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Exchange rate fluctuations and manufacturing output: Stylized evidence in Nigeria

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Abstract. One of the key engines of growth in many countries is the manufacturing sector, whose performance is impacted by the movement of the local currency. The manufacturing sector also offers opportunities like increased commerce, innovation, competitiveness, increasing exports, and productivity, which will only be possible when exchange rate is in the form of currency appreciation. The purpose of this study, therefore, was to investigate the effect of exchange rate fluctuations on Nigerian manufacturing output. The Generalized Autoregressive Conditional Heteroscedasticity technique was used in the study in order to examine the exchange rate oscillations. The result of the model estimation revealed that there is no persistence of shocks in the volatility of the exchange rate in the Nigerian economy. The business cycle stylized facts were also used to examine exchange rate volatility and the result established that exchange rate is highly volatile and has a negative effect on manufacturing output in Nigeria. The Auto Regressive Distributed Lag Bounds test was used to establish the long-run relationship and the result showed that there is a long-run relationship between exchange rate and manufacturing output. The variance decomposition and Impulse Response function were employed and the result

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revealed that exchange rate fluctuation has a negative impact on manufacturing gross domestic product in Nigeria. In practice, based on the results of the study, it can be recommended to the monetary authorities to constantly monitor the exchange rate fluctuations in order to create policies that are well-informed and match the exchange rate to the actual needs of manufacturing sector in order to boost its output

Keywords: generalized autoregressive conditional heteroscedasticity; Hodrick-Prescott filter; volatility; business cycle; consumer price index

INTRODUCTION

One of the major constraints on the overall development of an economy is exchange rate fluctuation because it makes planning more problematic and difficult and investment becomes riskier. Exchange rate is the value of one currency in relation to another. It is the price of the currency of one country in terms of another currency that a country uses in determining its level of economic performance (Onabote *et al.*, 2021). Exchange rate is significant because it bridges the gap between domestic and foreign prices. There is a high demand for foreign exchange in Nigeria, with a high import rate of raw materials and capital goods from the manufacturing sector. Thus, shocks to Nigerian exchange rates will have a wide range of effects on manufacturing sector (Areghan *et al.*, 2018). Exchange rate fluctuations impact the production level of manufacturing firms through trade channel effects and variations in the prices of inputs and outputs. In the words of R.O. Akeem (2019) increasing manufacturing sector performances have a positive impact on a country's economy. That is not the case in Nigeria because the inability to import due to currency depreciation has negative impacts on manufacturing production (Tams-Alasia *et al.*, 2018).

Statistics shows that Nigeria's exchange rate has been depreciating consistently (World Bank data, n.d.). Recently, CBN (Central Bank of Nigeria) recorded Nigeria exchange rate as $1: ₦460.6 (Exchange rate archives, 2023). This gave clear evidence of the country's exchange rate swings, which are observable in the increase in cost of production for manufacturers. Several programs have been adopted to reduce the continuous fluctuating exchange rate. Some of these programs are: exchange rate targeting, independent exchange rate management, Second-tier Foreign Exchange Market, Pro-rata System of foreign exchange allocation, Wholesale Dutch Auction System and New Flexible Exchange Rate Policy. Unfortunately, despite all these, exchange rate fluctuation and naira devaluation are still major problems in Nigeria (Sunday & Olajide, 2018). As a result, these movements have generally hindered the performance of the manufacturing sector (Orji *et al.*, 2018).

The economic effects of exchange rate fluctuation have been a focus of several authors. O. Tams-Alasia *et al*. (2018) investigated the impact of exchange rate deregulation on Nigerian manufacturing output performance. Using the ARDL (Auto-regressive distributed lag) they found out that there is no significant positive long-run effect on manufacturing industry output. Alternatively, A.J. Falaye *et al*. (2019) examined the relationship between Naira depreciation and manufacturing output using Johansen co-integration test. They discover that depreciation of Naira will be detrimental to Nigeria's manufacturing sector's performance. E. Buabeng *et al*. (2019) examined the impact of exchange rate fluctuations on the performance of Ghanaian manufacturing firms. The limits test approach to cointegration was adopted, and they found out that the performance of manufacturing firms is negatively and significantly linked to the exchange rate. Similarly, C. Mlambo (2020) examined how exchange rate affected manufacturing performance in Southern African Customs Union countries. The study used the FMOLS (fully modified ordinary least squares) and PMG (pooled mean group) panel group methods to analyse data. They find out that manufacturing performance was positively correlated with exports and inflation.

The macroeconomic effects of exchange rate fluctuations on Nigeria's manufacturing sector performance was examined by A.N. Amadi *et al*. (2018). Using the vector auto regression estimate method and GARCH (Generalised Autoregressive Conditional Heteroscedasticity) to estimate exchange rate volatility, they found that exchange rate fluctuations limit the performance of Nigeria's manufacturing sector and thus have a significant macroeconomic impact on the industry. Similarly, N.J. Okoye *et al*. (2021) examined the link between exchange rate oscillation and government spending in Nigeria. The study adopted the Mundell-Fleming model and descriptive statistics. They find that both capital and recurrent expenditures have no significant effect on exchange rate in Nigeria. N. Ali (2020) examined the impact of exchange rate fluctuations on manufacturing performance in Nigeria using the ARDL approach. The study's revealed that exchange rate fluctuation has a negative impact on the performance of the Nigerian manufacturing sector. Contrarily, O.T. Ayobami (2019) used an ARDL estimate technique to investigate the impact of exchange rate volatility on the performance of Nigeria's manufacturing sector. The author found that exchange rates have a positive but insignificant effect on manufacturing sector output in the long run, but a negative significant effect in the short run.

Despite several research works carried out on exchange rate fluctuations and their numerous effects on various macroeconomic variables, not much attention is given to its effect on manufacturing output using the GARCH method and the Hodrick-Prescott filtering approach. Thus, this study uses these techniques to investigate the impact of exchange rate fluctuations on manufacturing output in Nigeria.

MATERIALS AND METHODS

This study adopted Lewis Authur's structural change theory. The theory comprises the traditional- subsistence division and the modern-manufacturing segment. The hypothesis is that the overall improvement of an economy is subject to the development of two segments. This can be stated as:

$$Y = f(A, M), \quad (1)$$

where Y_t is Economic Development; A_t is Agricultural Sector; M_t is the Manufacturing Sector. Equation 1 can be explicitly stated as:

$$Y_t = a_0 + \sum b_i A_i + b_2 M_i + \varepsilon_t, \quad (2)$$

where Y_t is the output at time t, a_0 is the intercept, ε_t is the error term, b_1 and b_2 are the coefficients of independent variables.

$$MGDP_t = f(EXCH_t, INT_t, CPI_t, MCU_t, MCAP_t). \quad (3)$$

The economic relationship can be specified in a linear form as:

$$MGDP_t = \beta_0 + \beta_1 EXCH_t + \beta_2 INT_t + \beta_3 CPI_t + \\ + \beta_4 MCU_t + \beta_5 MCAP_t + \varepsilon_t. \quad (4)$$

Stating equation 4 in log form:

$$L\_MGDP_t = L\_\beta_0 + \beta_1 L\_EXCH_t + \beta_2 L\_INT_t + \\ + \beta_3 L\_CPI_t + \beta_4 L\_MCU_t + \beta_5 L\_MCAP_t + \varepsilon_t, \quad (5)$$

where $MGDP_t$ is Manufacturing Gross Domestic Product at time t, $EXCH$ is Exchange Rate at time t; MCU_t is Manufacturing Capacity Utilization at time t, $MCAP_t$ is Manufacturing Capital at time t; INT_t is Interest rate at time t, and CPI_t is Consumer Price Index at time t; μ_t is Error term at time t, β_0-β_5 are coefficient of the independent variables. The data used in this research are secondary time series annual data for the period of 1981-2022, and Eviews 9 (n.d.) was used for analysing the results. Table 1 describes the sources of data used in this study.

Table 1. Data sources and descriptions

Variables	Symbol	Description	Source	Measurement
Manufacturing Output	MGDP	Manufacturing Gross Domestic Product in Nigeria.	WDI	Manufacturing Output (% of GDP)
Exchange Rate	EXR	Nigerian Naira Exchange rate to Dollar.	WDI	Local Currency per US$
Manufacturing Capital	MCAP	Domestic Credit to the private sector.	WDI	Domestic credit to the private sector (% of GDP)
Manufacturing Capacity Utilization	MCU	Rate at which a firm employs its installed productive capacity.	CBN Bulletin	Average Manufacturing Capacity Utilisation (%)
Consumer Price Index	CPI	The yearly percentage change in the cost for an average consumer is measured by the consumer price index.	WDI	Inflation, consumer prices (annual %)
Interest rate	INT	The lending rate is adjusted for inflation using the GDP deflator to determine the real interest rate.	WDI	Real interest rate (%)

Source: compiled by the authors

Most time series data are typically non-stationary at the level of form, employing such series could produce spurious results. Therefore, it is crucial to verify stationarity before performing analysis on time series variables. In this work, the existence of a unit root (or non-stationarity) existence was investigated using the Augmented Dickey-Fuller (ADF) test. The ADF regression equation is as follows:

$$\Delta Y_t = \sigma_0 + \sigma_t \delta Y_{t-1} + \rho + \sum_{j=1}^{n} \delta_j \Delta Y_{t-k} + \varepsilon_t, \quad (6)$$

where Y_t is the time series, Δ is the first difference operator, ρ is the linear trend, σ_0 is a constant, and ε_t is the error term. If the null hypothesis is not accepted, then the variables are differenced. The series could therefore be integrated of order 1.

This study used the GARCH (1, 1) Model to determine the volatility of the naira exchange rate for the period considered. The GARCH model was selected because it excels at modelling the fluctuation of financial data. In line with B. Almisshal & M. Emir (2021) this study's GARCH (1,1) Model is specified as follow:

$$\varphi_t^2 = \alpha_0 + \beta_1 \gamma_{t-1}^2 + \delta_1 \varphi_{t-1}^2, \quad (7)$$

where φ_t^2 is the conditional variance. To ensure a positive variance in every situation the following restrictions are put in place: $\alpha_0 > 0$, and $\beta_1, \delta_1 \geq 0$.

As opposed to other cointegration methods like S. Johansen (1991), R.F. Engle & C.W.J. Granger (1987), this study used the ARDL because: (i) it can be used regardless of the regressor's order (ii) models allow different optimal lags for distinct variables, (iii) it uses a single reduced form equation to analyse the long-run and short-run relationships between variables (Lawal *et al.*, 2018; Popoola *et al.*, 2018). The ARDL framework for this study is as follow:

$$\Delta lnMGDP_t = \sigma_0 + \sigma_1 lnMGDP_{t-1} + \sigma_2 lnEXCH + \sigma_3 lnINT_{t-1} + \\ + \sigma_4 lnCPI_{t-1} + \sigma_5 lnMCU_{t-1} + \sigma_6 lnMCAP_{t-1} + \sum_{i=1}^{n1} \beta_{11} \Delta lnMGDP_{t-1} + \\ + \sum_{i=1}^{n2} \beta_{12} \Delta lnEXCH_{t-1} + \sum_{i=1}^{n3} \beta_{13} \Delta lnINT_{t-1} + \sum_{i=1}^{n4} \beta_{14} \Delta lnCPI_{t-1} + \\ + \sum_{i=1}^{n5} \beta_{15} \Delta lnMCU_{t-1} + \sum_{i=1}^{n6} \beta_{16} \Delta lnMCAP_{t-1} + \varepsilon_t, \quad (8)$$

where σ_0 is the constant terms, Δ is the first difference operator, σ_1 to σ_6 represent the long run coefficients, while the β_{11} to β_{16} represent the short- run coefficients, $n1$ to $n6$ represent the lag length and ε_t is the error term. The following criteria are used to determine whether to accept or reject the null hypothesis that there is no co-integration between the variables: (i) H_0 is rejected if F- Statistics (Fs) > upper bond, meaning that the variables are co-integrated; (ii) we accept H_0 if F statistics is less than the lower bound, this implies that all variables are not co-integrated; (iii) however, if F s ⩾ lower bound and ⩽ upper bound, the result is ambiguous under this circumstance and the decision is inconclusive.

The variance decomposition was used to show the amount of movement in the dependent variables caused by their own shocks versus the shocks of the independent variable. It establishes the amount of the forecast error variance for each variable that exogenous shocks to the other variables can account for. This impulse response function was also adopted to depict how a change in the

dependent variable in a system influences the time course of another. The impulse response study measures the response of each dependent variable in the model to an exogenous shock. The diagnostic checks on the estimated outcomes were performed to determine if the models are properly specified. The residual's series must be normally distributed, not serially correlated, and homoscedastic in order for a model to be adequately defined (Asaleye *et al*., 2018). After the model estimation in the following section, the diagnostic checks are discussed.

RESULTS AND DISCUSSION

The value of a country's currency determines whether foreigners will invest in such economy or not. In the face of currency depreciation, foreign investment will be low, hence, the monetary authorities will be forced to increase interest rate in order to encourage foreign investors, since the return from their investment will be higher. However, increasing interest rate is a hinderance to Nigeria's manufacturing firms that intend borrowing money for capital to carry out productive activities. The concept of exchange rate fluctuations and manufacturing output in Figure 1 demonstrates the linkage between these two macroeconomic variables as they are very crucial for economic growth and development. Insufficient capital will have adverse effect on the firm's levels of capacity utilization and productivity, as the firms will not be able to cover their costs and expenses.

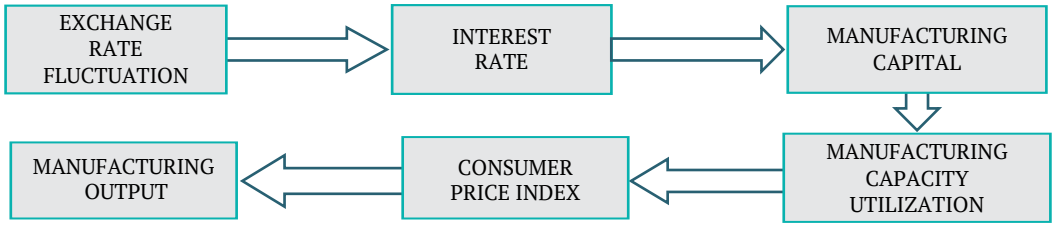

Figure 1. A conceptual framework on the relationship and linkages between Exchange Rate Fluctuations and Manufacturing Output

Source: made by the authors

The resultant effect of this will be borne by the consumers through the prices of goods and services produced by these firms. Following a fundamental principle of human behaviour, increasing prices of goods and services will make the consumers reduce their demand for the goods produced by these firms, and this is expected to have a negative effect of the firms' output, as they will be discouraged to produce in larger quantities since demand does not match up with their supplies. Hence, it is evident that exchange rate is important in the economy because of its impact on the prices of goods and services, resource allocation and investment decisions (Ehikioya, 2019). The macroeconomic variables discussed in these frameworks makes up the analytical result of this study below. Table 2 below shows the result from the ADF unit root test using trend and intercept for trend specification. The null assumption indicates that at 5% significance level the series is not stationary.

Table 2. Unit root test

Variables	ADF test		Critical Value		Interpretation
	LEVEL	1st Diff	1%	5%	
L_EXCH	1.521013	4.665964	4.110394	3.561159	I(1)
L_MGDP	0.649622	4.578760	4.110394	3.561159	I(1)
L_CPI	4.104288	-	4.110394	3.561159	I(0)
INT	4.379287	-	4.110394	3.561159	I(0)
L_MCAP	4.167780	-	4.110394	3.561159	I(0)
L_MCU	3.226890	5.241237	4.110394	3.561159	I(1)

Source: author's computation using Eviews 9 (n.d.)

It can be concluded from the table that *L_CPI*, *INT* and *L_MCAP* were stationary at a 5% level of significance in the level form while *L_EXCH*, *L_MGDP* and *L_MCU* became stationary at the first differentiation. The "Obs*R-squared" statistics (that is, the Auto-Regressive Conditional Heteroskedasticity (*ARCH*) test of autocorrelation in the squared residuals) has a probability value of 0.0000 and is displayed in Table 3 below, with a value of 0.78815.

Table 3. ARCH effects tests result

Heteroskedasticity Test: ARCH			
F-statistic	20.79431	Prob. F (1,148)	0.0000
Obs*R-squared	0.78815	Prob. Chi-Square	0.0000

Source: author's computation using Eviews 9 (n.d.)

This blatantly implies that either ARCH effect exists or that the null hypothesis of homoscedasticity has been rejected. As the F-statistic probability value is statistically significant at the 5% level, the table also shows that the residual has the ARCH effect, indicating the rejection of the null hypothesis that there is no ARCH effect and accept the alternative hypothesis that there is ARCH effect. Given that the p-value is below the necessary threshold of 5%, this suggests the existence of an ARCH effect in the variables. This finding implies that the present exchange rate volatility relative to US dollars is influenced by the volatility of the prior period's exchange rates. This is in line with the findings of C.E. Onwuka (2021) who examined the impact of exchange rate volatility on manufacturing sector in Nigeria. The author adopted the ARCH/GARCH model to establish the extent of exchange rate volatility in Nigeria and find that exchange rates in Nigeria is highly volatile and persistent, which was validated by their coefficients, which were positive and statistically significant at 1% level. The author therefore affirmed that exchange rate volatility, if not checked, would worsen the performance of the manufacturing sector in the country. This demonstrates that the GARCH model, which was used for the current study to explain exchange rate volatility, is appropriate (Table 4).

Table 4. GARCH effect test results

Variable	Coefficient	Std. Error	z-statistics	Prob.
C	0.106637	0.000776	131.7912	0.0000
L_EXCH(-1)	0.972264	0.000115	4148.991	0.0000
Variance Equation				
C	-0.095561	7.03E-06	-1.449310	0.1662
RESID(-1)^2	0.011517	0.101500	25.62961	0.0000
GARCH(-1)	-0.510442	0.006294	-0.044232	0.8557

Source: author's computation using Eviews 9 (n.d.)

Due to the probability of the value of the ARCH term being less than 0.05 (P<0.05), it is revealed that the coefficient is positive and statistically significant at the 5% level of significance, providing more proof of the volatility of the exchange rate in Nigeria. As their probability value is bigger than 0.05, the GARCH term, on the other hand, is negative and not statistically significant at the 5% level of significance. The GARCH (1,1) test result indicates that there are persistent shocks in the exchange rate volatility in the Nigerian economy. This is similar to the findings of the study by E. Adjei (2019) on exchange rate volatility and economic growth in Ghana, in which the author revealed that the coefficients of both the ARCH and GARCH are positive and close to one, implying that the volatility shocks are persistent.

A closer look at the results shows that the ARCH term's coefficient is higher than the GARCH term's, indicating that the periods under review are likely to have more extreme exchange rate volatility. The business cycle and the cyclical behaviour of the Nigerian economy in relation to exchange rate volatility and manufacturing output are reported in Table 5.

Table 5. Cyclical behaviour of MGDP and exchange rate volatility, Nigeria (1981-2022)

MGDP VOLATILITY	5.2297
MCU	**Countercyclical**
Volatility (%) Relative Volatility Contemporaneous Correlation Phase Shift	10.2241 1.80523 -0.3778 Lagging
EXCH	**Countercyclical**
Volatility (%) Relative Volatility Contemporaneous Correlation Phase Shift	94.8339 19.6749 -0.8557 Lagging
MCAP	**Countercyclical**
Volatility (%) Relative Volatility Contemporaneous Correlation Phase Shift	3.5231 0.5812 -0.8873 Lagging
INT	**Countercyclical**
Volatility (%) Relative Volatility Contemporaneous Correlation Phase Shift	15.8871 2.11710 -0.4331 Lagging
CPI	**Procyclical**
Volatility (%) Relative Volatility Contemporaneous Correlation Phase Shift	18.6654 3.11662 0.5531 Leading

Source: author's computation using Eviews 9 (n.d.)

Noting the variables measured by the percentage of standard deviation, it was observed that the volatility of manufacturing output, exchange rate, consumer price index, interest rate, manufacturing capacity utilization and market capitalization is about 5.2297%, 94.8339%, 18.6654%, 15.8871%, 10.2241% and 3.5231, respectively. This implies that exchange rate is the most volatile. According to the result of relative volatility that measures amplitude of fluctuations, market capitalization has a value less than one, implying that it is less vulnerable to macroeconomic fluctuations in comparison with other variables having their relative volatility above one. Also, among all the variables, exchange rate has the highest relative volatility (19.6749). This argument supports the findings of H. Kamalyan & V. Davtyan (2022) that high exchange rate volatility is a key driver of economic fluctuations in emerging countries. They investigated the influence of exchange rate uncertainty in business cycle fluctuations and found that while an elevated and persistent exchange rate uncertainty depresses economic activity, inflates prices and causes exchange rates to depreciate; no other known disruptions in economic literature can create these co-movement patterns amid macro variables. One economic implication of these findings is that an unstable exchange rate will worsen the performance of macroeconomic variables and exposes nations to unanticipated movements in exchange rate.

Examining the degree of contemporaneous correlation with Manufacturing output (MGDP), exchange rate has a countercyclical relationship (-0.8557) indicating that manufacturing output tends to fall during the period of negative change in exchange rate. This explains that exchange rate is highly volatile and subject to manufacturing output fluctuations in Nigeria. This finding corroborates that of C.G. Uruakpa *et al*. (2021) who examined the effects of exchange rate volatility and exchange rate movement on the performance of manufacturing firms in Nigeria, and found that appreciation of Nigeria's local currency has a positive impact on manufacturing firm's performance, whereas the effect of exchange rate volatility on manufactured output is negative and significant. This result conforms with D.H. Vo *et al*. (2019) who focused on the nexus between exchange rate volatility, exchange rate devaluation and Vietnam's manufactured export flows to her twenty-six trading partners and reveals that while Vietnam's currency depreciation enhance manufactured exports in the short run, exchange rate volatility could negate this positive effect in the long run.

Consumer price index has a procyclical relationship with manufacturing output in Nigeria. This implies that manufacturing output tends to rise as price rises. They are strongly correlated and the explanation for this could be due to a strong relationship that exists between price and output in Nigeria. This indicates that inflation contributes to the growth of manufacturing output in the country. Nevertheless, this is contrary to the study of J.W. Oduor *et al*. (2021) who verifies the implication of rising rate of inflation on Kenya's manufacturing sector growth and revealed a harmful effect of inflation on the growth of manufacturing sector in Kenya. In line with I. Bawa *et al*. (2020), J.W. Oduor *et al*. (2021) also found that increasing price level has adverse effect on manufacturing output in Nigeria. This was observed while investigating the effects of macroeconomic variables on output from the manufacturing sector. Focusing on the results of the phase shift, consumer price index is the only variable that leads the cycle of manufacturing output in Nigeria while the other macroeconomic variables are lagging the indicators over time, I. Bawa *et al*. (2020) argued.

Figure 2 depicts the actual trend and cyclical movement of Exchange Rate Fluctuation over a period of time. In the figure below, the red, green, and blue lines denote the trend, cyclical and actual series of Exchange Rate Fluctuation in Nigeria, respectively. The figure shows that there was fluctuation in Nigeria's Exchange Rate around its trend from 1994 until recently. These fluctuations led to contractions but eventually led to an expansion from 2016 upwards. Figure 3 reveals the actual trend and cyclical movement of Manufacturing Capital over a period of time. The figure below shows that there was fluctuation in Nigeria's Manufacturing Capital around its trend from 1981 until recently. These fluctuations led to the contraction in 2018.

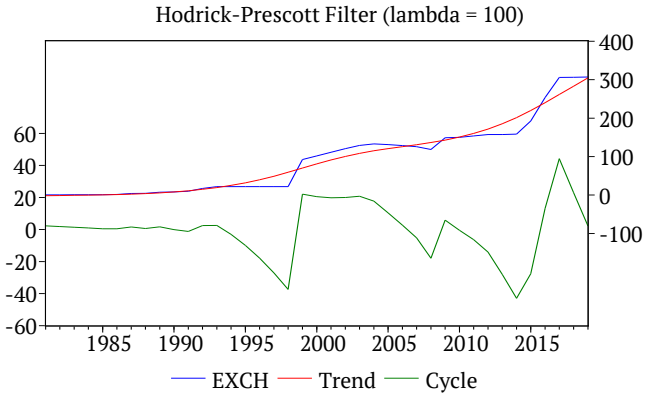

Figure 2. Exchange rate fluctuation

Source: author's computation using Eviews 9 (n.d.)

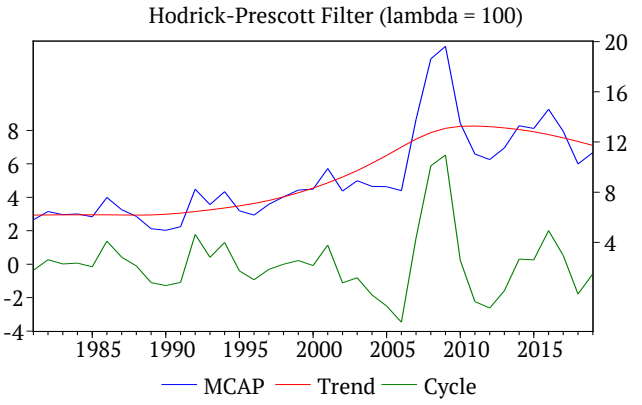

Figure 3. Manufacturing capitalization

Source: author's computation using Eviews 9 (n.d.)

Figure 4 depicts the actual trend and cyclical movement of Manufacturing Capacity Utilization over a period of time. It shows that there was fluctuation in Nigeria's Manufacturing Capacity Utilization around its trend from 1981 until recently. These fluctuations led to the contraction in 2012. Figure 5 reveals the actual trend and cyclical movement of Manufacturing Gross Domestic Product over a period of time. It shows that

there was fluctuation in Nigeria's Manufacturing Gross Domestic Product around its trend from 1983 until recently. These fluctuations led to the expansion in 2016. These findings support the study of H. Kamalyan & V. Davtyan (2022). They examine the effect of exchange rate uncertainty on business cycle fluctuations and observe that a high and persistent exchange rate uncertainty depresses economic activity, increases price level and generates exchange rate depreciation. In this view, the implication of volatile exchange rates is more severe than any other economic disruptions, H. Kamalyan & V. Davtyan (2022) argued.

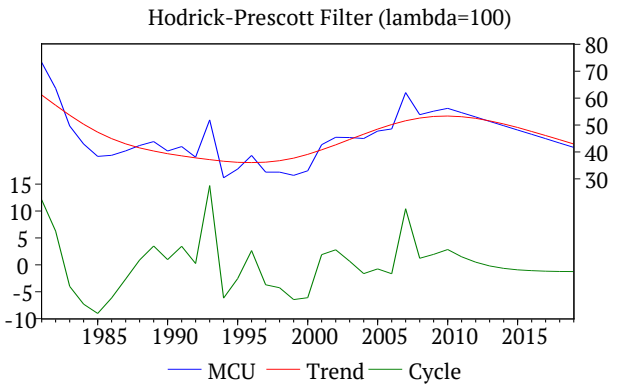

Figure 4. Manufacturing capacity utilization
Source: author's computation using Eviews 9 (n.d.)

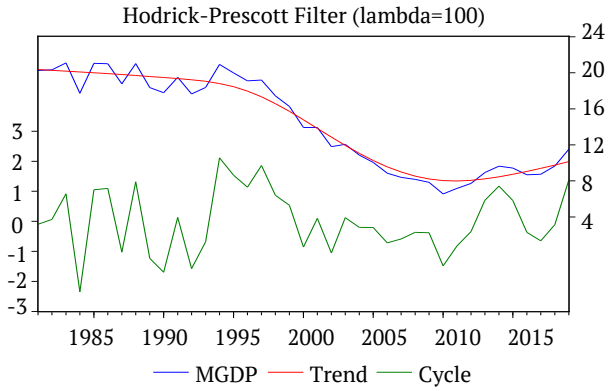

Figure 5. Manufacturing gross domestic product
Source: author's computation using Eviews 9 (n.d.)

The ARDL Bounds Test is appropriate to check for cointegration since variables are stationary at both level form and first difference, that is, variables consist of a combination of I(0) and I(1) (Table 6).

Table 6. ARDL bounds test results

SIGNIFICANCE LEVEL	CRITICAL BOUNDS		F STAT VALUE	KMAX	HYPOTHESIS TESTING
	I(0)	I(1)			
AT 10 %	2.21	3.41	3.62475	5	Cointegration exist
AT 5 %	2.21	3.88	3.62475	5	Cointegration exist
AT 2.5 %	2.88	4.11	3.62475	5	Cointegration exist
AT 1 %	2.99	4.77	3.62475	5	Cointegration exist

Source: author's computation using Eviews 9 (n.d.)

Table 6 displays the ARDL bounds test result, using *L_MGDP* as the dependent variable, with 6 lags for *L_MGDP* and 6, 6, 6, 6, and 6 lags for *INT*, *L_CPI*, *L_EXCH*, *L_MCAP*, and *L_MCU*. The result of the F-stat (3.62475) is above the lower bounds 2.21, 2.61, 2.88, and 2.99 at 10, 5, 2.5, and 1%, respectively; establishing the existence of long-run relationship between the variables and cointegration exists at all levels of significance. This is consistent with C.E. Onwuka (2021) who found a long run relationship between exchange rate volatility and the performance of manufacturing sector in Nigeria and confirmed that volatile exchange rates disrupt manufacturing sector's performance. A similar study by S. Jyoti & K.N. Bhatt (2022) also discovers a log run relationship between Indian manufacturing exports and exchange rate volatility, although the study found mixed effects of exchange rate volatility on manufactured exports, both in the short and long run. Using the coefficient in the VAR result in Table, it is evident that 7, the first lag of *MGDP*, has a positive relationship with *L_MCAP* and *L_CPI* while a negative relationship exists between *L_EXCH*, *L_MCU* & *INT* and *MGDP*.

Table 8 presents the variance decomposition of the exchange rate: emphasis of the result is on manufacturing output.

Table 7. Unrestricted vector autoregressive model result

	L_MGDP	*L_EXCH*	*L_MCU*	*L_MCAP*	*L_CPI*	*L_INT*
L_MGDP(-1)						
Coefficient	1.751446	-0.16165	-0.05522	0.023214	1.426101	-3.225114
Standard errors	(0.08011)	(0.45560)	(0.11236)	(0.16220)	(0.86441)	(9.44361)
t-statistics	[20.7113]	[-0.4290]	[0.3411]	[0.2715]	[1.5513]	[0.4288]

Source: author's computation using Eviews 9 (n.d.)

Table 8. Variance decomposition of EXCH

PERIOD	S.E.	L_MCAP	L_MCU	L_MGDP	L_EXCH	INT	L_CPI
1	0.053115	0.228613	0.037141	0.629910	99.31991	0.000000	0.000000
2	0.086110	0.384490	0.073710	0.399342	98.71226	0.128861	0.026192
3	0.137315	0.392285	0.062891	0.719191	98.50101	0.419066	0.031044
4	0.158821	0.324891	0.116288	0.872281	97.58133	0.856722	0.114522
5	0.189901	0.388901	0.091185	1.887211	96.37886	1.023113	1.087143
6	0.197731	0.520851	0.093328	2.879522	95.29732	1.345991	1.578817
7	0.210091	0.651952	0.161129	3.878809	92.76443	2.819942	1.623309
8	0.225561	1.233719	0.438439	5.501162	85.72971	5.790111	1.569901
9	0.236198	1.490549	1.388913	6.227813	86.44911	8.628440	1.487331
10	0.261134	1.882691	2.379411	7.591131	80.91330	11.88304	1.170932

Source: author's computation using Eviews 9 (n.d.)

It can be seen from the result that the forecast error shock of exchange rate affect manufacturing output more in period 5,6,7,8,9,10 compared to other periods. This implies that the forecast error shock of exchange rate shows more variations in manufacturing output than other macroeconomic variables. This finding is in line with the study of N. Ali (2020) who examined the effect of exchange rate fluctuations on the performance of Nigeria's manufacturing sector and established that fluctuations in exchange rates had a negative and significant impact on manufacturing output in Nigeria, indicating that a flexible exchange rate was riskier and more harmful than the fixed exchange rate. Figure 6 presents the impulse responses of manufacturing output (MGDP), and consumer price index (CPI) to exchange rate.

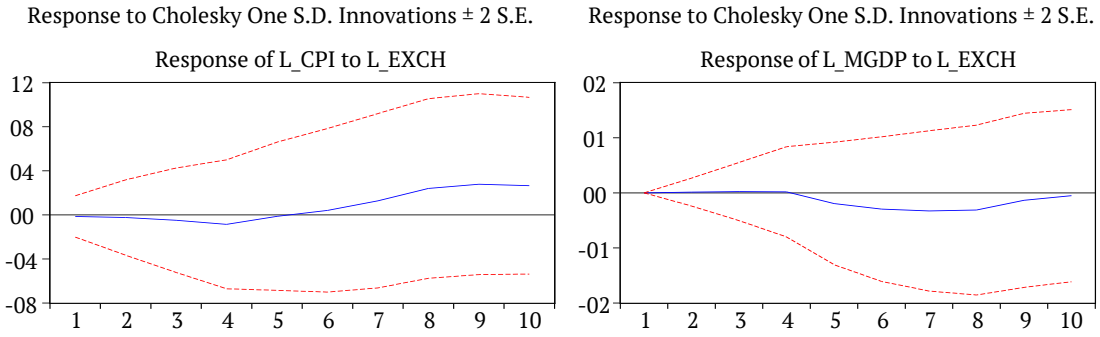

Figure 6. Impulse response function exchange rate

Source: author's computation using Eviews 9 (n.d.)

A one SD shock (innovation) to exchange rate initially has no noticeable impact on manufacturing output between periods one to four which indicates the short run while from periods four to eight, there was a fall in manufacturing output. Beyond the eighth period, manufacturing output begins to rise but remains in the negative region. This means that shocks to exchange rate will have a negative impact on manufacturing in Nigeria, indicating that an increase in exchange rate shocks aggravate the poor performance of the manufacturing sector in the country. However, a contrary study by J.C. Ukwunna *et al*. (2022), on the nexus between exchange rate fluctuations and industrial productivity growth in Nigeria uncovered that shocks to exchange rate would always have a positive effect of industrial productivity.

Also, a one SD shock (innovation) to exchange rate initially declines consumer price index between periods one to four which indicates the short-run period. Consumer price index then increases sharply from period four to six in the negative region and continues to increase beyond period six above the zero line. According to J.A. Asaleye *et al*. (2018) the specification of the model(s) should be examined for normality, autoregressive conditional heteroscedasticity, stability, and serial correlation. Shocks to exchange rate will have asymmetric impacts on manufacturing output in the long run and short run in Nigeria (Table 9).

Table 9. Diagnostic analysis

DIAGNOSTICS CHECK	PROBABILITY	HYPOTHESES TESTING
Histogram-Normality Test	0.6211	Do not Reject
Serial Correlation LM Test	0.4914	Do not Reject
Heteroskedasticity Test	0.5334	Do not Reject

Source: author's computation using Eviews 9 (n.d.)

In conclusion, the null hypothesis is accepted, which states that the variables are normally distributed, homoscedastic, and devoid of serial correlation because the probability of the three tests indicated above is greater than 0.05. In summary, the ARCH term's coefficient demonstrated the evidence of exchange rate volatility in Nigeria. In contrast, the GARCH term indicated that there is no persistent shock in the volatility of the exchange rate in the Nigerian economy. The result of the business cycle revealed that Nigeria's exchange rate is the highly volatile and has a negative effect on manufacturing output. On the other hand, the conclusion arrived at, based on the Variance Decomposition and Impulse Response Function Tests was that shocks to exchange rate will have negative impact on manufacturing output. Based on these findings, exchange rate fluctuations have negative impact on manufacturing gross domestic product in Nigeria which indicates that exchange rate fluctuations are harmful to the manufacturing sector. This result is in line with the findings of N. Ali (2020), C. Mlambo (2020) and C.G. Uruakpa *et al*. (2021). This implies that a shock to exchange rate will reduce the level of manufacturing output in Nigeria because the country depends largely on the external sector for the importation of inputs, hence, production cost increases leading to a corresponding decline in output.

CONCLUSIONS

This study examined the impact of exchange rate fluctuation on manufacturing output in Nigeria. While conducting this research, statistical tools such as GARCH effect test, business cycle stylized results, ARDL bounds test, variance decomposition, and impulse response were employed to examine the relationship between various variables. The result of the GARCH (1,1) shows evidence of exchange rate volatility in Nigeria, although the outcome of the GARCH (1,1) test indicates that there aren't any persistent shocks in the exchange rate volatility in Nigeria.

The business cycle result revealed that exchange rate is highly volatile and has a countercyclical relationship with manufacturing output, implying a negative relationship between them. The relationship between the consumer price index and manufacturing output is procyclical, meaning that there increase in price causes increase in manufacturing output. This is attributed to the positive relationship that exists between prices and supply under normal economic condition.

The Variance Decomposition and Impulse Response Function Tests show that shocks to exchange rate have a negative impact on manufacturing output. This implies that a depreciation of exchange rate will reduce manufacturing output while its appreciation will increase manufacturing output in Nigeria since the country depends largely on the external sector for import of inputs. These results made it evident that the stabilization of exchange rates will go a long way in maintaining a reasonably high level of Manufacturing Output in Nigeria. Monetary authorities therefore, need to continuously scrutinize the exchange rate in order to create informed policies, and match the exchange rate to the actual needs of manufacturing sectors to increase its output. Further studies can examine the effect of anticipated and unanticipated exchange rate shocks on manufacturing output. Invariably, this will help the monetary authorities to make adequate policies to cushion the economic effect of exchange rate fluctuations.

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CONFLICT OF INTEREST

None.

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Коливання обмінного курсу та випуск промислової продукції: стилізовані факти з Нігерії

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Анотація. Одним з ключових рушіїв зростання в багатьох країнах є виробничий сектор, на показники якого впливає рух місцевої валюти. Виробничий сектор також надає такі можливості, як зростання торгівлі, інновацій, конкурентоспроможності, збільшення експорту та продуктивності, які стають можливими лише за умови зміцнення валютного курсу. Тому метою цього дослідження було вивчення впливу коливань обмінного курсу на обсяги виробництва в Нігерії. У дослідженні використано метод узагальненої авторегресії з умовною гетероскедастичністю для вивчення коливань обмінного курсу. Результат оцінки моделі показав, що в економіці Нігерії немає стійких шоків у волатильності обмінного курсу. Стилізовані факти економічного циклу теж були використані для дослідження волатильності обмінного курсу, і результат показав, що обмінний курс має високу волатильність та негативний вплив на обсяг виробництва в Нігерії. Крім того, для встановлення довгострокового зв'язку було застосовано авторегресійний розподілений лаговий тест, який показав, що між обмінним курсом та обсягом виробництва існує довгостроковий зв'язок. Використано декомпозицію дисперсії та функцію імпульсного відгуку, і результат показав, що коливання обмінного курсу має негативний вплив на валовий внутрішній продукт промисловості Нігерії. На практиці, виходячи з результатів дослідження, можна рекомендувати монетарним органам постійно відслідковувати коливання обмінного курсу, щоб розробляти проінформовану політику, яка б відповідала реальним потребам виробничого сектора з метою збільшення його обсягів виробництва

Ключові слова: узагальнена авторегресивна умовна гетероскедастичність; фільтр Ходріка-Прескота; волатильність; економічний цикл; індекс споживчих цін