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Macroeconomic Determinants of Manufacturing Sector Performance in Nigeria: an Asymmetric Non-Linear Approach

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Abstract: *This study investigates the responsiveness of manufacturing sector performance to major macroeconomic determinants in Nigeria, covering the period between 1981 and 2018. It contributes to attendant literature by examining the asymmetric impact of each of the macroeconomic variables, including GDP per capita, exchange rate, inflation rate, interest rate proxied by prime lending rate, and gross fixed capital formation. The empirical evidence is based on a Non – Linear Autoregressive Distributed Lag (NARDL) model. Our result confirms important roles for all the macroeconomic variables although at different time periods. In the long run, important role on manufacturing sector performance is found for all variables except GDP per capita. In the short run however, it alongside exchange rate and period lags of manufacturing value added meaningfully determines manufacturing sector performance. Our findings also confirm the presence of asymmetric shocks on manufacturing performance for exchange rate at both time periods and interest rate only in the long run.*

Keywords: *Manufacturing sector performance, NARDL model, macroeconomic determinants, asymmetry, Nigeria.*

Introduction

Global concern for improved performance of the manufacturing sector as a result of its beneficial contributions to the growth and general economic welfare is still surging. Empirical evidence has shown that well-functioning, healthy, and competitive manufacturing sector is an effective tool in achieving adequate industrialization. Indeed, it has been demonstrated in the literature that manufacturing sector stimulates employment and economies of scale (Signe, 2018; Haraguchi, 2016), raise capital accumulation and reduce income inequality (Soderbom & Teal, 2003; Signe, 2018), creates spillovers to other sectors and subsequently drives economic growth, (Tkalec & Vizek, 2009; Naude & Szirmai, 2012). It is based on these potentialities that this sector has been considered to spearhead the change in economic focus of most developing countries. Because it is through this structural transformation and economic diversification that these nations can build resilience against external shocks and hence achieve required development (Unctad, 2011, 2013; KPMG Africa, 2014). These significances of the manufacturing sector have meant its determinants have become an important area of research.

This exact process has reformed the United States, United Kingdom, France, Japan, and Germany into some of the world's richest countries. Lately, a new wave of industrialization spearheaded by manufacturing production has tossed the Chinese economy amongst the fastest growing globally Signe (2018). However, unlike these developed countries and other emerging countries, the same description appears difficult to indicate for almost all African countries. In spite of the regions manufacturing possibilities, it produces majorly range of primary products and has remained relatively famine of

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factories. This constrained manufacturing development signifies unexploited chances towards economic transformation and quality employment generation that lessens poverty Signe (2018). It is against this background that the region has overtime embarked on policies to improve this unfavorable stance. In doing this, the region recently introduced the single market continental free trade area (AfCFTA) aimed to not only foster manufacturing development led industrialization but also to drive employment and sustainable growth among other purposes.

Therefore, it became important for literature to properly identify and harmonize factors that determine the performance of the manufacturing sector. While some of these extant studies have glorified the role of foreign direct investment in manufacturing and other sectorial growths (Ali, Wang, Morales, & Wang, 2019; Li, Strange, Ning, & Sutherland, 2016; Okoli and Agu, 2015; Hsu, Gao, Zhang, & Lin, 2011; Buckley, Clegg, & Wang, 2002), other studies have examined the role of infrastructures (Ahmed, 2016); energy consumption (Edame & Okoi, 2013; Hassan, Danmaraya, & Danlami, 2018); human capital (Dey & Ellis, 2013; Anyanwu, 2018) while in contrast the question of whether manufacturing sector performances are responsive to core macroeconomic variables has attracted fewer contributions. Diversifying from the general line of argument and following further recommendations for example, that of the European Commission, 2009, that aside industry-specific factors and industrial policies, macroeconomic circumstances are striking drivers of manufacturing performance and the believe that macroeconomic conditions might affect manufacturing activities especially in developing countries – which every African country are not exempted – that are characterized by unstainable macroeconomic instability rekindle the exploration of the macroeconomic drivers of manufacturing sector performance within the literature. For instance, (Varela, Ghosh, & Rahardha, 2018) found significant influence for inflation and exchange rate. In support, (Anyanwu, 2017; Djulius, Wongyu, & Santy, 2019) found relevance for domestic investments. Also, in contrast, while (Eze & Ogiji, 2013; Enu & Havi, 2014) found distortionary impact of government tax revenue and GDP respectively, (Judith & Chijindu, 2016; Onakoya, 2018) found no evidence for inflation and interest rate. While this relationship is considered less established, consideration of a single or few macroeconomic variables, diversified conclusions, the nature of the relationships – whether symmetric or asymmetric – is also unfound, thus confirming the existence of knowledge vacuum. Therefore, in light of these literature gaps in the debate about macroeconomic determinants and manufacturing sector performance, it is not unfitting to state that this relationship requires further enquiry.

The inquiry into the macroeconomic determinants – manufacturing sector performance relationship becomes important especially for Nigeria because, notwithstanding the potential positive impacts of the manufacturing sector, unfortunately for Nigeria and many other African manufacturing firms, despite several initiatives at the international and national levels, the progress made so far can be regarded as unpromising. In Nigeria for instance, several strategies and incentives not limited to the national development plans, structural adjustment program, Bank for Industry, export promotion, different tax holidays, export processing zones, and export incentives for industries among other strategies have been adopted over time to achieve the full potential of her manufacturing sector. Despite these efforts, the sector contributions to Nigerian economic growth still appear to be far below expectation. In essence, its contribution to growth has experienced a near consistent dip from an all-time value of 21.02% in 1988 to a depressing 7.78% within the last three decades (See figure1).

With the fringe performance of the Nigerian manufacturing sector in mind, the pertinent question remains: do macroeconomic measurements play any significant role in the determination of manufacturing performance in Nigeria? Offering responses to this raised question remains the main drive of the present paper. This study hence extends and contributes to the existing literature by offering new evidence on key drivers of manufacturing sector performance by investigating the macroeconomic determinants of the manufacturing sector performance in Nigeria.

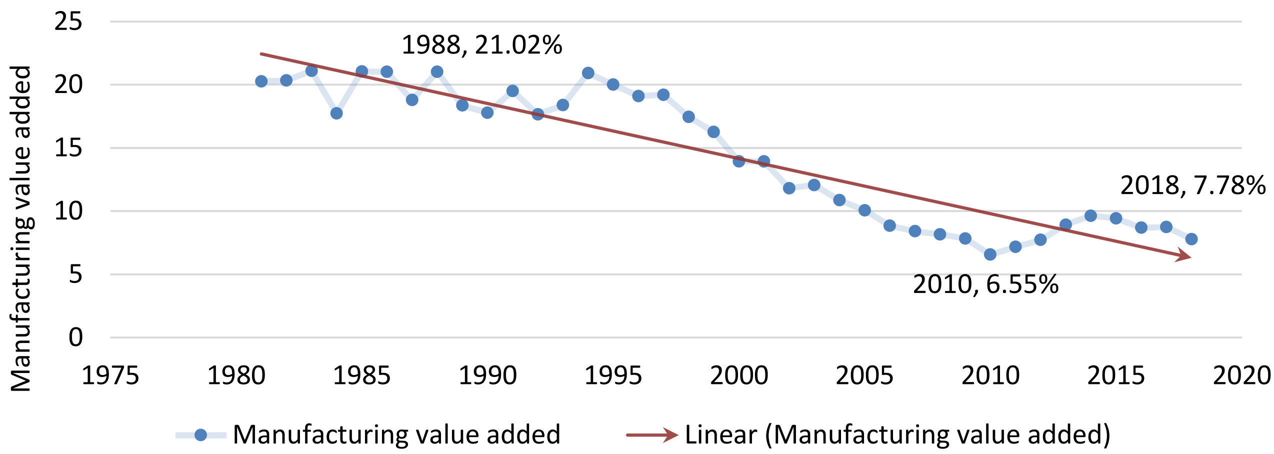

Figure (1): Annual Contributions of Manufacturing Sector to GDP in Nigeria (Source: Author, 2019)

In what follows, we first consider a number of reviews around the different determinants of manufacturing sector performance and that is immediately followed by the empirical approach i.e., the data and methodology in the third section. Section four presented and discussed the results of our estimation while the final section five presented the conclusion for this study.

Literature Review

This section reviewed briefly the empirical literature on the diverse drivers of manufacturing sector performance. This is performed along two strands; the first been the studies that exhibit positive relationships with manufacturing performance while the other strand reviewed studies that stated otherwise. This encompasses studies that recorded both negative and no significant relationships.

Regarding the positive discussions, Ilyas, Ahmad, Afzal, and Mahmood (2010) examined the determinants of manufacturing value added in Pakistan. Within a bound testing framework, total factor productivity (TFP) emerged the primary determinant of increasing value added in Pakistani manufacturing sector. In a similar finding, Chikabwi, Chidoko and Mudzingiri (2017) for Southern African Development Community (SADC) found trade openness, technology transfer and capital investment to positively influence manufacturing sector productivity growth. Similar positive conclusions were attained in Djulius et al (2019) in a study that examined the nexus of foreign direct investment, domestic investment, and manufacturing Industry value added in Indonesia. In addition to FDI, they found also domestic Investment to positively influence the value-added of the manufacturing industry. Karak and Basu (2017) in a panel of Indian states found that compared to industrial disputes, profitability to significantly raised manufacturing performance. In another study, Varela et al (2018) found support for the role of inflation and exchange rate in Indonesia. Anyanwu (2017) in a panel of North African countries found secondary education, agricultural land, domestic credit to the private sector, trade openness, inward stock of FDI, population size, and ICT infrastructure/technology to significantly promote manufacturing value added. Likewise, in his subsequent study, Anyanwu (2018) found tertiary education to be an important variable for manufacturing value added in Africa. In other studies, Charles (2012) found money supply to significantly improve manufacturing performance in Nigeria, Hassan et al (2018) found significance for energy consumption in Sub-Saharan Africa. Islam and Shazali (2011) found evidence supporting the degree of skills, favorable working environment and R&D in Malaysia while Efobi, Tanankem, Asongu, and Beecroft (2016) found support for financial inclusion.

In contrast to the above positive inferences of macroeconomic and other varying measurements on manufacturing export, within a consistent method of estimation with Ilyas et al (2010), Ali, Aliero, and Abubakar (2015) stressed the impact of monetary policies on the Nigerian manufacturing sector. With sole reliance on exchange rate as the measure of monetary policy, they, however, discovered negative effect on manufacturing sectoring output. In support of this, in Nigeria, Ubi, Effiom and Eyo (2012) and for Norwegian manufacturing firms, Ekholm, Moxnes, and Ulltveit-Moe (2012) found real exchange rate appreciation to influence firm's decision to shed labour. Lawal (2016) on the other hand found no support for exchange rate. In another contemporaneous study, Tkalec and Vizek (2009) examined the impact of macroeconomic policies on manufacturing production in Croatia. They showed that restrictive monetary policies are perilous for manufacturing output. Similar discovery was recorded in Ghana by Enu and Havi (2014). In similitude, Eze and Ogiji (2013) found that government tax revenue weighs down manufacturing sector output in Nigeria. Sukmana (2011) investigated the reaction of economic sectors to changes in the Islamic and conventional monetary policy in Indonesia. The findings suggested that the manufacturing sector was unaffected by the shocks to monetary variables. While Mawufemor, Isaac, and Faisal (2016) found negative impact for inflation in Ghana, Judith and Chijindu (2016) also found no significant relationship for inflation and interest rate on the Nigerian manufacturing sector. In the same vein, Onakoya (2018) found insignificant result interest rate and inflation rate, while Tams – Alasia, Olokoyo, Okoye, and Ejemeyovwi (2018); Saibu and Nwosa (2011) found no support for exchange rate in Nigeria.

In light of the above brief reviews, it is evident that studies across different regions have investigated a series of determining factors that could influence manufacturing sector performance. This highlighted the depth of investigation that this subject matter has attracted. However, while it is important to understand how this sector performs in the face macroeconomic determinants as noted by Signe (2018) studies have focused on other factors aside macroeconomic factors while ones that do for instance Ali et al (2015), Enu and Havi (2014), Varela et (2018), and Judith and Chijindu (2016) only investigated few variables which might not reflect a full representation of the macroeconomic impacts. This study addressed the discernable gap by considering a wide range of macroeconomic measurements within a robust method of estimation. This paper while investigating Nigeria and the further consideration of asymmetric impacts of the macroeconomic determinants contributes to the argument focusing on specifics for which its outcome will enable specific-tailored policy interventions to be formulated rather than applying broad unfeasible policy recommendations with a more general outlook on problems deserving specific policy attention.

Materials and Methods

Variables and Data Description

This paper employed annual data sourced from the CBN statistical bulletin (2018) and World Development Indicators (WDI, 2019) for the period 1981 – 2018. This is as a result of data limitations prior to this period. This dataset consists of manufacturing value added as the measure of manufacturing sector performance and five key macroeconomic indicators in GDP Per capita, Real Effective Exchange Rate, Inflation Rate, Gross Fixed Capital Formation, and Prime Lending Rate as a proxy for Interest Rate. Selections of these variables were informed by the literature. Table 1. Presents the general description of the data.

Model Specification

To empirically examine the growth performance effects of macro variables on the Nigerian manufacturing sector, this paper adopted a conventional Solow's neo-classical Cobb Douglas production function that has gained significant approval in studies that examines manufacturing industries growth Meeusen and Van den Broeck (1977).

$$Y_{i\,t} = A_{i\,t}K_{i\,t}^{\propto} H_{i\,t}^{\beta} L_{i\,t}^{\gamma} \qquad (1)$$

i and t are country and time subscripts. $Y_{i\,t}$ Infers to the aggregate output of country i at time t. $L_{i\,t}$is labour force; $K_{i\,t}$ is physical capital stock; $H_{i\,t}$ represents the average stock of human capital per worker; $A_{i\,t}$ is the total factor productivity (technological progress). $\propto, \beta$ and γ are elasticities measure of output relative to the predictor. He further presented (1) in a log – linear functional form to have;

$$lnY_{i\,t} = \beta_0 + \beta_1 lnL_{i\,t} + \beta_2 lnK_{i\,t} + \beta_3 lnX_{i\,t} + \omega_{i\,t} \qquad (2)$$

Equation (2) denotes a basic production function that explains how industrial productivity depends on the level of labour or its quality, investment in capital, and other augmented factors. The term $\omega_{i\,t}$ signifies three sources of productivity. Following Kilponen and Viren 2010; Chikabwi et al, 2017 who have extended the production function especially the $X_{i\,t}$ for the manufacturing sector growth, this study follows suit to modify and situate macroeconomic determinants within the production function; the model for this study is hereby given as;

$$lnMan_t = \beta_0 + \beta_2 lnK_t + \beta_3 lnX_t + \omega_t \quad (3)$$

Where Man_t is the manufacturing sector value added measured in terms of contributions to the GDP; K_t represents capital endowment measured by gross fixed capital formation (GCF_t); X_t represents the vector of other manufacturing sector determinants – Gross Domestic Product per capita ($GDPC_t$), Exchange Rate (EXR_t), Inflation (CPI_t), and Interest Rate (PLR_t); $\beta_{0\_\_\_\infty}$ are the parameters; ln is the natural logarithm; ω_t is the error term; and t denotes the time. Incorporating the components of X_t explicitly in (2), we have;

$$Man_t = \beta_0 + \beta_1 GCF_t + \beta_2 GDPC_t + \beta_3 lnEXR_t + \beta_4 lnCPI_t + \beta_5 PLR_t + \omega_t \quad (4)$$

Method of estimation

Following Pesaran, Shin, and Smith (2001), Shin, Yu, and Greenwood-Nimmo (2014), and Mensi, Shahzad, Hammoudeh, and Al-Yahyaee (2017) and their believe that macroeconomic variables are prone to non-linearity and asymmetries, this study employed the non – linear (asymmetric) Autoregressive Lag Distributed Model. The NARDL framework permits modelling asymmetric cointegration using positive and negative partial sum decompositions to observe asymmetric effects both in the long and short run. This model is suitable and reliable due to its flexible procedures and especially applied when series are of combined orders i.e., 1st, 2nd, or combination of both orders (I(0) and I(1)) but free of 2nd order (I(2)) series (Raza, Shahzad, Tiwari, & Shahbaz, 2016). Further, its specification is significant to control for possible endogeneity issues and residual autocorrelation. (Pesaran et al., 1997). This superiority has made it found it's ground in recent literature – like Sharma and Kautish (2019); Adeniyi and Kumeka (2019); Rahman and Ahmad (2019) – involving macroeconomic variables.
We hereby re-present (4) in an asymmetric ***NARDL*** model;

$$\begin{aligned}\Delta MAN_t = \beta_0 + \beta_1 MAN_{t-1} + \beta_3^+ GCF_{t-1}^+ + \beta_4^+ GCF_{t-1}^- + \beta_5^+ GDPC_{t-1}^+ + \beta_6^+ GDPC_{t-1}^- + \beta_7^+ EXR_{t-1}^+ \\ + \beta_8^+ EXR_{t-1}^- + \beta_9^+ CPI_{t-1}^+ + \beta_{10}^+ CPI_{t-1}^- + \beta_{11}^+ PLR + \beta_{12}^+ PLR_{t-1}^- \\ + + \sum_{i=1}^{p} \gamma_1 \, \Delta Man_{t-i} + \sum_{i=0}^{q} \gamma_2^+ \, \Delta \, GCF_{t-i}^+ + \sum_{i=0}^{q} \gamma_3^- \, \Delta \, GCF_{t-i}^- + \sum_{i=0}^{q} \gamma_4^+ \, \Delta \, GDPC_{t-i}^+ \\ + \sum_{i=0}^{q} \gamma_5^- \, \Delta \, GDPC_{t-i}^- + \sum_{i=0}^{q} \gamma_6^+ \, \Delta \, EXR_{t-i}^+ + \sum_{i=0}^{q} \gamma_7^- \, \Delta \, EXR_{t-i}^- + \sum_{i=0}^{q} \gamma_8^+ \, \Delta \, CPI_{t-i}^+ \\ + \sum_{i=0}^{q} \gamma_9^- \, \Delta \, CPI_{t-i}^- + \sum_{i=0}^{q} \gamma_{10}^+ \, \Delta PLR_{t-i}^+ + \sum_{i=0}^{q} \gamma_{11}^- \, \Delta PLR_{t-i}^- + \omega_t\end{aligned} \quad (5)$$

Where; all variables are in their natural log as in (4); $MAN, GCF, GDPC, EXR, CPI, PLR, and\ \omega$ are as defined above, β_{0---14} $and\ \gamma_{1----11}$ are parameter for the long run and short run coefficients respectively. It is however worthy to note that, NARDL estimation is suitable only when the long run cointegration of the variables is ascertained. If this is so, the Pesaran et al.'s (2001) bounds tests that uses F -statistics is applied. Its null hypothesis assumes ($\beta_i^+ = \beta_i^- = 0$). The long run coefficients for the positive and negative changes in the explanatory variables are obtained by calculating $^{-\beta_i^+}/_{\beta_1}$ and $-\,^{\beta_i^+}/_{\beta_1}$ respectively.

Further, it employs the Wald – test to determine the long run ($\beta_i^+ = \beta_i^-$) and the short run ($\gamma_i^+ = \gamma_i^-$) asymmetries. The minus (-) and the plus (+) superscripts in Equation (5) represent the partial sum processes of the negative and positive changes in the variables. Constructed as;

$$Y_t^+ = \sum_{n=1}^{t} \Delta Y_{it}^+ = \sum_{n=1}^{t} \max(\Delta Y_{it}, 0) \; and \; Y_t^- = \sum_{n=1}^{t} \Delta Y_{it}^- = \sum_{n=1}^{t} \min(\Delta Y_{it}, 0) \quad (6)$$

Where Y_t can represents $MAN, GCF, GDP, EXR, CPI,$ and PLR. Finally, to ascertain the long run equilibrium and observe the dynamic multiplier effect of the positive (lnX_t^+) and negative changes (lnX_t^-) in our macroeconomic variables (lnX_t) on manufacturing sector performance ($lnMan_t$), the calculation of dynamic multiplier for all variables is considered. This is given as; $dm_h^+ = \beta_i^+ / \beta_1$ and $dm_h^- = \beta_i^- / \beta_1$; this procedure is thereby considered for all our key determining variables. Hence, we have;

$$dm_h^+ = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial GCF_t^+}\right), dm_h^- = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial GCF_t^-}\right); \; dm_h^+ = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial GDPC_t^+}\right), dm_h^- = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial GDPC_t^-}\right)$$

$$dm_h^+ = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial EXR_t^+}\right), dm_h^- = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial EXR_t^-}\right); \; dm_h^+ = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial CPI_t^+}\right), dm_h^- = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial CPI_t^-}\right)$$

$$dm_h^+ = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial PLR_t^+}\right), dm_h^- = \sum_{j=0}^{h} \left(\frac{\partial MAN_{t+j}}{\partial PLR_t^-}\right); \quad (7)$$

Where; $h \to 0, 1, 2, - - - \infty$,

Results and Discussion

Preliminary Tests: Descriptive statistics and correlation matrix, Unit root tests, Test of structural breaks and the Bound test of cointegration

Table 1 presents at its upper part the descriptive statistics and at the lower part the correlation matrix. From the descriptive statistics and starting with the mean values, all the series are positive at average with GDP per capita having the highest mean and inflation rate having the lowest. Exchange rate displayed the highest level of volatility and GDP per capita showed the highest stability among the macroeconomic series. On the other hand, the lower part of Table 1 revealed that the correlation coefficients among the independent variables lie within the acceptable region. This implies that the model is free of multi-collinearity and absence of serial correlation.

In Table 2 we presented the Augmented Dickie Fuller (ADF) and Phillips-perron (PP) unit root tests to validate the presence of unit roots in the series. The outcomes revealed variables are stationary at a mixture of both levels and at first difference. It specifically observed that inflation rate, gross fixed capital formation, and interest rate are stationary at levels while manufacturing value added, GDP per capita, and real exchange rate became stationary after first differencing.

Structural Break Unit Root Test

Inability of the ADF, PP, and other traditional unit root tests to account for breaks in series and hence a resultant spurious regression as suggested by Rahman and Ahmad (2019) triggered the further test of stationarity within a structural break framework. This study conducted the Chow test which signifies the presence of breaks in series and the Perron break test of unit root. This result further verifies the ADF and PP tests regarding all variables except interest rate which became stationary after first differencing. In other words, within the presence of possible structural break, series are stationary at either levels or after first differencing.

Broock, Dechert and Scheinkman (BDS) Test

Developed by Broock, Dechert, and Scheinkman (1996) to perceive non – linearity dependencies in time series data, this study adopts the BDS test of independence in Table 4 in the occurrence of breaks in our dataset. It ultimately reveals the rejection of the null hypothesis of linearity signifying a non-identical and non-independently distributed series (IID). The ensuing absence of linearity and presence of linearity, therefore, gives credence to the estimation of a non – linear analysis. In this study, we estimated the Non – Linear ARDL. This method further gives room to account for the asymmetries arising from the shocks to our variables of interest.

Estimation Results

Results of Non – Linear Autoregressive distributed (NARDL)

Interpretation of Key statistics

From Table 5, in examining the relationship between macroeconomic measurements and manufacturing sector performance in Nigeria, the positive and negative changes for instance in exchange rate, gross fixed capital formation, and interest rate posits a differential impression on manufacturing sector performance. Implying a possible asymmetric impact of the selected macroeconomic variables on manufacturing sector performance. An adjusted R^2 of 0.851 infers that 85.1% of the variation in manufacturing sector performance are explained by the independent variables. Likewise, as the significant F – statistics gives credence to the joint significance of the explanatory variables on manufacturing sector performance, the Durbin – Watson test of (2.3) signifies the problem of serial correlation is less severe and hence the estimated results are reliable. This position is further reinforced by rejecting the null hypothesis of the Breusch Godfrey serial correlation test that posits a presence of serial correlation. Further, the Ramsey Reset for functional form F-value connotes that the relationship between manufacturing value added and macroeconomic explanatory variables are reliable. White Heteroskedasticity test and the Normality test suggests the absence of heteroscedasticity and a normally distributed result respectively. Moreover, the linear ARDL Bound test of cointegration which surpassed

Table (1): Descriptive Statistics and Correlation Matrix

Description of Variables	*Name*	*Mean*	*Maximum*	*Minimum*	*Std. Dev.*	*Obs.*	*Source*
Manufacturing Value Added (% of GDP)	MAN	14.38	21.10	6.55	5.26	38	WDI
Real GDP Per Capita	GDPC	1758.61	2563.90	1324.30	439.88	38	WDI
Real Effective Exchange Rate	EXR	4.79	6.29	3.92	0.62	38	WDI
Inflation, Consumer Price Index (annual %)	CPI	2.68	4.29	1.68	0.70	38	WDI
Gross Fixed Capital Formation (% of GDP)	GFC	36.11	89.39	14.17	19.68	38	WDI
Interest Rate (Prime Lending Rate)	PLR	17.58	29.80	7.75	4.63	38	CBN
Correlation Matrix	*MAN*	*GDPC*	*EXR*	*CPI*	*GFC*	*PLR*	– –
MAN	1	– –	– –	– –	– –	– –	– –
GDPC	-0.862	1	– –	– –	– –	– –	– –
EXR	0.394	-0.197	1	– –	– –	– –	– –
CPI	0.366	-0.299	-0.149	1	– –	– –	– –
GFC	0.839	-0.693	0.492	0.193	1	– –	– –
PLR	-0.119	-0.077	-0.751	0.327	-0.309	1	

Note: Std. Dev.: Standard Deviation; Obs.: Observation; WDI: World Development Indicator, 2019; CBN: Central Bank of Nigeria Statistics, 2018.

Table (2): Unit Root Tests

Variables	Augmented Dickie Fuller (ADF)		Phillips – Perron (PP)		Order of Integration
	Levels	First diff.	Levels	First diff.	
MAN	-0.725	-8.172*	-0.5934	-7.9693*	*I (1)*
GDPC	-1.1456	-3.4997**	-0.1053	-3.4997**	*I (1)*
CPI	-3.3515**	– –	-3.2371**	– –	*I (0)*
EXR	-2.1706	- 4.5920*	-2.3557	-4.4553*	*I (1)*
GFC	-3.2729**	– –	-3.2342**	-4.8103*	*I (0)*
PLR	-3.0463**	– –	-3.4838**	– –	*I (0)*

Note: *, **, *** denotes 1%, 5%, and 10% respectively; diff: difference; Critical Values at 1%, 5%, 10%: – 3.63, – 2.95, – 2.61.

Table (3): Test of Structural Breaks in Series

Variables	Chow Test		Perron Structural Breaks Unit Roots (Intercept)				
			At Levels			At First Difference	
	F – statistic	Br Date	T – statistic	Br Date		T – statistic	Br Date
MAN	26.7574*	2010	-3.8360	1999		- 9.4265*	1994
GDPC	16.1769*	1995	-3.2896	1990		- 4.9850***	2010
EXR	68.55460*	1987	-3.0470	1989		-5.5573**	1987
CPI	11.4218*	1997	-5.2413**	1995		-7.3854*	1988
GFC	40.9081*	1988	-6.7854*	2013		-5.7986**	1988
PLR	16.4173*	1985	-2.7796	2003		-10.8554*	1991

Note: *, **, *** denotes 1%, 5%, and 10% respectively: Critical Values: – 5.92, – 5.23, – 4.92, for 1, 5, and 10% respectively; Br: Break date.

Table (4): BDS Non-Linearity Test of Independence

BDS Statistics	Dimensions				
Variables	m = 2	m = 3	m = 4	m = 5	m = 6
MAN	0.1482*	0.2650*	0.3456*	0.4023*	0.4403*
GDPC	0.0813*	0.1277*	0.1314*	0.1346*	0.1249*
EXR	0.1617*	0.2614*	0.3218*	0.3512*	0.3618*
CPI	0.0768*	0.1191*	0.1614*	0.1783*	0.1838*
GFC	0.1807*	0.3142*	0.4103*	0.4765*	0.5225*
PLR	0.0721*	0.1265*	0.1584*	0.1856*	0.1973*

Note: m = is the dimension; BDS: Broock, Dechert, and Scheinkman test that relies on the VAR residuals for selected variables; MAN: Manufacturing Value Added; GDPC: GDP per capita; EXR: Real Effective Exchange Rate; CPI: Inflation, consumer price index; GFC: Gross Fixed Capital Formation.

The upper critical value at 2.5% signifies the presence of a long run cointegration. In support, Pesaran et al (2001) statistics conducted using the Wald test F – statistics gives further credence to the long-term convergence among variables. In essence, these findings have clearly revealed the presence of a future convergence, hence, estimating the macroeconomic determinants within the NARDL context is justified.

The Long run Outcomes

The estimates from the NARDL estimation (Table 5) showcased the positive and negative degrees of the influence of GDP, inflation, exchange rate, interest rate, and gross fixed capital formation on manufacturing sector performance. However, within a NARDL framework, these coefficients do not reveal the actual magnitude of the long run asymmetric relationships between the dependent and explanatory variables. Hence, the need to obtain the calculated long run magnitudes (LR. Coefficients) as in Table 5 above. This is obtained by dividing the negative of the coefficients of each of the explanatory variable in the long run model by the coefficient of the one period lagged value of the dependent variable (MAN(-1)) operating as an explanatory variable $\{-(\text{coefficients of explanatory variables} / (\text{coefficient of MAN}(-1))\}$. From this result, there is discernable evidence for the presence of asymmetric impact of macroeconomic variables in the long run. Specifically, exchange rate and interest rate have asymmetric impacts on manufacturing sector performance, also see Table 6. It is also visible from this result that while total significant impressions on manufacturing sector performance can be discovered for exchange rate and gross fixed capital formation, partly for inflation rate and interest rate at negative and positive changes respectively, the same conclusion cannot be made for gross domestic product per capita. In essence, the estimates suggest that a percentage increase in exchange rate is associated with a 6.39% dip in manufacturing performance, while a percentage decrease leads to a 2.14% increase in manufacturing performance. This implies that the Nigerian manufacturing sector suffers from an unfavourable position of the Nigerian Naira in the global market. When the Naira depreciates in value against the dollar in the international market, manufacturing firms experience rising production costs and subsequently leads to reducing manufacturing outputs. Similarly, when the exchange rate is favourable, encouraging performances of the manufacturing sector are imminent. This result is consistent with the theoretical expectations of inverse relationships for positive and negative changes in exchange rate on manufacturing performance. It also conforms the findings of Ali et al (2015) and Ubi et al (2012). However, in contrast to the study of Saibu and Nwosa (2011) and Tams – Alasia, et al (2018) that found no evidence of exchange rate determinants. The signs of the estimated coefficients on inflation rate are mixed. While it is not consistent on its positive indicator although, with non-significant outcome, its negative indicator is consistent with the theoretical expectations. It specifically explains that any attempt to decrease inflation by 1% would potentially raise the manufacturing sector output by 2.36%. Plausible explanation for this indicates that a lower level of inflation is important for manufacturing growth because at higher price levels, not only do consumers demand for manufacturing goods drastically experience a dip, the costs of production are also likely to surge upward. The result is in tandem with the findings of Tams – Alasia, et al (2018) and Freeman and Yerger (2000) and contradicts the findings Mawufemor, et al (2016) and Enu and Havi (2014). The results of gross domestic product (GDP) at both dimensions are nonsignificant. Which implies no significant evidence of economic growth shaping the manufacturing sector growth. Also important is the result of gross fixed capital formation, as its coefficients aligned to statistical and economic reasoning. In essence, an increase (decrease) in gross fixed capital formation

Table (5): NARDL Long run and Short run dynamics of the Macroeconomic determinants of Manufacturing Sector Performance in Nigeria.

Variables	Coefficient	LR. Coefficient	Std. Error	t-Statistic	Prob*
Long Run Dynamics					
Constant	-18.5823	– –	3.6557	-5.0831	0.0002*
MAN (-1)	0.7808	– –	0.1908	4.0916	0.0013*
EXR_P (-1)	4.9869	-6.3869	2.1683	2.3000	0.0387**
EXR_N (-1)	-1.6691	2.1377	0.6740	-2.4763	0.0278**
CPI_P (-1)	-0.8729	1.1180	0.5549	-1.5733	0.1397
CPI_N (-1)	-1.8389	2.3551	0.4986	-3.6882	0.0027*
GDPC_P (-1)	-0.0036	0.0046	0.0038	-0.9462	0.3613
GDPC_N (-1)	-0.0058	0.0074	0.0070	-0.8242	0.4247
GFC_P (-1)	-0.3555	0.4553	0.1474	-2.4116	0.0314**
GFC_N (-1)	0.2514	-0.3220	0.0482	5.2165	0.0002*
PLR_P (-1)	0.1631	-0.2089	0.0744	2.1929	0.0471**
PLR_N (-1)	-0.0559	0.0716	0.1052	-0.5310	0.6044
Short Run Dynamics					
ΔMAN (-1)	-1.6023	– –	0.2166	-7.3978	0.0000*
ΔMAN (-2)	-0.8270	– –	0.1277	-6.4735	0.0000*
EXR_P (-2)	-5.5901	– –	1.6451	-3.3979	0.0048*
EXR_N (-2)	-0.6933	– –	0.5439	-1.2746	0.2248
GDPC_P	0.0114	– –	0.0049	2.3296	0.0366**
GDPC_N	0.0181	– –	0.0068	2.6653	0.0194**
EXR_P	5.2386	– –	2.1732	2.4106	0.0315**
EXR_N	-1.3096	– –	0.6565	-1.9949	0.0675***
R Squared	0.9429	– –	– –	– –	– –
Adj. R-squared	0.8506	– –	– –	– –	– –
F-statistics	10.220*	– –	– –	– –	– –
Durbin-Watson Stat	2.299	– –	– –	– –	– –

Cointegration Tests				F – stat	
Linear $ARDL_{BT}$	– –	– –	– –	4.094**	– –
F_{BT}	– –	– –	– –	8.0627*	– –
Test of Asymmetry					*Decision*
Wald LR	– –	– –	– –	4.9695*	Present
Wald SR	– –	– –	– –	3.9436**	Present
Diagnostic Tests	*Statistics*				*Prob**
Ramsey Reset (F-stat)	0.4302	– –	– –	– –	0.5243
X^2_{SEC}	1.7166	– –	– –	– –	0.2245
X^2_{WHET}	0.5675	– –	– –	– –	0.8801
X^2_{NOR}	3.6837	– –	– –	– –	0.1585
Cusum & Cusum SQ	– –	– –	– –	– –	Stable

Note: *, **, *** denotes 1%, 5%, and 10% level of significance; P and N represents positive and negative changes in selected variables as regards the variables asymmetric nature; X^2_{WHET}: White Heteroskedasticity Test; X^2_{SEC}: LM Serial correlation Test; X^2_{NOR}: Normality Test; F_{BT}: Pesaran et al (2001) bound test; Cusum: Cummulative sum; Cusum Sq: Cummulative sum of squares; Wald LR: Wald Long run - Presence of cointegration by rejecting the null hypothesis that C(2)=C(3)=C(4) = , . . . , = C(12) and that of asymmetry that assumes -C(3)/C(2) = -C(4)/C(2) = , . . . , = -C(12)/C(2); ARDL Bound Critical Values: 1%, 2.5%, 5%, 10% - 4.15, 3.73, 3.38, 3 respectively.

By 1% will raise (dampen) the performance of the manufacturing sector by 0.45% (0.32%) respectively. This outcome is not startling because an increase in net investment in fixed capital is crucial to expand aggregate demand and productive capacities. This result is consistent with the findings of Zavaleta, & Cruz (2019) and Velazquez & Juan (2016) and contradicts the verdicts of Enu and Havi (2014). The final result emanating from our long run estimation expound the importance of interest rate as a significant macroeconomic determinant for manufacturing sector performance. While it conforms to theoretical expectations at both dimensions, it is unfortunately only significant at an increasing interest rate. In essence, a 1 per cent increase in interest rate is expected to wield a 0.21 per cent reduction in manufacturing sector performance. This is no surprise as a rising interest rate raises the cost of borrowing which could be unaffordable for many manufacturing firms, especially small and medium firms which dominates a larger section of the Nigerian manufacturing industry. This hence stiffens new investments and diversification activities of existing firms. This result should be disturbing because while the interest rate increase is inversely related to manufacturing sector performance in the long run, its decline will not translate into an increase in manufacturing performance. In other words, the declining manufacturing output will remain around even if the interest rate was adjusted downward after the initial increase. While this finding is in similitude to the verdicts of Tkalec and Vizek (2009), it, however, contradicts the judgment of Sukmana (2011).

The Short run Outcomes

The short run result from the lower part of Table 5 revealed the importance of GDP per capita, exchange rate, and shocks to manufacturing sector performance as critical determinants of manufacturing sector performance. Precisely, changes in manufacturing sector performance extending up to period lags is detrimental to achieve required immediate growth in the Nigerian manufacturing sector. In contrast, GDP per capita – at positive and negative changes – and exchange rate – positive change – at current periods are more likely to exert immediate impact towards improved manufacturing sector performance. However, the impact on manufacturing performance is detrimental when positive changes to exchange rate is extended beyond its current period, especially when extended to its second period lag. Similarly, negative changes to exchange rate at current period also pose a threat to manufacturing performance. In terms of asymmetry see Table 6, the estimates reveal that only exchange rate at current and 2 periods lag have asymmetric impact on manufacturing sector performance in Nigeria.

Table (6): Long and short run test of asymmetry

Test	F - Statistics	Decision
W_{LR}	4.9695*	Presence of asymmetry
EXR	5.4144**	Presence of asymmetry

CPI	1.6093	Asymmetry absent
GDPC	0.0783	Asymmetry absent
GFC	0.3819	Asymmetry absent
PLR	3.9167***	Presence of asymmetry
W_{SR}	3.9436**	Presence of asymmetry
GDPC	0.6940	Asymmetry absent
EXR (-2)	6.2721**	Presence of asymmetry
EXR	4.8028**	Presence of asymmetry

Note: *, **, *** denotes 1%, 5%, and 10% level of significance; W_{LR}: Overall Wald Long run; W_{SR}: Total Wald Short run; EXR: Exchange rate; CPI: Inflation rate; GDPC: real GDP per capital; GFC: Gross fixed capital formation; PLR: Prime lending rate.

Stability Test

To confirm the robustness of our statistical estimation stability test of cumulative sum CUSUM and cumulative sum of square CUSUMSQ developed by Brown, Durbin, & Evans (1975) was employed. Presented in Fig: 2, we confirm that the parameter estimates are stable within a NARDL framework.

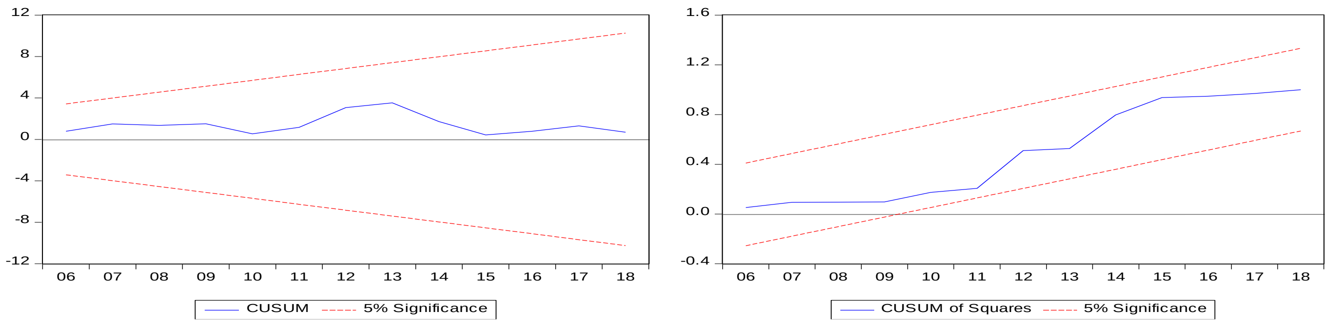

Figure (2): Plots of cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) for stability of the NARDL estimation.

Conclusion

This study investigates the macroeconomic determinants of manufacturing sector performance in Nigeria for the period 1981 – 2018. More specifically, we inspect whether manufacturing sector performance respond asymmetrically to changes in different macroeconomic determinants, a study area which has attracted miniature consideration in extant literature. Examining this empirical analysis within a Non – Linear Autoregressive Lag Model (NARDL) framework may help in specifying a reliable manufacturing policy. From the analysis, we find macroeconomic variables to have stern impact on manufacturing performance. Further, evidence for the existence of asymmetries both in the long and short run are glaring. More precisely, in the long run, if exchange rate increases, it stiffens the scope of manufacturing performance expressively. A diversion from this stance by the decrease in exchange rate result confirmed the hostile impact of rising exchange rate on manufacturing sector performance. Similar implication applied to variations in exchange rate in the short run. Its asymmetric properties at long and short run are apparent. Further, despite the unresponsive impact of its positive shocks, negative shocks to inflation contributed significantly to manufacturing sector performance. Maintaining a stable period of reduced inflation will lower the risk of unanticipated price increase and hence increase the chances of long-term manufacturing investments in Nigeria. Additionally, impact of GDP per capita is unfound in the long run but otherwise in the short run therefore explaining the relevant role of other manufacturing performance determining factors in the long run. Its asymmetric impact is unfound at both time periods. Lastly, the presence of long run asymmetric impact found for the rate of interest is absent for gross fixed capital formation. While both positive and negative shocks to fixed capital formation are important determinants, only positive shocks to interest rate is capable of driving changes in manufacturing sector performance. However, in the short run, inflation rate, gross fixed capital formation, and interest rate impacts on manufacturing performance are unresponsive. On the basis of these outcomes, recommendation from this study encourage continuous government practices towards:

reduced and stable exchange rate that makes the local currency stronger; low and stable rate of inflation; raise income and fixed capital accumulation; and lastly maintaining a low rate of interest.

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