses of exchange rates to nominal, demand and supply shocks. The data were sourced from secondary sources including various editions of the CBN statistical bulletin, the Nigeria Bureau of Statistics, the U.S Federal Reserve Bank, World Bank Development Indicators and the Organization of Petroleum Exporting Countries. This e-study revealed that the determinants are similar in terms of their nature on exchange rates across the various exchange rate sub-regimes considered, however there exist striking dissimilarities in terms of their magnitudes on exchange rates across the exchange rate sub-regimes considered. Specifically, the determinants of exchange rate dynamics in Nigeria under the; Second-tier foreign exchange sub-regime are relative real income, relative inflation and trade openness; Wholesale Dutch Auction System are relative inflation and oil price; Interbank Foreign Exchange Market are interest rate differential, relative inflation, oil price and trade openness. Demand and supply shock variables were also found to elicit strong responses from exchange rates overtime. This e-study recommended in addition to the implementation of trade policies that the government should have policies that increase the added value of exports in order to improve the quality of trade openness.

Keywords: ARDL, Exchange rate dynamics, shocks, SVAR, Nigeria,
JEL Classification: C22, E42, E52, F31

Introduction
Since the Bretton-woods system was abandoned in 1973, the exchange rates of numerous countries have experienced significant volatility overtime. Nigeria in particular has witnessed the greatest depreciation of its currency since its existence as a nation; the fall in her exchange rate has been adduced to erosion of her reserves, triggered by the global decline in oil prices (Yusuf, Jelilov, Onyegoke, & Haruna 2019). Exchange rate plays a crucial role in the Nigerian monetary policy space because of its crucial impact on the country's trade relations with other countries, first, as a mono-product (oil) export dependent economy and second, as an import dependent (developing) nation (Ajao, 2015).

Mark (2017) defines exchange rate dynamics as the response path of the exchange rate following the revelation of some economic shocks (news) when the country in question operates under a flexible exchange-rate system. The exchange rate is the rate at which one currency is exchanged for another. It is the price of one currency in terms of another currency (Jhingan, 2005). Exchange rate is the price of one unit of the foreign currency in terms of the domestic currency. Exchange rate indicates the competitiveness of a country in a globalized world (Ajao, 2015).

The transmission effect of changes in oil price onto exchange rate particularly for oil exporting and importing economies is entrenched in both theory and practice. However, the debate in terms of the nature of this transmission effect onto the exchange rate of nations have continued to receive attention from economists and policy makers (Abubakar, 2019). From a theoretical perspective, the effect of oil price shocks on oil exporting economies should

differ from that of oil importing economies. Buetzer, Habib, & Stracca (2012) propose that a positive shock in oil price is expected to lead to an appreciation of the exchange rate of an oil exporting nation through an increase in foreign exchange earnings and a buildup of foreign exchange reserve. The exchange rate of oil importing nations, is however, expected to depreciate. With oil accounting for the largest share of foreign exchange earning to the Nigerian economy, its role in determining the value of the foreign exchange rate of the Nigerian naira cannot be over emphasized.

The nexus between money supply and exchange rate dynamics is ensconced in both theory and practice. If the exchange rate is pegged or managed in any way, the central bank will need to purchase or sell foreign exchange. These transactions in foreign exchange will have an effect on the monetary base similar to open market purchases and sales of government bond; if the central bank buys foreign exchange, the monetary base expands, and vice versa. (Pugel, 2007)

Inflation is closely related to interest rates, both of which can influence exchange rate dynamics. Low interest rates spur aggregate spending and economic growth, and generally have positive effect on currency value (appreciation); however, low interest rates do not attract foreign investment. Higher interest rates tend to attract foreign investment, which is likely to increase the demand for a country's currency. If consumer spending increases such that demand exceeds supply, inflation may arise, which is not necessarily a bad outcome but is more likely to have a negative effect rather than a positive effect, on a currency's value and foreign exchange rate (Potters, 2022).

Government spending may also influence exchange rate dynamics in Nigeria. For example, the government spending on the construction of new infrastructure (capital expenditure) may involve importation of some machineries and technology that might indirectly influence the demand for foreign currency, hence exert pressure on exchange rate.

The major concern of policy makers with the exchange rate is the attainment of equilibrium exchange rate which is the rate at which the internal balance and external balance is achieved. But they cannot effect what they do not completely know. For equilibrium exchange rate value to be attained, there is need to identify the variables that determine exchange rate dynamics, and their respective effects within each peculiar economy, so that these proximate variables could be used to nudge exchange rate towards its long run equilibrating value. This premise is necessitated by the reality that despite various efforts – in terms of introducing various exchange rate systems within the flexible regime - by the monetary authorities to maintain exchange rate stability (as well as its fluctuations and mis-alignment in the last three decades), the naira to U.S dollar depreciated on a macro level over the period of the flexible exchange rate regime (Yusuf et al., 2019) and the end of this trend is not in sight.

From the empirical literature reviewed, the foreign studies focused on nominal shock variables (Bilson, 1984; Evans & Lyons, 2002; Yuan, 2008 and so on). For the domestic studies, Udoye (2009), Ajao (2015), Yusuf (2019), Idris (2021) and Ani &Mashood (2021) employed nominal, demand and supply shock variables but these studies did not subject the data to the possibility of structural breaks due to regime change. They also used the nominal variables in their absolute forms rather than using them in terms of relatives or differentials (Evans & Lyons, 2002; Pugel, 2007). Essien et al. (2017) subjected the data to structural breaks test due to regime shift but they omitted demand shock variables in their analysis. Only Adu et al. (2015) included all three shock variables in their study and subjected the data to structural break test due to regime change, but this study was done for the Ghana. Also only Adu et al. (2015) and Nandrajog (2019) included oil price in their analysis, and these studies were done for Ghana and India respectively.

This e-study bridges these gaps by examining or investigating the determinants of exchange rate dynamics under the various exchange rate sub-regimes in the overall flexible exchange rate regime. The rationale behind this is that some information may be lost due to smoothening as a result of macro time frames. For instance, we may wrongly assume the identified tentative determinants to behave similarly across these sub-regimes especially with the possibility of the presence of structural breaks by lumping time frames together. This e-study also takes another departure from previous studies in the Nigerian exchange rate literature space by expressing the core variables of the monetary theory framework for exchange rate determination in their relative forms (Evans & Lyons, 2002 and Pugel, 2007). The rationale behind this is that using these variables in their absolute forms may not tell the full story. For instance, since the exchange rate of the naira is expressed in terms of the U.S dollar, per the monetary theory, we will not expect only domestic money supply to influence exchange rate dynamics but also U.S money supply since movements in domestic money supply may be off-set by movements in foreign (U.S) money supply. This e-study

also examines the response of exchange rates to various shocks (nominal, demand and supply). This will aid policy prescription in the sense that it will inform the appropriate mix of demand and supply side policies for effective management of exchange rate movements in a bid to maintain external balance.

Table 1: Stylized facts on Exchange rate policy/regimes in Nigeria

Exchange Rate Regime/Method of Exchange Rate Determination	Date
Foreign Exchange market/Second-Tier FEM (FEM/SFEM)	September 1986 – 1994
Autonomous Foreign Exchange Market (AFEM)	1995- September 1999
Re-introduction of IFEM	October 1999
Retail Dutch Auction System (RDAS)	July 2002
Wholesale Dutch Auction System (WDAS)	February 2006 – October 2013
Retail Dutch Auction System (RDAS)	October 2 - 31, 2013
Interbank Foreign Exchange Market (with CBN intervention)	November 2013
Flexible Exchange rate Interbank Market	15th June 2016

Source: CBN (2017)

Policies that have been implemented prior to 2000 include the Autonomous Foreign Exchange Market (AFEM), introduced in 1995 and the Inter-bank Foreign Exchange Market (IFEM), which was introduced on October 25, 1999. The Retail Dutch Auction System (RDAS) was reintroduced in July 2002. The policy saw the exchange rate depreciating from N92.7 per dollar in 1999 to N121.0, N129.4, N133.50 and N132.15 per US dollar in 2002, 2003, 2004 and 2005, respectively.

In response, the Wholesale Dutch Auction System (WDAS) was introduced on the 20th of February, 2006 in order to further liberalize the foreign exchange market, reduce the dependence of authorized dealers on CBN for foreign exchange and achieve convergence in exchange rates. This intervention led to an appreciation of the exchange rate from its level of N132.15/US$ in 2005 to N128.65/US$, N125.83/US$ and N118.57/US$ in 2006, 2007 and 2008, respectively. Following the impact of the global financial crisis on the economy, depreciation pressures mounted on the naira as its exchange rate moved to N148.91/US$, N150.30/US$ and N153.90/US$ in 2009, 2010 and 2011, respectively. These led to the reintroduction of IFEM in November 2013 while the CBN continued to intervene in the market. (Abubakar, 2019)

Theoretical Framework and Model Specification

This study is anchored on the monetary approach of exchange rate determination which postulates that the rates of exchange are determined through the balancing of the total demand and supply of the national currency in each country. According to this approach, the demand for money depends upon the level of real income, the general price level and the rate of interest. The demand for money is the direct function of the real income and the level of prices. On the other hand, it is an inverse function of the rate of interest. Money supply, on the other hand, is determined autonomously by the monetary authorities of different countries.

Model 1

Assume there are two countries Nigeria and the U.S.A. denoted as countries 1 and 2 respectively. The monetary equilibrium in each of them is determined when the demand for money (M_d) gets balanced with the supply of money (M_s).

$M_{d1} = M_{S1}$

$M_{d2} = M_{S2}$

The subscripts 1 and 2 denote the two countries.

$M_{d1} = K_1P_1Y_1$

$M_{d2} = K_2P_2Y_2$

Here K_1 and K_2 are the desired rates of nominal money balances to nominal national income in two countries. P_1 and P_2 are the price levels in two countries and Y_1 and Y_2 are the real national incomes or outputs in the two countries.

The conditions for monetary equilibrium in two countries are written as:

$M_{S1} = K_1P_1Y_1$ (1)

$M_{S2} = K_2P_2Y_2$ (2)

Dividing equation (1) by (2), we get:

$M_{S1}/ M_{S2} = K_1P_1Y_1/ K_2P_2Y_2$

$P_1/ P_2 = M_{S1}/ M_{S2}. K_2Y_2/ K_1Y_1$

P_1/ P_2 is the rate of exchange (R) on the basis of the PPP theory

$R = M_{S1}/ M_{S2}. K_2Y_2/ K_1Y_1$ (3)

If K_2 and Y_2 in the U.S.A. and K_1 and Y_1 in Nigeria remain unchanged, R will remain unchanged so long as M_{S1} and M_{s2} remain constant. The change in R is directly proportional to change in $M_{S1}$and inversely proportional to changes in $M_{S2.}$

By assuming the Ks to be constant, equation (3) can be re-written as:

Exchange rate (R) = f (relative MS, relative real NI) (4)

By modifying equation (4) in order to make the model more robust by adding other variables relevant to the peculiarities of the Nigerian economy in the spirit of Adu et al. (2015) as was done for the Ghanaian economy, we get:

EXCH=f (RMS, RRGDP, INTRD, OILP, RINFL, GCEXP, TROP) (5)

The mathematical specification of the model is:

$EXCH = b_o + b_1RMS + b_2RRGDP + b_3INTRD + b_4OILP + b_5RINFL + b_6GCEXP + b_7TROP$ (6)

Changing this to an econometric model by including the error term gives:

$EXCH = b_o + b_1RMS + b_2RRGDP + b_3INTRD + b_4OILP + b_5RINFL + b_6GCEXP + b_7TROP + \mu$ (7)

Where EXCH is the nominal exchange rates between the Nigerian naira and the U.S dollar, RMS is the relative money supply between Nigeria and U.S, OILP is the international oil price, INTRD is the interest rate differential, RINFL is the relative inflation rate, GCEXP is government capital expenditure and TROP is trade openness, b_o = the intercept of the model, b_1-b_7 are the partial slope coefficients and μ error term which is used to capture other variables that affect the model. It is expected to be purely random.

The first model for this study is specified using the ARDL model because it allows for the model to take a sufficient number of lags to capture the data generating process in a general-to-specific modelling framework. Thus, if there is no co-integration, the ARDL model is given as;

$$\Delta EXCH_t = b_o + \Sigma^p_{i=1}b_{1i}\Delta EXCH_{t-1} + \Sigma^q_{i=1}b_1\Delta RMS_{t-1} + \Sigma^q_{i=1}b_2\Delta RRGDP_{t-1} + \Sigma^q_{i=1}b_3\Delta INTRD_{t-1} + \Sigma^q_{i=1}b_4\Delta OILP_{t-1} + \Sigma^q_{i=1}b_5\Delta RINFL_{t-1} + \Sigma^q_{i=1}b_6\Delta GCEXP_{t-1} + \Sigma^q_{i=1}b_7\Delta TROP_{t-1} + u_t$$

If there is co-integration, the error correction model (ECM) representation is specified as:

$$\Delta EXCH_t = b_o + \Sigma^p_{i=1}b_{1i}\Delta EXCH_{t-1} + \Sigma^q_{i=1}b_1\Delta RMS_{t-1} + \Sigma^q_{i=1}b_2\Delta RRGDP_{t-1} + \Sigma^q_{i=1}b_3\Delta INTRD_{t-1} + \Sigma^q_{i=1}b_4\Delta OILP_{t-1} + \Sigma^q_{i=1}b_5\Delta RINFL_{t-1} + \Sigma^q_{i=1}b_6\Delta GCEXP_{t-1} + \Sigma^q_{i=1}b_7\Delta TROP_{t-1} + \lambda ECT_{t-1} + u_t$$

where λ = speed adjustment parameter with a negative sign; ECT, the error correction term is the extracted residuals from the regression of the long run equation; b_{1i}, b_1-b_7 are the short-run dynamic coefficients of the model's adjustment to long-run equilibrium.

Model 2

Prior to estimating our SVAR model, the unit root test results show some of the variables to be stationary (at level) and others to be non-stationary (stationary at first difference) as reported in the later part of this study. The requirement for the use of OLS or VAR estimation techniques is that the variables be all stationary (at level) or all non-stationary (stationary only after first differencing). A mix of orders (level and first difference) necessitates the use of ARDL model in estimating the determinants of exchange rate dynamics in Nigeria. However we decide to further estimate those variables found to be level stationary which includes the dependent variable (exchange rates) and its determinants (interest rate differential and trade openness) in order to use the VAR estimation technique for a second model. This is done in order to ascertain the responses of exchange rates to its various shocks or innovations

Following Clarida and Gali (1994) as cited in Adu et al. (2015), we decompose the innovations into supply, demand and nominal shocks and use the implied long run effects of these shocks for our model identification. Our definition and classification of shocks in this study follows the two-country open-economy of Dornbusch (1976) and Obstfeld (1985) as in the seminal papers of Clarida and Gali (1994) and Muntaz and Sunder-Plassmann (2013) as cited in Adu et al. (2015). Supply shocks refer to shocks that affect the supply side of the economy, such as productivity shocks, oil price shocks, trade openness etc. Openness raises imports and exports of goods and services and improves domestic technology, hence production process is more effective and productivity rises. Demand shocks refer to shocks that affect aggregate demand, such as shocks to real balances, fiscal policy shocks. Last but not least, nominal shocks refer to monetary disturbances such as unexpected changes in nominal money supply, and short term nominal interest rates.

We employ the original monetary approach model with some modification in order to obtain the VAR estimates. The VAR model is estimated thus:

$$EXCH_t = \alpha + \Sigma^k_{i=1} b_1 EXCH_{t-i} + \Sigma^k_{j=1} \Phi_j INTRD_{t-j} + \Sigma^k_{m=1} \varphi_m TROP_{t-m} + u_{1t}$$

$$INTRD_t = a + \Sigma^k_{i=1} b_1 EXCH_{t-1} + \Sigma^k_{j=1} \Phi_j INTRD_{t-j} + \Sigma^k_{m=1} \varphi_m TROP_{t-m} + u_{2t}$$

$$TROP_t = \vartheta + \Sigma^k_{i=1} b_1 EXCH_{t-1} + \Sigma^k_{j=1} \Phi_j INTRD_{t-j} + \Sigma^k_{m=1} \varphi_m TROP_{t-m} + u_{3t}$$

where $EXCH_t$, $INTRD_t$ and $TROP_t$ are exchange rates, interest rate differential and trade openness expressed in their level forms to avoid mis-specification; α, a and ϑ are the intercept terms; b_1, Φ_j and φ_m are the slope coefficients; and u_{1t}, u_{2t} and u_{3t} are the innovations of the VAR model.

Nature and sources of Data

This study uses secondary quarterly time series data spanning 1986 to 2020 which is the period covering the overall flexible/managed float exchange rate regime The major sources are the Central Bank of Nigeria statistical Bulletin, the Nigerian Bureau of Statistics, World Bank Development Indicator, the Organization of Petroleum Exporting Countries, the U.S Federal Reserve Bank and other relevant literatures (books, Journals, research papers and electronic sites).

Presentation of results

Results of Unit Root Tests

The result of the unit root test was conducted using the augmented dickey-fuller (ADF) and the Phillips-perron test as presented in Table 2. The result presented below is useful in order to avoid the problem of running a spurious regression.

Table 2: Summary of Unit Roots Tests

VARIABLE	ADF TEST STATISTICS	PP TEST STATISTICS	CRITICAL VALUE @ 5%	ORDER OF INTEGRATION
LNEXCH	-3.346460	-3.268962	-2.882279	I(0)
LNRMS	-11.61330	-11.69014	-2.882433	I(1)
LNRRGDP	-3.583395	-14.15468	-2.882910	I(1)
LNINTRD	-3.556316	-3.556316	-2.882279	I(0)
LNRINFL	-2.927432	-13.88731	-2.882910	I(1)
LNOILP	-10.99732	-10.97315	-2.882433	I(1)
LNTROP	-3.847953	-3.807609	-2.882279	I(0)
LNGCEXP	-11.72791	-11.72789	-2.882433	I(1)

Source: Researchers' Computation using E-Views 10

The ADF and Phillip-Perron tests for unit root show that exchange rates (LNEXCH), interest rate differential (LNINTRD) and trade openness (LNTROP) are stationary at level, while relative money supply (LNRMS), relative real gross domestic product (LNRRGDP), relative inflation (LNRINFL), oil price (LNOILP) and government capital expenditure (LNGCEXP) are all stationary at first difference. Because the variables are integrated at different orders, we proceeded to carrying out a test to determine the existence of a long-run relationship.

Co-integration Test

Given the results of the various unit root tests conducted, we then proceed to test for the existence of long-run relationship among the variables. The Autoregressive Distributive (ARDL) Bound testing approach proposed by Pesaran and Shin (1999) and Pesaran et al. (2001) is appropriate since there are mixture of 1(0) and 1(1) variables.

Table 3: Summary of ARDL Bounds Test

F-statistic Value	Lower Bound at 5%	Upper Bound at 5%
9.112411	2.32	3.5

Source: Researchers' Computation using E-Views 10

Since the F-statistics (9.112411) is greater than the upper bound at 5% level of significance, the result indicates that there exists long run relationship among variables. Given the existence of a long run relationship among the variables in each model, we then estimate an error correction model to account for the short run dynamics of the model.

Summary of Short-run Estimates

A. SFEM/FEM model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.747613	0.695556	8.263333	0.0000
D(LNRRGDP)	-0.792213	0.448445	-1.766577	0.0926
D(LNOILP)	0.465623	0.133970	3.475572	0.0024
D(LNGCEXP)	0.347789	0.053835	6.460231	0.0000
CointEq(-1)*	-0.549629	0.066796	-8.228528	0.0000

Source: Researcher's Computation using E-Views 10

B. WDAS model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.857118	0.216175	8.590792	0.0000
D(LNRRGDP)	0.013263	0.096581	0.137323	0.8923
D(LNINTRD)	-0.091008	0.027226	-3.342683	0.0036
D(LNOILP)	-0.079090	0.026109	-3.029228	0.0170
CointEq(-1)*	-0.580902	0.067791	-8.569051	0.0000

Source: Researcher's Computation using E-Views 10

C. IFEM model

C	0.546584	0.107055	5.105611	0.0002
D(LNRRGDP)	-0.352247	0.102612	-3.432797	0.0045
D(LNINTRD)	-0.825841	0.143249	-5.765076	0.0001
D(LNRINFL)	0.954773	0.344440	2.771957	0.0159
D(LNOILP)	-0.147185	0.048347	-3.044350	0.0094
D(LNTROP)	-0.089561	0.107592	-0.832419	0.4202
D(LNGCEXP)	0.230038	0.060563	3.798347	0.0022
CointEq(-1)*	-0.212730	0.041994	-5.065733	0.0002

Source: Researcher's Computation using E-Views 10

Results from the SFEM/FEM short run model reveals relative real GDP (D(LNRRGDP)) to conform to economic a-priori criteria in terms of sign; in terms of magnitude, it is found to exert a statistically insignificant impact on exchange rate dynamics. Oil price (D(LNOILP)) conforms to economic a-priori expectations in terms of magnitude as it has a statistically significant impact on exchange rate in the short run SFEM/FEM model; in terms of sign, it exerts a positive impact (depreciation) on exchange rates. Government capital expenditure is revealed to conform to economic a-priori expectation in terms of both sign and size; it exerts a positive impact on exchange rates and a statistically significant impact as well. The error correction term for the SFEM/FEM model is -0.549629 which is statistically significant, less than 1 and negative as well. This implies that about 55% of disequilibrium in exchange rates in the previous quarter is corrected in the current quarter.

Results from the WDAS short run model reveal relative real GDP (D(LNRRGDP) and interest rate differential (D(LNINTRD)) to conform to economic a-priori criteria in terms of sign; oil price exerts a negative influence. In terms of magnitude, interest rate differential (D(LNINTRD)) and oil price (D(LNOILP)) are observed to exert a statistically significant impact on exchange rate while relative GDP exerts a statistically insignificant impact on exchange rate. The error correction term is given as -0.580902 which is negative, less than 1 and statistically significant. It implies that about 58% of disequilibrium in exchange rates in the previous quarter is corrected in the current quarter.

Results from the IFEM short run model show relative real GDP (D(LNRRGDP)), interest rate differential (D(LNINTRD)), relative inflation rate (D(LNRINFL)) and government capital expenditure (D(LNGCEXP)) to all conform to economic a-priori expectation in terms if signs; in terms of size, relative real GDP, interest rate differential, relative inflation rates, oil price and government capital expenditure are found to be statistically significant. The error correction term is given as -0.212730. It is negative, less than 1 and statistically significant. It implies that about 21.3% of disequilibrium in exchange rate for the previous quarter is corrected in the current quarter.

Summary of Long-run Estimates

A. SFEM/FEM model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRMS	0.377053	0.235569	1.600603	0.1251
LNRRGDP	-3.395020	1.471427	-2.307298	0.0319
LNINTRD	-0.068569	0.127325	-0.538538	0.5961
LNRINFL	1.605552	0.594932	2.698714	0.0138
LNOILP	0.288263	0.413528	0.697083	0.4938
LNTROP	0.650301	0.237035	2.743477	0.0125
LNGCEXP	0.725669	0.399072	1.818390	0.0840

Source: Researcher's Computation using E-Views 10

B. WDAS model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRMS	0.086517	0.155393	0.556761	0.5845
LNRRGDP	-0.425865	0.273549	-1.556818	0.1369
LNINTRD	-0.082833	0.085615	-0.967508	0.3461
LNRINFL	0.595285	0.224800	2.648071	0.0164
LNOILP	-0.340148	0.101842	-3.339947	0.0036
LNTROP	0.194991	0.119961	1.625454	0.1214
LNGCEXP	0.076733	0.162968	0.470845	0.6434

Source: Researcher's Computation using E-Views 10

C. IFEM model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRMS	0.560672	3.197108	0.175368	0.8635
LNRRGDP	-0.086439	1.837518	-0.047041	0.9632
LNINTRD	-4.932399	1.337680	-3.687273	0.0040
LNRINFL	8.394392	2.711473	3.095879	0.0251
LNOILP	-2.189348	0.853331	-2.565649	0.0214
LNTROP	2.988579	1.445440	2.067591	0.0351
LNGCEXP	0.078324	0.574847	0.136252	0.8937

Source: Researcher's Computation using E-Views 10

The SFEM/FEM long run model reveals relative money supply (LNRMS), relative real GDP (LNRRGDP), interest rate differential (LNINTRD), relative inflation rates (LNRINFL) and government capital expenditure (LNGCEXP) to all conform to economic a-priori expectation in terms of sign. In terms of size however, relative money supply,

interest rate differential, oil price and government capital expenditure are all revealed to exert a statistically insignificant impact on exchange rates over the SFEM/FEM period.

The WDAS long run model reveals relative money supply (LNRMS), relative real GDP (LNRRGDP), interest rate differential (LNINTRD), relative inflation rates (LNRINFL) and government capital expenditure (LNGCEXP) to conform to economic a-priori expectation in terms of signs; in terms of size or magnitude however, only relative inflation rates and oil price exert a statistically significant impact on exchange rates over the WDAS period.

The IFEM long-run model show relative money supply (LNRMS), relative real GDP (LNRRGDP), interest rate differential (LNINTRD), relative inflation rates (D(LNRINFL)) and government capital expenditure (LNGCEXP) to all conform to economic a-priori expectation in terms of signs; in terms of magnitude however, interest rate differential, relative inflation oil price and trade openness are found to exert a statistically significant impact on exchange rates while relative money supply, relative real GDP, and government capital expenditure are found to exert a statistically insignificant impact on exchange rates over the IFEM period.

Summary of Diagnostic Tests for ARDL estimates

a. Test for Heteroscedasticity

The essence of this test is to see whether the error variance of each observation is constant or not. Non-constant variance can cause the estimated model to yield a biased result. The Breasch Pagan-Godfrey heteroscedasticity test is adopted for this purpose. For the SFEM/FEM model, since F-prob (0.1092)>0.05, we do not reject the null hypothesis and we conclude the existence of homoscedasticity. The F-prob value for the WDAS model (0.1002) is greater than 0.05, therefore we do not reject the null hypothesis of no heteroscedasticity. The F-prob value for the IFEM model (0.1743) is also greater than 0.05, therefore we do not reject the null hypothesis of no heteroscedasticity and we conclude the existence of homoscedasticity.

b. Test for Serial Correlation

The Breusch-Godfrey serial correlation LM test was applied to test for serial correlation errors in a regression model.

SFEM/FEM model

F-statistic	0.754513	Prob F(1,19)	0.3959
ObsR.squared	1.222223	Prob.Chi-square(1)	0.2689

Source: Researcher's Computation using E-Views 10

WDAS model

F-statistic	0.938418	Prob F(1,17)	0.1119
ObsR.squared	1.549625	Prob.Chi-square(1)	0.1020

Source: Researcher's Computation using E-Views 10

IFEM model

F-statistic	0.631024	Prob F(1,12)	0.4424
ObsR.squared	1.398832	Prob.Chi-square(1)	0.2369

Source: Researcher's Computation using E-Views 10

The Breusch-Godfrey final correlation LM Test indicates that there is no serial correlation since the p-value of the F-statistic is greater than the 5% significance level. This implies the acceptance of the null hypothesis of no serial correlation in the models.

c. Test for Model Specification

The Ramsey-Reset test is used to test whether the model adopted in this study is correctly specified.

SFEM/FEM model

	Value	d.f	p-value
t-statistics	0.206491	19	0.8386
F-statistic	0.042639	(1, 19)	0.8386

Researcher's Computation using E-Views 10

WDAS model

	Value	d.f	p-value
t-statistics	0.151319	17	0.9058
F-statistic	0.930810	(1, 17)	0.9058

Researcher's Computation using E-Views 10

IFEM model

	Value	d.f	p-value
t-statistics	0.262842	12	0.7971
F-statistic	0.069086	(1, 12)	0.7971

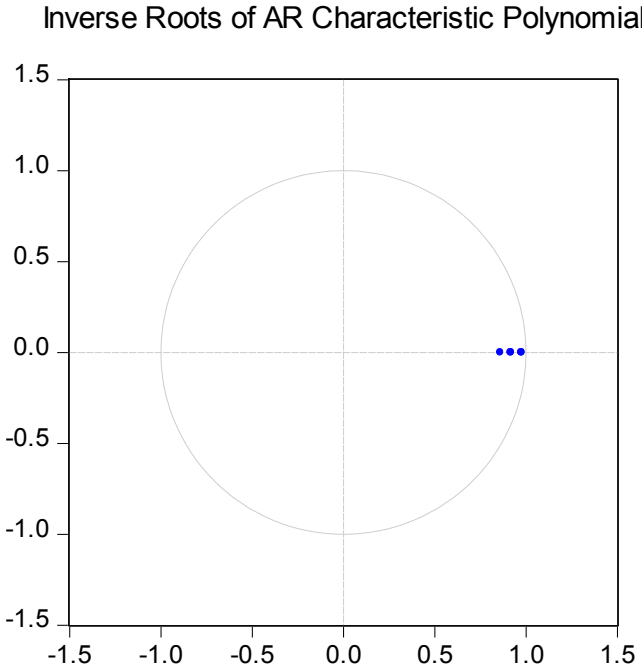
Researcher's Computation using E-Views 10

Since the probability (p-value) of the t-statistic and F-statistic is greater than 5% level of significance, we accept the null hypothesis of no model misspecification and reject the alternative hypothesis.

Presentation of the SVAR Results

The VAR lag order selection criterion was used to select the optimal lag of one (1) as given by the Akaike Information criterion. The VAR stability condition check was ascertained using the tabular roots of characteristic polynomial and the graphical inverse roots of AR characteristic polynomial. All the modulus figures in figure 5.1 were found to be below 1. The graph also showed the inverse roots of the AR polynomial to be within the circle thereby validating the VAR stability condition.

Figure 1 VAR Stability Condition



Researcher's Computation using E-Views 10

Table 4: Structural VAR Estimation Output

Structural VAR Estimates
Date: 11/01/22 Time: 13:44
Sample (adjusted): 1986Q2 2020Q4
Included observations: 139 after adjustments
Estimation method: Maximum likelihood via Newton-Raphson (analytic
derivatives)
Convergence achieved after 8 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

A =

1	0	0
C(1)	1	0
C(2)	C(3)	1

B =

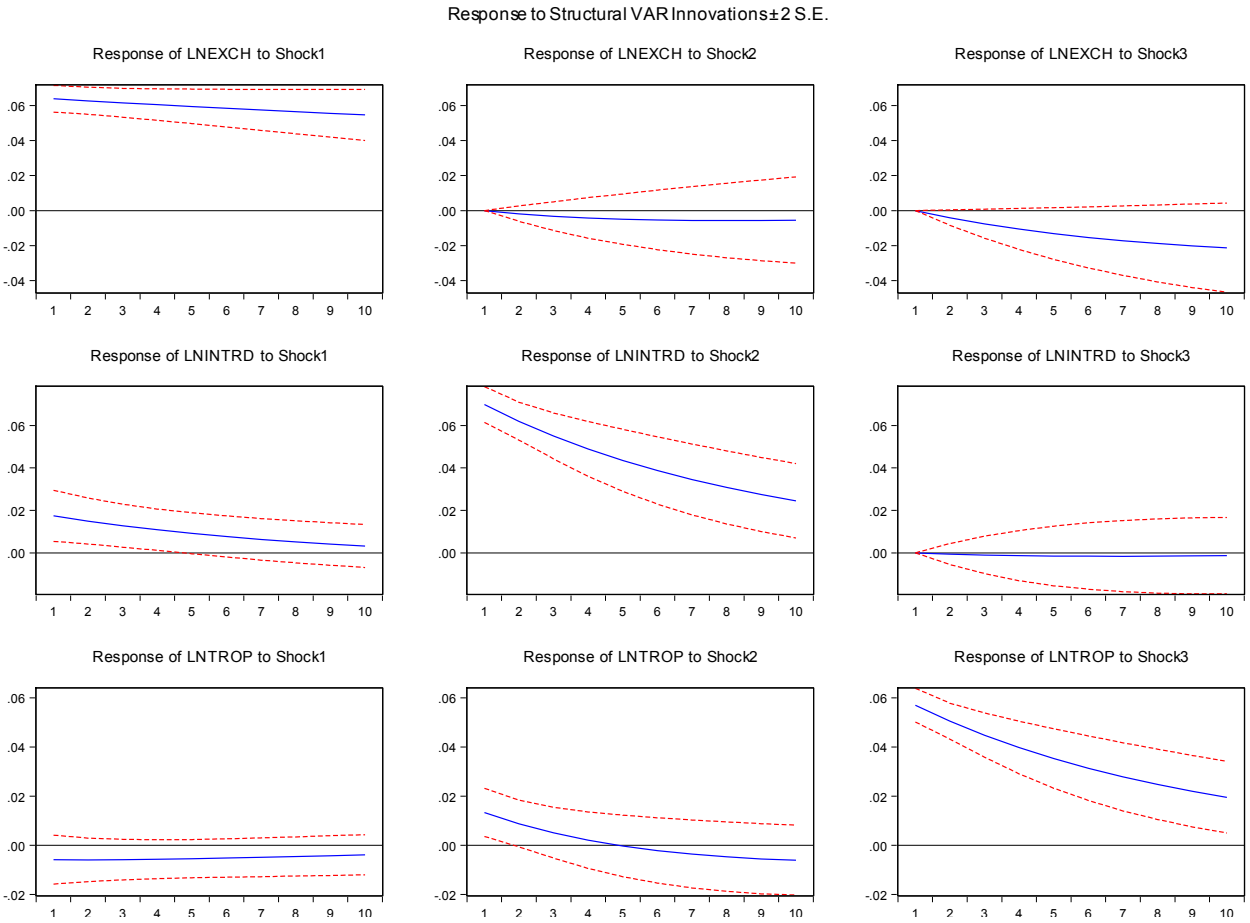
C(4)	0	0
0	C(5)	0
0	0	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.272410	0.092709	-2.938349	0.0033
C(2)	0.144786	0.077927	1.857973	0.0632
C(3)	-0.190663	0.069179	-2.756082	0.0058
C(4)	0.063884	0.003832	16.67333	0.0000
C(5)	0.069827	0.004188	16.67333	0.0000
C(6)	0.056951	0.003416	16.67333	0.0000
Log likelihood	558.9423			

Source: Researchers' Computation using E-Views 10

The estimation output for the structural VAR is also presented in table 5.3 and the results show the structural VAR to be just identified. The log likelihood also supports our acceptance of the identifying restrictions.

Figure 2: Impulse-Response Function for Structural VAR



Source: Researchers' Computation using E-Views 10

For the sakes of precision and brevity, we shall restrict our analysis to the results of the top three graphs in figure 2 which show the response of exchange rates to various structural VAR innovations; shock 1, shock 2 and shock 3 which depict lagged values of exchange rates, interest rate differentials and trade openness respectively. The first graph shows the response of exchange rate to itself. From the IVF graphs affixed above, the red dots are the standard error confidence bands. The confidence intervals are computed as +/- 2SE confidence bands. The x-axis represents the periods (quarters) while the y-axis shows the percentage variation.

A one standard deviation shock on lagged values of exchange rates has a gradual positive effect on itself across all quarters. In other words, shocks to LNEXCH will have a positive impact on LNEXCH both in the short-run and long-run.

A one standard deviation shock on interest rates differential initially has no perceptible impact on exchange rates until the second quarter when exchange rate goes below its steady state value and remains in the negative region until the tenth quarter. In other words, shocks to LNINTRD have no immediate perceptible impact on LNEXCH in the short-run albeit a mild impact on LNEXCH in the long-run as it remains negative from the second all through the tenth quarter.

A one standard deviation shock on trade openness has no perceptible impact on exchange rate in the first quarter. However it exerts a negative impact on exchange rate from the second period and gets steeper up till the tenth period.

Table 5: Variance Decomposition of LNEXCH using Structural VAR factors

Period	S.E.	Shock1	Shock2	Shock3
1	0.063884	100.0000	0.000000	0.000000
2	0.089631	99.75223	0.042850	0.204923
3	0.109067	99.26388	0.117363	0.618756
4	0.125257	98.61434	0.203956	1.181707
5	0.139381	97.86401	0.290211	1.845775
6	0.152033	97.05770	0.368858	2.573438
7	0.163558	96.22782	0.436168	3.336012
8	0.174175	95.39724	0.490751	4.112006
9	0.184030	94.58169	0.532677	4.885636
10	0.193230	93.79156	0.562870	5.645570

Source: Researchers' Computation using E-Views 10

Results from the variance decomposition in table 5 underscore our findings from the IRF graphs. We restrict our concern to the top third of the V.D table which depicts the variance decomposition of exchange rates. Exchange rate lagged values are seen to be strong predictors of the current value as they account for up to 93.8% variations in current values of exchange rate in the tenth quarter. Interest rates differential is seen to have no impact whatsoever on exchange rates in the first quarter, however a mild impact from the second quarter up until the tenth quarter. Trade openness is also seen to have no impact whatsoever on exchange rates in the first quarter, however as we progress, it is found to account for up to about 5.6% variations in exchange rate values in the current period.

Policy Implications of results

Results from the SFEM/FEM model show that relative real GDP, relative inflation rates and trade openness are adequate proximate variables to influence exchange rate changes. In other words, real GDP, relative inflation rates

and trade openness are very important variables to consider when formulating policies in a bid to influence exchange rates towards its equilibrating value under the SFEM/FEM exchange rate sub-regime.

Results from the WDAS model show the relative inflation rates and oil price as significant proximate variables policy makers have to take into consideration in a bid to influence exchange rate dynamics in Nigeria under a Wholesale Dutch Auction System. In other words, these variables are significant variables to consider when formulating policies aimed at nudging exchange rates towards its equilibrating value under the Wholesale Dutch Auction system.

Results from the IFEM model show the interest rate differential, relative inflation, oil price and trade openness as significant proximate variables policy makers need to take into consideration when trying to nudge exchange rates under the Interbank foreign exchange market sub-regime. In other words, these variables are significant variables to consider when trying to nudge exchange rates towards its equilibrating value under the Interbank Foreign Exchange Market sub-regime.

Results from the structural VAR model show that shocks or innovations to trade openness exert considerable impact on exchange rates in the long-run. The economic implication of this is that policies that are formulated to increase trade volume (imports and exports) relative to GDP will help nudge exchange rate to its long-run equilibrating value.

Conclusion and Recommendations

Conclusion

The determinants of exchange rate dynamics in Nigeria are similar in terms of their nature on exchange rates (i.e the signs) across the various exchange rate sub-regimes considered. However there tends to be striking dissimilarities in terms of their magnitude or sizes on exchange rates across the sub-regimes considered. Specifically, the determinants of exchange rate dynamics in Nigeria under the; Second-tier Foreign Exchange Market are relative real income, relative inflation and trade openness; Wholesale Dutch Auction System are relative inflation and oil price; Interbank Foreign Exchange Market are interest rate differential, relative inflation, oil price and trade openness. Also, demand and supply shock variables are found to elicit strong responses from exchange rates overtime.

Recommendations

Under the SFEM/FEM exchange rate sub-regime, policy makers are to pay very close attention to relative national income, relative inflation rates and trade openness in the following ways: Income taxes could be lowered in order to raise the 'disposable national income' which improves domestic national income relative to foreign national income; Corporate taxes could also be lowered (taxes on businesses) in a bid to reduce the operating costs of business firms (which puts demand pressure on prices of goods and services produced) thereby lowering domestic price level; Trade policies are to be monitored closely and tweaked depending on the prevailing economic conditions at various points in time. In a period of rapid depreciation, import duties on luxury goods or items which are adequately produced domestically could be raised to prohibit currency demand pressure on the dollar. Conversely, in times of rapid appreciation, import duties on selected goods could be lowered to lessen currency demand pressure on domestic currency.

Under the WDAS exchange rate sub-regime, policy makers are to pay very close attention to relative inflation rates and oil price in the following ways: For Oil; since Nigeria is a major exporter and importer of Oil, the domestic regulation of oil price is very crucial to avoid persistent shocks on the economy. This could be done by way of setting up a board which fixes or pegs the prevailing price of petroleum products within the economy and then uses this fixed/pegged price as a benchmark to determine when excess oil revenues from exports go into the excess crude account and when it should be used to fund subsidies (instead of having a fixed subsidy as this is not sustainable in the long-run). For example, when world price of petroleum products falls below the domestically fixed price, excess revenue from previous sales could be used to fund subsidy and maintain price at the domestic peg. In the event where world price of petroleum products exceeds the domestic set price, subsidies are removed and any excess revenue from oil exports will be moved to the excess crude account. Of course, the feasibility of this depends on the inter-relationships between oil export volume and revenue and oil import volume and revenue. If the export volume and revenue exceeds import volume and revenue, then this policy will be easier to implement.

Under the IFEM exchange rate sub-regime, the variables of interest are interest rates differential, relative inflation, oil price and trade openness. Interest rates should be set using the U.S fed rate as a benchmark; setting the domestic interest rates higher than that of the U.S attracts foreign capital flows, all things being equal. Although this should be done with caution to avoid disruptive internal imbalances since the relative inflation is another vital variable of interest under this sub-regime.

Finally, because exchange rates have been found to respond strongly to innovations or shocks of trade openness overtime, in addition to the implementation of the trade policies suggested above, the government should have policies to increase the added value of exports to improve the quality of trade openness. Policies, national or global, which facilitate trade among countries, should also promote macroeconomic stability. From successful trade rounds that reduce various forms of protection, to bilateral or multilateral agreements (such as NAFTA) that dismantle trade barriers, to the trade liberalization that is one of the characteristics of globalization.

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