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Exchange Rate Volatility, Its Determinants and Effects on the Manufacturing Sector in Nigeria

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***Abstract*—**This study evaluated the effect of exchange rate volatility on the manufacturing sector of Nigeria. The flow and stock market theories of exchange rate determination was adopted considering macroeconomic determinants such as balance of trade, trade openness, and net international investment. Furthermore, the influence of changes in parallel exchange rate, official exchange rate and real effective exchange rate was modeled on the manufacturing sector output. Vector autoregression techniques and vector error correction mechanism were adopted to explore the macroeconomic determinants of exchange rate fluctuation in Nigeria and to examine the influence of exchange rate volatility on the manufacturing sector output in Nigeria. The exchange rate showed an unstable and volatile movement in Nigeria. Official exchange rate significantly impacted on the manufacturing sector of Nigeria and shock to previous manufacturing sector output caused 60.76% of the fluctuation in the manufacturing sector output in Nigeria. Trade balance, trade openness and net international investments did not significantly determine exchange rate in Nigeria. However, own shock accounted for about 95% of the variation of exchange rate fluctuation in the short-run and long-run. Among other macroeconomic variables, net international investment accounted for about 2.85% variation of the real effective exchange rate fluctuation in the short-run and in the long-run. Monetary authorities should maintain stability of the exchange rates through proper management so as to encourage local production and government should formulate and implement policies that will develop other sectors of the economy as this will widen the country's revenue base, reduce our over reliance on oil sector for our foreign exchange earnings and in turn reduce the shocks on our domestic economy.

***Keywords*—**Exchange rate volatility, exchange rate determinants, manufacturing sector, official exchange rate, parallel exchange rate, real effective exchange rate.

I. Introduction

THE effect of the global economic meltdown on Nigerian exchange rate remarkably pushed the Naira-USD exchange over N180/1$ from about N120/1$ between 2008 and 2009 [14]. Reference [14] argued that it could be as a result of the sharp decline in Nigeria's foreign exchange earnings, which resulted from the persistent decrease in international oil price. This decline in crude oil price plunged from the highest point, US$147 per barrel, in July 2007 to as low as US$45 per barrel in December 2008 [14].

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Evidently, the 2008/2009 global economic crisis revealed Nigeria's excessive exposure to shocks from outside its borders. Although numerous factors are blamed for Nigeria's poor economic performance, the major problem has been the economy's intolerable dependence on the earnings from oil market for foreign exchange thereby causing recurring volatility in the country's exchange rate [15].

Reference [15] reported that in light of the perceived emphasis on the production of substitutes to fossil-fuel energy in developed economies, there would be a decline in oil demand, which will further weaken the Nigerian foreign exchange earnings. Therefore, if the government does not focus its effort to forestall loss of earnings by expanding the revenue sources, revenue from crude oil will drastically reduce as well as the nation's savings of the excess income from crude oil export and foreign exchange earnings in the future. This will have serious negative implications for the economy, as the cost of living and doing business will rise, given the trend of consumption of imported goods and heavy reliance on foreign exchange for the purchase of raw material for production in Nigeria. Crude oil is an exhaustible asset and therefore, cannot be relied upon to sustain the development of Nigerian economy [13].

Reference [16] echoed that the poor performance of the Nigerian manufacturing sector and its vulnerability to negative external shock suggests the urgent need for a reappraisal of the focus of the development policies and commitments to their implementation. They advocate for an immediate change in the policy focus of the Nigerian government and a shift in the industrialization strategy, if the Nigerian economy must be returned to the path of sustainable growth and external viability. This therefore raises the following questions;

i. To what extent is the Nigerian manufacturing sector sensitive to exchange rate volatility?
ii. To what extent do macroeconomic factors such as trade balance, net international investment, and trade openness influenced the exchange rate fluctuation in Nigeria?

II. Literature Review

Reference [1] examined how policy and macro-economic variables affect the daily volatility of the exchange rate against the U.S. Dollar with panel data from 43 countries in 1990-2001 and found that flexibility of the exchange rate regime, central bank's intervention and the uncertainty of the domestic economy increase exchange rate volatility, while the country's economic wealth decreases volatility but restrictions on capital flows did not affect exchange rate volatility. Reference [7] studied the sources of real exchange rate fluctuations in

Pakistan employing a long run structural VAR approach and found that nominal shocks are significantly responsible for the country's exchange rate fluctuations. Based on this finding, they advised the Pakistani authorities to focus on the real side of the economy, such as improving the efficiency, technologies and productivity in order to improve its competitiveness. Reference [9] investigated the sources of the movements of the real exchange of Poland and Hungary and found that nominal shock had a bigger influence in the short-run changes in the real exchange rate of Poland while real shocks had a larger influence on the Hungarian real exchange rate.

Reference [10] x-rayed the exchange rates determining factor in the long run, while studying the effect of primary factor such as: Productivity, international assets, net international assets, fiscal balances, terms of trade and real rates of interest. Findings of the study showed that the aforementioned primary factors had significant bearing in determining both long and short-run exchange rates. Also, [11] opines that fundamental macroeconomic forces and global political uncertainties have the potential to force a sustained decline in a country's exchange rate. Reference [3] studied the behaviour of the bilateral real exchange rate of the United States with five of its trading partners: Canada, Germany, Japan, Korea and Mexico and found that the relative price of non-traded goods accounts significantly for real exchange rate variance for the most important U.S. trade partners.

In an investigation of bilateral exchange rates between the United States of America and other developed nations, [4] showed that nearly all real exchange rate volatilities were caused by shock to relative prices of internationally traded commodities. Findings of the study were at least consistent with the correlation of real and nominal exchange rate variations. There is a high simultaneous correlation between the variability of the relative price non-traded goods to traded good across countries, while the variability of the real exchange rate is far greater than the two [2]. Using a multicounty, multisector general equilibrium business cycle model in which the degree of tradability of output differs across sectors, [2] discovered that an international real business model with sectoral detail and differing degrees of tradability among sectoral outputs has the potential to account for both relative price movements by sector and for real exchange rate fluctuations.

Reference [12] investigated the sectoral sensitivity to exchange rate fluctuations in Europe and showed that the most important sectors of the European economy, which comprises of food, paper products, chemicals, metals, machinery, electrical products and transport equipment, reacted differently to exchange rate changes resulting from exports and also from imports. Their results revealed that the aforementioned sectors had a great level of sensitivity in their export as well as in their import except for transport equipments. The market structure of the European economy was the major determinant of sectoral sensitivity to exchange rate fluctuations as identified in the study. Reference [5] used a modified model of [17] to estimate monthly time-varying exchange rate exposure for one hundred and sixty four United States of America's manufacturing multinationals both during the months of exchange rate crisis and non-crisis spanning a period of 1995 to 1999. The study showed that about 25% of the firms had significant exposure only in crisis periods while others were exposed significantly during normal fluctuations in exchange rates. Findings of the study further revealed that although the exchange rate exposure of these manufacturing companies did not depend on the magnitude of the exchange rate fluctuation, its effect on the companies' returns was quite large during crisis periods.

Reference [8] examined the extent of exchange rate pass-through in Kenya in a bid to gauge the country's vulnerability to foreign shocks noting that the fluctuation of exchange rate were transmitted to local prices through prices of imported final consumer goods, intermediate goods (through production cost-channel) and domestic goods priced in foreign currency. Their study revealed that exchange rate volatility accounts for about 70% of the fluctuation of import price and seventy six percent of the variation in prices of imports and their study also revealed that competitive pressure decreased as ime passed as the price of manufacturing output increased outpace world export prices. On the other hand, [6] investigated the effect of exchange rate fluctuations on economic performance using output and price data of twenty-two emerging economies. Reference [6] observed that perceived future exchange rate depreciation determined the cost of imported intermediate goods and therefore, the supply of output. In contrast, the study argued that unanticipated currency fluctuations determined aggregate demand through exports, imports, and demand for currency, while aggregate supply is determined through the cost of imported intermediate goods. According to [6], the first channel increases aggregate demand as currency depreciation increases exports and decreases imports. The second channel decreases aggregate demand. An unexpected depreciation of the domestic currency, relative to its anticipated steady-state value, increases the demand for domestic currency. On the supply side, [6] notes that currency depreciation increases the cost to buy intermediate goods and decreases the output supplied. The combined effects of the three channels are indeterminate on output and price. The study argued that anticipated movement in the exchange rate is assumed to vary with agents' observations of macro-economic fundamentals that determine changes in the exchange rate over time [6].

Various literatures reviewed adopted approaches that considered at the effect of shock to exchange rate on the economy. The studies employed dynamic modeling approach, business cycle model, vector auto-regression, vector error correction method, etc. while a few studies employed real exchange rate as a proxy for exchange rate fluctuations, some studies used nominal exchange rate and others average official exchange rate. While the adopted variables and methods may have suited the study purpose, it is pertinent to note that most of the studies were international, covering the United States of America, United Kingdom, Pakistan, Kenya, Europe, etc.

Studies in this area covering Nigeria are not yet sufficient in empirical literature. Furthermore, Nigeria uses two foreign exchange rates; the official exchange rate and the parallel exchange rate. This is not so in the economies reviewed in the literature and therefore peculiar circumstances may have been excluded from the study, causing a critical limitation in adopting the study for reference to Nigeria. Notably, the time series data of the reviewed literature stopped in 2010, causing a huge gap in the year of coverage. Therefore, it is necessary to update the scope of coverage with regards to the country (location of study) and the period of study (years of coverage), so as to give relevance and credence to recent study on the subject. The study seeks to fill these identified gaps in the reviewed literature.

III. Methodology

The study adopted the ex-post facto research design, utilizing the flow approach and stock market approach to exchange rate determination for the analysis. The analysis is based on time series data for the exchange rate of Nigeria for the period 1986-2014. Therefore, exchange rate determinants in Nigeria used in the study are trade balance, proxied by *trade balance* and financial, real assets investments balances proxied by Net international investments (NII), and a macroeconomic variable, trade openness.

To investigate the impact of exchange rate fluctuations on the manufacturing sector of Nigeria, the mean equation of the vector error correction mechanism was used, having manufacturing output as the dependent variable while the independent variables include: Average official exchange rate of Naira vis-à-vis US Dollar, change in average official exchange rate of Naira vis-à-vis US Dollar, interest rate and inflation rate. Further, in order to measure the exchange rate movement, fluctuation and or pass-through, the variance equation of vector error correction model was adopted for the study. Vector autoregression, however, was adopted to x-ray the macroeconomic determinants of exchange rate fluctuation; the real effective exchange rate was used as the dependent variable while NII, trade balance, trade openness were the independent variables.

The hypotheses for the study are;

i. Exchange rate volatility does not significantly affect the Nigerian manufacturing sector.
ii. Exchange rate volatility is not significantly influenced by her macroeconomic factors such as trade balance, net international investment, and trade openness.

Thus, the model that satisfies the hypotheses is as:

Model One (Exchange rate Volatility Determinants in Nigeria)

$$Reer = f(bot, imex, nii) \quad (1)$$

To make it stochastic;

$$Reer_t = d_0 + d_1Bot_t + d_2Imex_t + d_3Nii_t + \mu \quad (2)$$

where, Reer - Real Effective Exchange Rate of Naira vis-à-vis US Dollar; BOT - Balance of Trade; Imex - Trade Openness; Nii - Net International Investments; d_0 - Constant (parameter to be estimated); d_1, d_2, d_3... - Parameters to be estimated; μ - Error term; t - time period.

It is expected that $d > 0$, $d_1 > 0$, $d_2 < 0$, $d_3 > 0$, and $d_4 > 0$

Model Two (Exchange Rate Volatility and the Nigerian Manufacturing Sector)

$$Mo = f(coer, cparaer, creer) \quad (3)$$

To make it stochastic;

$$Mo_t = c_0 + c_1Coexr_t + c_2Cparaer_t + c_3Creer_t + \mu_t \quad (4)$$

where, Mo - Manufacturing Output (Manufacturing contribution to the GDP); Coer - Change in official Exchange Rate of Naira vis-à-vis US Dollar; Cparaer - Change in parallel market Exchange Rate of Naira vis-à-vis US Dollar; Creer - Change in real effective exchange rate; c_0 - Constant (parameter to be estimated); c_1, c_2, c_3 ... - Parameters to be estimated; μ - Error term; t - time period. This refers to the sign and size of the parameters in economic relationships.

$$Mo_t = c_0 + c_1Coexr_t + c_2Cparaer_t + c_3Creer_t + \mu_t$$

where c, c_1, c_2, c_3 are parameters. It is expected that $c > 0$, $c_1 > 0$, $c_2 < 0$, and $c_3 > 0$.

IV. Presentation and Analyses of Results

A. Test of Normality

	MO1	COER	CPARAER	CREER
Mean	5200.712	5.341724	5.438138	-0.578966
Median	3044.910	0.650000	2.000000	-1.500000
Maximum	18402.19	64.09000	59.31000	69.05000
Minimum	61.70000	-7.700000	-7.300000	-47.91000
Std. Dev.	5835.467	14.25217	12.27278	23.54149
Skewness	1.124924	3.023061	3.290351	0.627013
Kurtosis	2.998192	12.12447	14.44031	4.674424
Jarque-Bera	6.116365	144.7722	210.4753	5.288005
Probability	0.046973	0.000000	0.000000	0.071076
Sum	150820.7	154.9100	157.7060	-16.79000
Sum Sq. Dev.	9.53E+08	5687.478	4217.388	15517.65
Observations	29	29	29	29

Fig. 1 Normality and descriptive statistics of manufacturing output, official exchange rate, parallel exchange rate, interest rate and inflation

The test of normality showed that the change in real effective exchange rate was normally distributed. This evidence is in the Jarque-Bera estimates and probability value ($0.071076 > 0.05$). Change in parallel exchange rate, change in official exchange rate and manufacturing output were not normally distributed, as the probability of Jaque-Bera statistics was less than 5% (0.000000; 0.000000; $0.046973 < 0.05$

respectively). This follows the decision rule as stated in the previous chapter, that variables are normally distributed if JB-TAB is greater than JB-CAL at 5% level of significance or if the probability of Jarque-Bera statistics is greater than 0.05.

	BOT	REER	NII	IMEX
Mean	1720.593	31.66138	-11199.30	10.75918
Median	509.8000	46.49000	-1209.100	7.518113
Maximum	5822.600	101.0100	-19.40000	31.45396
Minimum	-85.60000	-72.06000	-138755.6	0.057801
Std. Dev.	2028.219	58.16883	27235.90	9.876945
Skewness	0.726419	-0.224306	-3.813018	0.565255
Kurtosis	1.892003	1.474803	17.96729	2.005782
Jarque-Bera	4.033891	3.054036	340.9628	2.738715
Probability	0.133061	0.217182	0.000000	0.254270
Sum	49897.20	918.1800	-324779.8	312.0162
Sum Sq. Dev.	1.15E+08	94741.15	2.08E+10	2731.513
Observations	29	29	29	29

Fig. 2 Normality and descriptive statistics of real effective exchange rate, net international investment, trade openness and balance of trade

The normality test in Fig. 2 revealed that real effective exchange rate, trade openness and trade balance were normally distributed given their Jarque-Bera probability values of 0.133061, 0.217182, and 0.254270 respectively, which were greater than 0.05. However, the Jarque-Bera probability of the net international investment was less than 0.05, implying that it was not normally distributed. This follows the decision rule as stated in the previous chapter, that variables are normally distributed if JB-TAB is greater than JB-CAL at 5% level of significance or if the probability of Jarque-Bera statistics is greater than 0.05.

B. Exchange Rate Volatility in Nigeria

TABLE I
AUGMENTED DICKEY FULLER UNIT ROOT TEST

Variable	ADF Test Stat	5% Critical Value	Order of Integration
REER	-4.240663	-3.587527	I(1)
IMEX	-4.789280	-3.587527	I(1)
NII	-4.910245	-3.595026	I(1)
BOT	-4.658497	-3.644963	I(2)

The Augmented Dickey Fuller test for stationarity reveals that all the variables (real effective exchange rate, Net international investment, trade openness (imex)) are integrated at order one except for balance of trade, which is stationary at 2nd difference. This implies that the variables have a unit root situation and therefore need be tested for cointegration to identify if there is a long-run relationship before conducting the regression analysis.

Johansen cointegration tests were conducted at 5% significance level using the e-views software and the outcome shows that there is no cointegrating equation. This implies that there is no long run relationship between the variables. Therefore, since there is no long-run relationship between the variables, we cannot use vector error correction mechanism (VECM), being that the time-series condition for adopting the error correction model (ECM) and (or) the VECM is that the variables must be cointegrated. We therefore, estimate the vector autoregression (VAR). However, the variables must be estimated using the VAR at their stationary form (this satisfies the time-series condition that the variables must be estimated at their stationary form). Hence the VAR model will be estimated using the 1st difference form of the variables [their stationary level; I (1)].

Sample (adjusted): 1988 2014
Included observations: 27 after adjustments
Trend assumption: Linear deterministic trend
Series: BOT REER NII IMEX
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.440662	35.41380	47.85613	0.4264
At most 1	0.387757	19.72674	29.79707	0.4415
At most 2	0.206263	6.479852	15.49471	0.6388
At most 3	0.008952	0.242781	3.841466	0.6222

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.440662	15.68705	27.58434	0.6922
At most 1	0.387757	13.24689	21.13162	0.4298
At most 2	0.206263	6.237071	14.26460	0.5830
At most 3	0.008952	0.242781	3.841466	0.6222

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Fig. 3 Johansen cointegration test

VAR Lag Order Selection Criteria
Endogenous variables: REER NII IMEX
Exogenous variables: C

Sample: 1986 2014
Included observations: 23

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-465.4567	NA	9.86e+13	40.73536	40.88347	40.77261
1	-418.0387	78.34268*	3.53e+12*	37.39467	37.98710*	37.54367
2	-413.8154	5.875907	5.61e+12	37.81004	38.84679	38.07078
3	-406.8931	7.825220	7.63e+12	37.99071	39.47178	38.36319
4	-400.7509	5.341046	1.28e+13	38.23921	40.16461	38.72344
5	-383.6213	10.42671	1.07e+13	37.53229	39.90202	38.12827
6	-355.0247	9.946639	5.94e+12	35.82824*	38.64229	36.53596*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Fig. 4 VAR lag length selection criteria

The VAR lag selection criteria were used to choose the optimal lag length for the VAR model. The result showed that the sequential modified LR test statistic (LR), the final prediction error (FPE), and the Schwarz Information Criterion (SC) indicated lag one as the optimal lag length while Akaike Information Criterion (AIC) and Hannan-Quinn Information Criterion (HQ) indicated lag six (6) as the optimal lag length.

Using simple majority, the researcher chooses lag one (1), which was indicated by 3 out of 5 lag selection criteria, as the optimal lag length.

TABLE II
VAR ESTIMATES

Dep. Var.		REER (-1)	BOT (-1)	NII (-1)	IMEX (-1)
REER	t*	0.6098	-0.1599	-0.0210	0.8939
	prob. of t*	0.5436	0.8733	0.9833	0.3739

Source: Excerpts from author's computation using E-views 9.5 software
F*– 0.312385
R^2 – 0.056160

Considering the result of the VAR, it shows that coefficients of BOT (-1), and NII (-1) were negative. However, IMEX impacted positively on REER after one lag. This implies that an increase in IMEX causes a decrease in real effective exchange rate; however, the effect becomes direct after one year. The coefficient of multiple determinations of VAR was very poor (0.056160). The R^2 of VAR showed that only 5.6% variations in exchange rate is caused by variations in balance of trade, NII and trade openness after one year. It is therefore not a good fit. Result of the f* of the VAR (0.312385) indicates insignificance of the general regression analysis. Furthermore, there is no serial correlation (evidence from the Autocorrelation LM test) and the residual of the regression is homoscedastic as evidenced by the VAR heteroscedasticity (with cross term) test (prob. of chi square 0.1656 > 0.05).

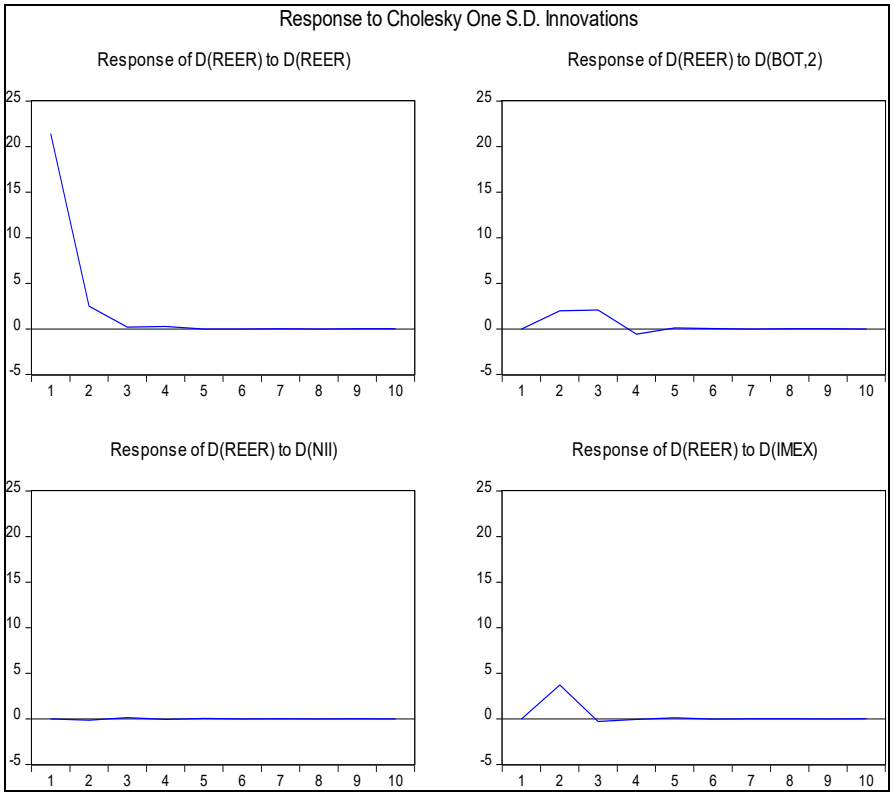

Fig. 5 Impulse Response Graph, Source: Author's computation using E-views 9.5 software

Real effective exchange rate responded significantly and positively to shocks in trade balance, NII and trade openness over the 10 periods. However, own shock (shock to real effective exchange rate) responded insignificantly in period one and then significantly for the rest of the period.

The variance decomposition of ten time periods of the shocks to real effective exchange rate (REER) shows that the shock to real effective exchange rate (own shock) account for more than 95% variation of the volatility in real effective exchange rate throughout the period (in the short run and in the long-run). The shock to Nigeria's trade openness (IMEX) accounted for just about 2.85% variation of the fluctuation in real effective exchange rate over the period.

Variance Decomposition of D(REER):

Period	S.E.	D(REER)	D(BOT,2)	D(NII)	D(IMEX)
1	21.37925	100.0000	0.000000	0.000000	0.000000
2	21.93245	96.31165	0.819091	0.004884	2.864372
3	22.03258	95.44580	1.690395	0.007750	2.856051
4	22.04191	95.37963	1.757486	0.008452	2.854428
5	22.04240	95.37547	1.759719	0.008568	2.856239
6	22.04244	95.37509	1.759949	0.008586	2.856375
7	22.04246	95.37498	1.760053	0.008590	2.856372
8	22.04246	95.37498	1.760060	0.008591	2.856373
9	22.04246	95.37498	1.760060	0.008591	2.856374
10	22.04246	95.37498	1.760060	0.008591	2.856374

Fig. 6 Variance decomposition, Source: Author's computation using E-views 9.5 software

Sample: 1986 2014
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
BOT does not Granger Cause REER	27	0.89845	0.4216
REER does not Granger Cause BOT		4.45816	0.0237
NII does not Granger Cause REER	27	1.58613	0.2273
REER does not Granger Cause NII		0.13169	0.8773
IMEX does not Granger Cause REER	27	1.38666	0.2709
REER does not Granger Cause IMEX		1.56770	0.2309

Fig. 7 Granger causality, Source: Author's computation using E-views 9.5 software

The Granger causality test shows that real effective exchange rate Granger-caused trade balance by 97.64% (0.0237 < 0.05). Therefore, there is a significant Granger causality from REER to MO, while balance of trade did not significantly cause REER. The test further revealed that net international investment and trade openness did not granger cause real effective exchange rate.

C. Exchange Rate Volatility and the Manufacturing Sector in Nigeria

TABLE III
AUGMENTED DICKEY FULLER UNIT ROOT TESTS

Variable	ADF Test Statistics	5% Critical Value	Order of Integration
COER	-4.665630	-3.580623	I(0)
CPARER	-5.783379	-3.580623	I(0)
CREER	-3.926546	-3.580623	I(0)
MO	-4.488795	-3.658446	I(2)

Source: Author's computation using E-views 9.5 software.

The Augmented Dickey Fuller test for stationarity of variables (manufacturing sector output, official exchange rate, parallel exchange rate, interest rate and inflation) used for regression reveals that the variables have unit root. ADF shows that change in official exchange rate, change in parallel exchange rate and change in real effective exchange rate are stationary at levels form, while manufacturing output is stationary at 2nd difference. This implies that all the variables cannot be used for regression at level form because manufacturing output is not integrated of the same order with the other three regressors. Therefore, a cointegration test should be conducted to identify if there exist a long-run relationship among the variables.

Sample (adjusted): 1988 2014
Included observations: 27 after adjustments
Trend assumption: Linear deterministic trend
Series: CREER COER CPARAER MO1
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.587544	53.40516	47.85613	0.0138
At most 1	0.398035	29.49329	29.79707	0.0542
At most 2 *	0.386061	15.78928	15.49471	0.0451
At most 3	0.092380	2.617084	3.841466	0.1057

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Fig. 8 Johansen cointegration test, Source: Author's computation using E-views 9.5 software

Johansen cointegration test was conducted at 5% significance level using the e-views software and the outcome reveals that there is a cointegrating equation using trace test. The existence of a long-run relationship between variables necessitated the adoption of VECM for the analysis. In this study of volatility, vector error correction is most suitable to capture the fluctuation effect, lagged effect, pass-through, and forecast.

VAR Lag Order Selection Criteria
Endogenous variables: CREER COER CPARAER MO1
Exogenous variables: C

Sample: 1986 2014
Included observations: 27

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-606.6921	NA	5.20e+14	45.23645	45.42843	45.29353
1	-550.0264	92.34403*	2.60e+13*	42.22418*	43.18406*	42.50960*
2	-543.2492	9.036245	5.63e+13	42.90735	44.63513	43.42111

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Fig. 9 VAR lag length selection criteria, Source: Author's computation using E-views 9.5 software

The result of the VAR lag selection criteria revealed that all lag selection criteria (LR, FPE, AIC, SC, HQ) indicated lag 1 as the optimal lag. Therefore, the VEC will be estimated using just a lag, which will become the decisive lag.

TABLE IV
VECTOR ERROR CORRECTION ESTIMATES

Dep. Var.		VEC	D (MO (-1), 3)	D (CREER (-1))	D (COER (-1))	D (CPARAER (-1))
D (MO,3)	t*	-5.43989	1.60506	0.58234	-2.29596	-0.64013
	prob. of t*	0.0000	0.1250	0.5672	0.0332	0.5297

Source: Excerpt from author's computation using E-views 9.5 software
F* - 12.98258
R^2 - 0.773575

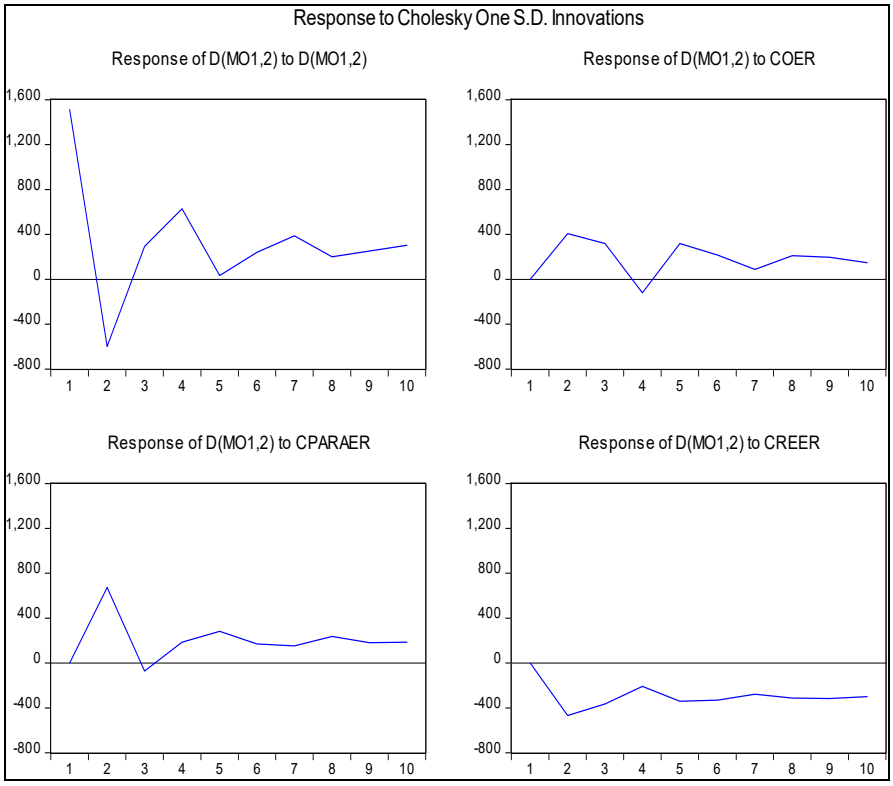

Fig. 10 Impulse Response Graph, Source: Author's computation using E-views 9.5 software

The result of the vector error correction conducted at 5% level of significance, considering the optimal lag selected showed that only change in official exchange rate [COER(-1)] impacted on the manufacturing sector of Nigeria (prob. of t* 0.0332 < 0.05). This means that change in official exchange rate significantly affects manufacturing output after one year. However, change in official exchange rate had an inverse effect on the manufacturing sector in Nigeria. Change in parallel exchange rate also had inverse effect on the manufacturing sector of Nigeria. This passed the a priori expectation in relation to manufacturing output. On the contrary, real effective exchange rate had a direct (positive) relationship with manufacturing output. The f-statistics (f*) of 12.98258, which is greater than the f-critical ($f_{0.05}$) proves the general statistical significance of the regressors on the manufacturing output in Nigeria.

The ECM coefficient had a negative sign, which is a priori expected. Furthermore, the ECM is statistically significant (prob. of * 0.0000 < 0.05) and the coefficient is -2.036874, implying that there is a significant mechanical adjustment of the residual of variables to long-run equilibrium at the speed of 203.37%.

The coefficient of multiple determinations (R^2) of 0.773575 reveals that 77.36% of the variations in the dependent variable (manufacturing output) is caused by variations in COER, CPARAER, and CREER.

Nigerian manufacturing sector output's response to change in official exchange rate revealed mostly positive fluctuation over the period. Manufacturing output had similar response to change in parallel exchange rate and change in official rate of exchange. Notably, manufacturing output responded negatively to one S.D. innovation to change in real effective exchange rate, while response to own shock was highly volatile positively and negatively.

Period	S.E.	D(MO1,2)	COER	CPARAER	CREER
1	1511.600	100.0000	0.000000	0.000000	0.000000
2	1865.741	75.92683	4.761380	13.00447	6.307322
3	1950.672	71.69404	7.011755	12.03298	9.261220
4	2071.209	72.75649	6.554528	11.46727	9.221705
5	2141.846	68.06034	8.336676	12.45881	11.14417
6	2197.970	65.83028	8.878597	12.43472	12.85641
7	2256.018	65.41913	8.575312	12.26767	13.73788
8	2308.174	63.23760	9.014810	12.78326	14.96434
9	2358.416	61.71022	9.316562	12.83269	16.14053
10	2407.982	60.76676	9.306876	12.90256	17.02381

Cholesky Ordering: D(MO1,2) COER CPARAER CREER

Fig. 11 Variance decomposition, Source: Author's computation using E-views 9.5 software

The variance decomposition showed that in the short run and long-run, previous manufacturing output shock (i.e. own shock) accounted for substantial (from 75.92% in period two to 60.76% in period ten) variation in current manufacturing sector output. The shock to change in parallel exchange rate accounted for 13% of the variation in manufacturing output in period two (short-run), while shock to change in real effective exchange rate accounted for 17.02% of the variation in manufacturing sector output in the long run (period 10). Therefore, it can be argued that against popular opinions that own shock (i.e. shock to manufacturing sector output) is a

major factor that influences the manufacturing sector output of Nigeria.

Pairwise Granger Causality Tests

Sample: 1986 2014
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
COER does not Granger Cause MO1	27	0.81730	0.4546
MO1 does not Granger Cause COER		0.22913	0.7971
CPARAER does not Granger Cause MO1	27	1.45480	0.2550
MO1 does not Granger Cause CPARAER		0.36662	0.6972
CREER does not Granger Cause MO1	27	0.10882	0.8974
MO1 does not Granger Cause CREER		0.96901	0.3951

Fig. 12 Granger causality, Source: Author's computation using E-views 9.5 software

The Granger causality test shows that none of the variables significantly caused each other. There is therefore no significant causation from change in real effective exchange, change in official exchange rate, change in parallel exchange rate to manufacturing sector output in Nigeria and vice versa.

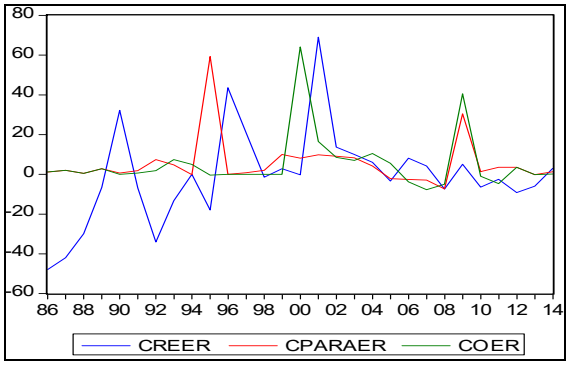

Fig. 13 The degree of exchange rate volatility

The exchange rates as seen above reveal upward and downward (at times stability) movement throughout the period 1986-2014. Therefore, in order to take proper cognizance of the extent of volatility of the variables, the change in real effective exchange rate, change in parallel exchange rate and change in official exchange rate were trended.

It is evident from the graphic trend that the exchange rate variables were not just volatile (i.e. upward and downward swing), but they were further characterized by irregular and unpredictable movement, swinging immediately in the opposite direction the next near (upward or downward) moving from the previous year.

It is interesting to note that while the changes in the official exchange rate and parallel exchange rate started slightly above 1 and remained relatively stable in the region of 0-8 until 1994 (change in parallel exchange rate) and 1998 (change in official exchange rate), change in the real effective exchange rate started below the zero line, at its trough (lowest point), from about -47 and rose steadily above 30 on the scale in 1990 and dropped to -34 in 1992. The change in real effective exchange rate was at its peak in 2001 having scored 69.05 the previous year. The change in real effective exchange rate still maintained its volatile and staggering movement narrowly bordering the zero line to end at a positive change of 2.97 between 2013 and 2014. While this is so for the change in the real effective exchange rate, the changes in parallel exchange rate and official exchange rate had similar movement (though fluctuating) from 2002 to 2014. However, their positive change was peaked at 59.31 (change in parallel exchange rate) in 1995 and 64.01 (change in official exchange rate) in 2000. Their lowest (negative) change bordered between 0 and -7

D. Test of Hypotheses

$H_0$1 - An exchange rate volatility does not significantly affect the Nigerian manufacturing sector. Following the result of the VECM, manufacturing sector output lag one (MO(-1)) and change in official exchange rate had statistically significant effect on the manufacturing sector output. Furthermore, the f* was greater than the $f_{0.05}$, indicating the general statistical significance of the regressors. Therefore, we reject the null hypothesis and conclude that exchange rate fluctuation significantly affects the manufacturing sector output in Nigeria.

$H_0$2 - Exchange rate fluctuation is not significantly influenced by Nigerian macroeconomic factors such as trade balance, trade openness, and NII. The result of the vector autoregression analysis showed that none of the independent variables significantly affected the manufacturing sector output in Nigeria. Furthermore, the f* of 0.312385 showed that interaction of the independent variables generally did not impact on the real effective exchange rate of Nigeria. The VAR analysis showed that the independent variables are not significant determinants of the real effective exchange rate in Nigeria. We therefore accept the null hypothesis and conclude that exchange rate fluctuation is not significantly determined by the macroeconomic factors such as balance of trade, net international investment, and trade openness.

V. Conclusion And Policy Recommendations

The empirical analysis reveals that post-SAP era has witnessed relative increase and persistent volatility in the exchanges rates. Therefore, it can be said that the exchange rates of Nigeria in post-SAP have been characterized by uncertainty. Exchange rate policy and management under SAP have left some issues unresolved and/or created some distortions in the economy. The econometric results showed that the Nigerian manufacturing sector is not sensitive to exchange rate volatility. It responded more significantly to the previous year manufacturing sector output (lag 1) and change in official exchange rate, but insignificantly to other variables (parallel exchange rate, official exchange rate and real effective exchange rate). Furthermore, the major cause of variations in real effective exchange rates of Nigeria identified in the study is shock to previous year real effective exchange rate [REER (-1)] (own shock). Contrary to theoretical underpinning, trade balance, trade openness, and net

international investment were insignificant in the determination of real effective exchange rate in Nigeria.

One clear conclusion which emerged from the above analysis is that the previous year manufacturing sector output and official exchange rate seemed to be more important drivers of activities in the Nigerian manufacturing sector. However, alongside changes in other exchange rate variables, they all significantly drive the manufacturing sector of Nigeria. Proper management of exchange rate, to forestall costly distortions, constitutes an important pillar in enhancing the performance of the manufacturing sector in Nigeria. It is important that monetary authorities ensure transparency in determining exchange rate process such that various economic distortions associated with exchange rate should be reduced. Probably, the major contribution of the study suggests that preceeding year output of the manufacturing sector in Nigeria alongside changes in exchange rate variables are a source of worry for Nigerian manufacturers. The study also confirms that the direction of effects of exchange rate volatility remains controversial as in the literature.

Considering the negative relationship between exchange rate variables and manufacturing sector output in Nigeria, monetary authorities should maintain stability of the exchange rates through proper management so as to encourage local production. Further considering the direction of effect, the regressors had on the dependent variable, it is recommended that monetary authorities manage official and parallel market exchange rate in such a way that changes in official exchange rate will decrease by 1% in order to increase manufacturing sector output by 40%. In line with the analysis, monetary authorities in Nigeria should further changes in parallel exchange rate will decrease by 1% in order to boost manufacturing sector output by 12%. The government must continue to discourage importation in order to maintain exchange rate stability with zero tolerance on illegal importation. Lastly, The Nigerian government should formulate and implement policies that will widen the country's revenue base and reduce reliance on oil sector for exchange earnings.

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