EXPLORING THE NEXUS BETWEEN EXCHANGE RATE VOLATILITY AND MANUFACTURING SECTOR OUTPUT IN NIGERIA: A QUANTITATIVE ANALYSIS

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ABSTRACT

This study examined the impact of exchange rate volatility on the manufacturing sector output between 1980 and 2021. The manufacturing sector is one of the sectors whose success or failure depends on the stability of exchange rate. This is because its depreciation or appreciation has negative or positive repercussions on all the sectors of the economy, especially the manufacturing sector. Using the Autoregressive Distributed Lag Model, the study examined the short run and long run relationship between exchange rate volatility and manufacturing sector output in Nigeria. The estimated results revealed that exchange rate volatility had negative and statistically significant impact on manufacturing sector output in Nigeria. The study concluded that exchange rate volatility has negative impact on manufacturing sector output in Nigeria due to the dependence of the manufacturing sector on imported raw materials and machines. The study, therefore, recommended amongst others that manufacturers should explore diversifying their sources of inputs to include a mixture of local content which can help reduce vulnerability to currency fluctuations and enhance stability in the production process. This could help mitigate the negative effects and enhance the resilience of the manufacturing sector.

Keywords: Nigeria; exchange rate volatility; manufacturing sector
JEL Classification: F31, N67, O14, O24

INTRODUCTION

Exchange rate plays a crucial role in international economic transactions because no nation can afford to close its border and forfeit the benefits from external factor endowments without its consequences (Ismaila, 2016). Exchange rate, therefore, remains one of the important macroeconomic variables and stabilization tools to be managed carefully by the monetary authority towards harnessing the gains from

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open economy as it constitutes an institutional arrangement under which nations facilitate transactions among themselves (Rasaq, 2013).

There have been significant changes in Nigeria exchange rate policy throughout the years, starting with the fixed parity with the British pound era and continuing through the oil boom of the 1970s and 1986 currency floating. The political and economic factors that shaped exchange rate policy during each of these periods had a significant impact on real income, inflation, the balance of payments, and the structural development of the economy. This summersault and inconsistency in policies and lack of continuity in exchange rate policies aggravated the unstable nature of naira rate.

Exchange rate volatility (ERV) is associated with flexible exchange rate regime where exchange rate is subject to market forces which are mostly unpredictable. It measures the degree of exchange rate changes over time and became more pronounced after the Bretton Woods agreement broke down in 1973 which led to a situation of flexible exchange rate among world currencies but became more pronounced in Nigeria since the adoption of SAP till date (Opaluwa, Umeh & Ameh, 2010). Ever since the adoption of SAP, naira exchange rate to the US dollars has steadily and consistently remained unstable. The nominal exchange rate in Nigeria against the US dollar ranges between ₦1.75 in 1986 and ₦358.81 in 2020 with notable depreciation experienced in 1999, 2009 and 2015. The real exchange rate (RER) ranges between ₦0.03 in 1986 and ₦117.52 in 2020 (WDI, 2020). This huge gap in exchange rate within this period has adverse implication on the cost of imported materials and would even pose more adverse effect if the unpredictable movement is unabated. Owolabi and Adegbite (2013) and CBN (2020), for instance, reported that manufacturing companies in Nigeria are operating below 40 percent capacity partly because of uncertain movement in exchange rate adding that most manufacturing companies are import dependent, while others (Opaluwa, Umeh & Ameh, 2010; Adenekan, Sanni & Otodo, 2019) assert that this exchange rate movement and the continuous depreciation on Naira has led to a fall in living standards, widespread unemployment and increase in cost of production, thus contributing to cost push inflation.

The manufacturing sector in Nigeria has over several decades exhibited low-capacity utilization and this has led to the low contribution to Gross Domestic Product (Ojo, 1998). The low level of capacity utilization has also led to low level of manufacturing output and development which has over the years been attributed to over dependence on the external sector for the importation of most of the inputs required for the manufacturing in the sector (Okigbo, 1993). Importation of inputs was also affected by the scarcity of foreign exchange which had over the years resulted in low productivity in the manufacturing sector. The introduction of

Structural Adjustment Programme (SAP) created a challenge for the sector, most especially the deregulation of exchange rate. The deregulation consequently led to unstable and rising exchange rates over the years (Ochei, Areghan and Tochukwu, 2016). The ability of the manufacturing sector to import input materials depended on the level of the exchange rates. It is evident that most manufacturing sector firms in Nigeria source their inputs externally. Hence, the devaluation or depreciation of exchange rate tends to hinder the performance of the sector (Nsofo, Takson & Ugwuegbe, 2017).

Although there have been studies on the exchange rate-manufacturing sector nexus in Nigeria, the studies have shown mixed results regarding the impact of exchange rate volatility on Nigeria's manufacturing sector output. It is against this backdrop that this study examines the nexus between exchange rate volatility and manufacturing sector output in Nigeria.

LITERATURE REVIEW

Conceptual Review

Exchange rate has been defined by various scholars. According to Mordi (2006), exchange rate is defined as the price of one currency in terms of another. Fahrettin (2001) asserted that an exchange rate is a price of one country's currency in terms of another's, it is among the most important prices in an open economy. It influences the flow of goods, services, and capital in a country, and exerts strong pressure on the balance of payments, inflation and other macroeconomic variables. Therefore, the choice and management of an exchange rate regime is a critical aspect of economic management to safeguard competitiveness, macroeconomic stability, and growth.

Manufacturing sector refers to the numerous industries which are involved in the production/manufacturing and processing of items and indulge in either creation of new commodities or in value addition (Adebayo, 2010). To Dickson (2010), manufacturing sector accounts for a significant share of the industrial sector in developed countries. The final products can either serve as finished goods for sale to customers or as intermediate goods used in the production process.

Theoretical Review

This study is anchored on the Mundell–Fleming model. The Mundell–Fleming model, also known as the IS–LM–BoP model, was first developed by Robert Mundell and Marcus Fleming in the early 1960s. The model is an extension of the IS–LM model. The Mundell–Fleming model describes the short run relationship between an open economy's nominal exchange rate, interest rate, and output (in contrast to the closed-economy IS–LM model, which focuses only on the relationship between the interest rate and output). The Mundell–Fleming model has been used to argue that an economy cannot simultaneously maintain a fixed exchange rate, free capital movement, and an independent monetary policy. An economy can only maintain two of the three at the same time. The model shows that the effectiveness of national macroeconomic policy depends on the exchange rate system. This is because in open economy the real exchange rate influences net export and thus income and output.

Empirical Review

Some empirical studies have been conducted to ascertain the impact of exchange rate volatility on the manufacturing sector output. Ihezie (2022) studied the impact of exchange rate volatility on manufacturing output in the Economic Community of West African States (ECOWAS) region, using time series data spanning from 1970 to 2019. Using Panel fixed and random effect models to assess the magnitude of the effects of exchange rate volatility on manufacturing output in ECOWAS, the results revealed that exchange rate volatility has a positive and significant impact on manufacturing output in ECOWAS. Krotamunobaromi, Akani and Nwosu (2020) also investigated the relationship between exchange rate volatility and manufacturing sector output in Nigeria. Using secondary data, the study adopted Ordinary Least Squares model to analyse the relationship between exchange rate volatility and manufacturing sector output and the result revealed that official exchange rate volatility has a negative relationship with manufacturing output, while parallel exchange rate volatility has a positive relationship with manufacturing sector output in Nigeria.

Similarly, Tams-Alasia, Olokoyo and Okoye (2018) examined the impact of exchange rate deregulation on manufacturing output performance in Nigeria over the period 1980 to 2016. Employing the Granger causality test and Error Correction Model, the study found that the exchange rate has no significant long run effect on manufacturing industry output. However, a unidirectional causality was found between the exchange rate and manufacturing output, with causation running from exchange rate to manufacturing output. Again, Yelwa and Kazeem (2019) investigated the effect of exchange rate volatility on manufacturing output using secondary quarterly data from 1986:1 to 2016:4. Using Autoregressive Distributed Lag (ARDL) model to test for the long run relationship among the variables, the result revealed that exchange rate volatilities have a negative and insignificant impact on manufacturing output. George-Anokwuru, Obayori and Oriji (2018) examined the impact of exchange rate on manufacturing sector output in Nigeria. Using error correction model (ECM) as the main technique of analysis, the result showed that the performance of the manufacturing sector output over the study period is a reflection of unstable exchange rates and high interest rates.

METHODOLOGY

Research Design

This study is designed to explore empirically, the nexus between exchange rate and manufacturing sector output in Nigeria. The research is necessitated by the dwindling performance of the manufacturing sector over the years, and the recent agitation to make the manufacturing sector one of the key driving sectors of the economy as a result of the call to diversify the economy. The study adopted causal research design, also called the explanatory research design. The study made use of information from the Central Bank of Nigeria (CBN) Statistical Bulletin for data collection.

Model Specifications

To achieve the objectives of this study, the model of Ayobami (2019) was adapted for this study with modifications. The model of Ayobami (2019) which expressed manufacturing output as a function of exchange rate, exchange rate volatility, interest rate, inflation, import and gross capital formation was modified by first dropping exchange rate variable from the model. This is because, using exchange rate and exchange rate volatility which are derived from exchange rate in the same model is most likely to lead to the problem of multicollinearity. Further, the study incorporated government funding of manufacturing sector in the model to account for the several interventions made by the government in the time past to boost manufacturing sector output. Therefore, the mathematical/functional forms of the models for this study are stated as:

$$MANopt \ = \ f \ (EXRV, GFMS, INTR, IMP) \tag{1}$$

The econometrics form of equation one can thus be written as

$$MANopt_t = \alpha_0 + \alpha_1 EXRV_t + \alpha_2 GFMS_t + \alpha_3 INTR_t + \alpha_4 IMP_t + \varepsilon_t \tag{2}$$

Where $MANopt$ = manufacturing sector output; $EXRV$ = exchange rate volatility; $GFMS$ = government funding of manufacturing sector; $INTR$ = interest rate; IMP = manufacturing import; α_0 = the constant or intercept terms; $\alpha_1 - \alpha_4$ = are the parameter estimates and ε_t = the error or disturbance terms.

The logarithm transformation for equation (2) becomes:

$$lnMANopt_t = \alpha_0 + \alpha_1 lnEXRV_t + \alpha_2 lnGFMS_t + \alpha_3 lnINTR_t + \alpha_4 lnIMP_t + \varepsilon_t \tag{3}$$

Where ln represents the natural logarithm of the variables. It is worth noting that in equation (3), rates are not being expressed in log form.

Method of Data Analysis

Apart from using table for data presentation and illustration, the following econometric techniques were used in analysing the data.

Unit Root Test

Unit Root Test of Stationarity is aimed at determining whether the variables have dependable means and variances. The testing procedure for the unit root test in this study followed the Zivot-Andrews' process. The choice of the Zivot-Andrews' test was based on the fact that conventional unit root tests, such as the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP) and the KPSS tests, tend to provide spurious results due to their inadequacy in accommodating information about structural breaks in the series, which tend to lower their predictive power.

Autoregressive Distributed Lag (ARDL)

This study made use of the autoregressive distributed lag and bound test of co-integration to determine the long run relationship between the variables. This test for co-integration was developed by Pesaran *et al.* (2001). ARDL cointegration technique does not require pretests for unit roots unlike other techniques. Consequently, ARDL cointegration technique is preferable when dealing with variables that are integrated of different orders, I(0), I(1) or mixture of both and, robust when there is a single long run relationship between the underlying variables in a small sample. The autoregressive distributed lag (ARDL) method does not require the unit root test of stationarity, but to avoid ARDL model crash in the presence of variables that are stationary at second difference, the unit root test was carried out to determine the number of unit root in series of co-integration. The long run relationship of the underlying variables is detected through the F-statistic (Wald test). In this approach, long run relationship of the series is said to be established when the F-statistic exceeds the critical value bond (Nkoro & Uko, 2016).

To ascertain the co-integration between the variables, equation (2) can therefore be expressed as an ARDL model thus

$$\begin{aligned} \Delta MANopt_t = {} & \alpha_0 + \alpha_1 MANopt_{t-1} + \alpha_2 EXRV_{t-1} + \alpha_3 GFMS_{t-1} + \alpha_4 INTR_{t-1} \\ & + \alpha_5 IMP_{t-1} + \sum_{i=0}^{q} \alpha_6 \Delta MANopt_{t-1} + \sum_{i=0}^{q} \alpha_7 \Delta EXRV_{t-1} \\ & + \sum_{i=0}^{q} \alpha_8 \Delta GFMS_{t-1} + \sum_{i=0}^{q} \alpha_9 \Delta INTR_{t-1} + \sum_{i=0}^{q} \alpha_{10} \Delta IMP_{t-1} \\ & + \lambda ECM_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

The null hypothesis of no long run relationship is tested using the F-test on ($H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$) against ($H_0: \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$). If the computed F-test exceeds the upper critical bounds value, then H_0 is rejected, signalling cointegration amongst the different variables. If the computed F-value is below the critical bound, we fail to reject H_0. But if the computed F-value falls within the critical value bound, the result is inconclusive (Moslares & Ekanyake, 2015). If these series are found to be co-integrated, an unrestricted error correction version of the corresponding ARDL model can be estimated to trace the short-term dynamics of the model (Wool & Baharumshah, 2010). The reparametrized result gives the short run dynamics and long run relationship of the underlying variables. Consequently, the error correction model is therefore presented as follows:

$$\Delta lnMANopt_t = \emptyset_0 + \sum_{i=1}^{m} \beta_i \Delta lnMANopt_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta X_{t-j} + \varphi ECM_{t-1} + \varepsilon_t \quad (5)$$

Where X is a vector of the explanatory variables in the model, i and j are the optimal lags of the dependent and explanatory variables respectively, φ is the error correction mechanism which is expected to be negative and statistically significant for adjustment to long run equilibrium to be feasible, and ε is the error term.

Data Sources

The data used for this study were obtained from secondary sources constituting the Central Bank of Nigeria statistical bulletin and the World Development Indicators. The data which are time series in nature covered the period of 1981 through 2021.

RESULTS AND DISCUSSION

Results

Zivot-Andrews Unit Root Test with Structural Breaks

Since this study is utilizing time series variables, it becomes pertinent to ascertain whether the variables are influenced by time. In this regard, it is relevant to ascertain the stationarity of the time series variables before they could be used for analysis. This leads to the test for the existence of unit root among the variables. The test for unit root was conducted based on the Zivot-Andrews unit root test approach and presented in Table 1.

The result of the unit root test as portrayed in Table 1 reflects that the variables are stationary in mixed order. The mixed order of integration of the variables further justified the choice of the ARDL technique in estimating the relationships.

Table 1: Results of Zivot Andrews (ZA) Unit Root Test with Structural Breaks

Variable	ZA Test @ level		ZA Test @ first difference	
	ZA Statistic	*Break Point*	*ZA Statistic*	*Break Point*
MANopt	-3.9855 (2)	1993	-5.2914 (2)**	1993
EXRV	-2.1758 (2)	2005	-5.2745 (2)**	2005
GFMS	-6.1252 (2)**	2004	-7.4864 (2)**	2002
INTR	-11.0997 (2)**	2005	-6.8850 (2)**	1996
IMP	-3.2403 (2)	1993	-6.4099 (2)**	1998
Sig. Level	**Crit. Values**			
1%	-5.34		-5.34	
5%	-4.93		-4.93	
10%	-4.58		-4.58	

*Note: Values in parenthesis are the lag length of variables, ** denote rejection of null hypothesis 5% level. Reject the null hypotheses of unit root when the test statistics is greater than the critical value in absolute terms.*

ARDL Bounds Cointegration Analysis

Given that some of our variables are stationary at first difference while others are stationary at level, it becomes pertinent to ascertain whether their linear combinations could yield some long run relationship. Given the mixed order of integration so observed, the appropriate test for cointegration to utilize is the autoregressive distributes lag (ARDL) bounds test. The test is conducted using the F-statistic, and it is required that the F-statistic must lie outside the 5% upper and lower bounds for cointegration to exist.

Table 2: Cointegration Test using ARDL Bounds Test

ARDL Bounds Test (F-STATISTICS)			
Estimated Model	**F-statistic**		**Conclusion**
$MANopt = f(EXRV, GFMS, INTR, IMP)$	5.3890**		Cointegrated
Critical Values	**Lower Bound**	**Upper Bound**	
10%	2.20	3.09	
5%	5.56	3.49	
1%	3.29	4.37	

*Note: I(0) and I(1) denote lower and upper bounds of the ARDL bounds test respectively. ** & *** shows statistical significance at 5% level & 10% level, respectively.*

The result of the test as captured in Table 2 revealed that the F-statistic for the model is 5.3890. This is greater than the upper bound I(1) bound value of 3.49 at the 5% significance level. Hence, we reject the null hypothesis of no cointegration and conclude that there was cointegration or a long-term relationship among the variables. The existence of the long run relationship in the model was a pointer for the estimation of both the short run and the long run models to see how the independent variables would interact to affect manufacturing sector output.

Model Estimation

The fact that there exists a levels relationship among the variables in the model signals the need for the estimation of the ARDL model for the study to check how short run distortions could be corrected in the long run; and then to see the nature of the long run behaviours of the variables in influencing the dependent variable. The results are shown in Table 3.

Table 3: Results of the Short and Long run ARDL Estimates (Manufacturing Output Model)

	Coefficient	Std. Error	t-Statistic	Prob.
Long Run Equation				
EXRV	-0.586677	0.225916	-2.596878	0.0158
GFMS	0.377613	0.093078	4.056948	0.0005
INTR	-0.024491	0.010007	-2.447330	0.0221
IMP	0.822585	0.169441	4.854691	0.0001
C	0.708462	1.490944	0.475177	0.6390
Short Run Equation				
D(EXRV)	-0.034481	0.032211	-1.070451	0.2951
D(EXRV(-1))	-0.114909	0.035541	-3.233162	0.0035
D(EXRV(-2))	-0.142075	0.035376	-4.016185	0.0005
D(EXRV(-3))	-0.080616	0.034530	-2.334696	0.0283
D(GFMS)	0.085824	0.021682	3.958300	0.0006
D(GFMS(-1))	0.023333	0.020042	1.164195	0.2558
D(GFMS(-2))	0.062543	0.019181	3.260698	0.0033
INTR	0.006718	0.002888	2.326114	0.0288
IMP	0.225650	0.049305	4.576586	0.0001
ECM(-1)	-0.274318	0.043886	-6.250638	0.0000
R-Squared	0.618686	S.D. dependent var		0.095690
Adjusted R^2	0.526645	Akaike info criterion		-2.414508
S.E. of regression	0.065835	Durbin-Watson stat		2.207487

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels respectively

The evidence from Table 3 revealed that exchange rate volatility ($EXRV$) and interest rate ($INTR$) had negative and statistically significant effect on manufacturing output in the long run. It implies that a 1% increase in $EXRV$ led to a decrease in manufacturing output by 0.5867 percent, and an increase in $INTR$ caused a marginal decrease in manufacturing output by 0.02449 percent. Both variables had p-values of 0.0158 and 0.0221 respectively, which were all less than 0.05 level of significance, implying that they were statistically significant at 5% level.

On the other hand, the result showed that government funding of manufacturing sector ($GFMS$) and imports (IMP) had positive and statistically significant impact on the manufacturing output in Nigeria during the period under study. It implies that a 1% increase in $GFMS$ and IMP led to increase in manufacturing output by 0.3776 percent and 0.8226 percent respectively. Both variables had p-values of less than 0.05 which indicated statistical significance at 5% level. The positive and significant effect of $GFMS$ on manufacturing output is theoretically plausible because, the necessary infrastructure such as electricity, access roads and loans to the sector have to be in place for manufacturing activities to flourish. The positive impact of imports is however contrary to economic expectations, but can be justified on the basis that, most of the inputs used in the sector were imported, therefore, an increase in such imports led to increase in the output in the long run.

The adjusted R^2 value of 0.526645 suggested that about 52.66% of the variations or changes in the manufacturing output in Nigeria were explained by the independent variables. Furthermore, the error correction model – ECM (-1) – which indicates the speed of adjustment to the equilibrium in the event of disequilibrium was -0.274318 and negative and statistically significant as required. The implication of this finding is that in the event of disequilibrium, the short run disequilibrium will have a slow speed of adjustment (27%) back to equilibrium.

Discussions of Findings

The objective of this study was to evaluate the impact of exchange rate volatility on manufacturing sector output in Nigeria. The results revealed that the coefficient of exchange rate volatility was negative and statistically significant. This implies that there is a negative or inverse relationship between exchange rate volatility and manufacturing sector output in Nigeria. Going by its coefficient, 1% increase in exchange rate volatility will bring about a 58.67% decrease in manufacturing sector output in Nigeria. As revealed by the result, the probability value of $EXRV$ (0.0158) is significant at 5%. It is on this basis that the study concluded that exchange rate volatility has been a significant variable that has negatively impacted on the Nigerian manufacturing sector and the economy at large over the period of study.

This finding aligned with a priori expectation as it conformed to the findings of Krotamunobaromi, Akani and Nwosu (2020) and Yelwa and Kazeem (2019). On the other hand, the findings of the study disagreed with the studies of Ihezie (2022), which found a positive impact of exchange rate volatility on manufacturing output. The implication of this in the Nigerian context is based on the fact that an increasing exchange rate volatility through the period of study has brought about decreased manufacturing sector output. Also, the negative and significant effects of exchange rate volatility on manufacturing output were expected because the manufacturing activities in Nigeria depend on the use of foreign intermediate goods, where an increase in exchange rate volatility increases the production cost of the manufacturing firms in Nigeria, thereby reducing the manufacturing sector output produced within the study period.

CONCLUSION AND RECOMMENDATIONS

The study investigated the impact of exchange rate volatility on manufacturing sector output in Nigeria covering the period from 1981 to 2021. The unit root properties of the variables were tested using the Zivot-Andrews test for stationarity. The autoregressive distributes lag (ARDL) bounds test was applied, which confirmed cointegration among the model variables. Further, the study applied the ARDL model to investigate the long run and short run relationship between exchange rates volatility and manufacturing sector output. Based on the findings of this study, it was concluded that there exists a negative relationship between exchange rate volatility and manufacturing sector output. Based on the findings, the study made the following recommendations:

1. Manufacturers should explore diversifying their sources of inputs to include a mixture of local content. Diversifying the sources of raw materials and intermediate goods in the production process can help reduce vulnerability to currency fluctuations and enhance stability in the production process. This could help mitigate the negative effects and enhance the resilience of the manufacturing sector.

2. Furthermore, structural reforms by government such as the former structural Adjustment Programme (SAP) that come with exchange rate devaluation should be avoided, as these have negative effects on manufacturing sector output. Instead, policy tools such as interest rates and reserve requirements should be implemented to manage the money supply and inflation, which can help stabilize the exchange rate to enable local manufacturers to afford the imports of raw materials and capital goods, given the current import-dependent nature of the sector.

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