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THE ROLE OF TECHNOLOGICAL AND TERMS OF TRADE SHOCKS ON INDUSTRIALISATION IN NIGERIA

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ABSTRACT

The industrial sector has been recognised as one of the catalyst for rapid economic growth and development. However, evidence shows that the contribution of the sector to Gross Domestic Product (GDP) has been relatively low in comparison to other sectors of the economy. In particular, the oil sector contributed 11.4 percent and 10.4 percent to GDP in 2013 and 2014, respectively, while the industrial sector accounted for 9.3 percent and 9.95 percent in the same period. The economic recession that started in late 2015 has only stressed the entire economy. The reports from the National Bureau of Statistics (NBS) revealed that the economy contracted by -1.30 percent in the fourth quarter of 2015, and by the first and second quarter of 2016, the economy declined by -0.36 percent and -2.06 percent, respectively. This suggests the presence of business cycle fluctuations in the Nigerian economy which was provoked by several shocks (Alege, 2009). The drivers of these shocks should be identified and addressed in order to ensure sustainable industrial development. Our economies are susceptible to both domestic and international shocks and these shocks can perturbate the outcome of any economy. Therefore, the research questions of the paper include the following: what are the drivers of the economy? To what extent do these shocks influence the economy? In particular what are the roles of technological and commodity trade shocks in the quest for industrialisation? Therefore, the main objective of this paper is to identify the shocks that are perturbing the Nigerian economy with a view to providing shock therapy to mitigate the effect of the shocks on the economy and industrialisation in particular. In order to achieve the objective of the paper, a

Real Business Cycle (RBC) methodology is proposed. This approach is termed "real" because they do not represent a failure of markets to clear but rather reflect the most efficient possible operation of the economy, given the structure of the economy. Other theories of the business cycle such as Keynesian economics and Monetarism see recession as the failure of some markets to clear. Therefore, the RBC provides the mechanism to explain how macro-economy responds to shocks in the economy. This approach follows Kydland and Prescott (1982), and a response to Lucas (1980) critique of macroeconomic models. The study documents the key stylised facts in relation to the contemporaneous movement, volatility and phase shift of the macroeconomic variables. Then, the paper proposes the Bayesian Vector Autoregressive (BVAR) in estimating the deep parameters of the model. Being a dynamic general equilibrium approach, it will facilitate the understanding the interactions between the different agents in the economy. Secondary data will be used for the analysis and will be obtained from both Local and International sources such as World Development Indicators and International Financial Statistics and Central Bank of Nigeria Statistical Bulletin. The major findings of the paper are that business cycles exist within the industrial sector and real shocks in the form of technology and terms of trade shocks are drivers of the macroeconomic fluctuations witnessed in the sector. Furthermore, the results from the stylised facts indicated that all the variables have a pro-cyclical relationship with industrial output. The study, therefore, recommends that efforts should be made by the government to take advantage of new technologies being developed daily. This will help improve efficiency, thereby, allowing industrial firms to produce better quality products in a cost-effective manner translating into more competitive products in the international market as well as at home. In addition, emphasis should be placed on infrastructural development in order to ensure that industrial products are not exhorbitant.

Keywords: *Industrialisation, Real business cycle, Bayesian vector autoregressive models, technological shocks,*

Introduction

It has been widely acclaimed that the industrial sector plays an important role in the development of any economy. According to Loto (2012), the sector serves as a catalyst in the modern economy, providing diverse dynamic benefits that are crucial for economic transformation. Simon and Awoyemi (2010) noted that some of the benefits of industrialisation include: the generation of employment opportunities, enhancement of income level, the production of goods and services, creation of foreign exchange earnings and it promotes the growth of investment. This, therefore, suggests that for a developing economy like, Nigeria, industrialisation is imperative for rapid and sustainable economic development. However, evidence shows that the contribution of the sector to Gross Domestic Product (GDP) has been relatively low in comparison to other major sectors of the economy. In particular, the oil sector contributed 11.4 percent and 10.4 percent to GDP in 2013 and 2014, respectively, while the industrial sector accounted for 9.3 percent and 9.95 percent in the same period. This statistics reveals how the industrial sector is lagging in terms of its contribution to the development of the Nigerian economy despite the numerous benefits that accrues from industrialisation.

The economic recession that started in late 2015 following the unexpected fall in oil prices has only put further stress on the entire economy as government revenue drastically declined and the shortage of foreign exchange earnings. The reports from the National Bureau of Statistics (NBS) revealed that the economy contracted by -1.30 percent in the fourth quarter of 2015, and by the first and second quarter of 2016, the economy declined by -0.36 percent and -2.06 percent, respectively. This suggests the presence of business cycle fluctuations in the Nigerian economy which was provoked by several shocks as indicated by Alege (2009). Business cycle can, therefore, be defined as cyclical periods of economic expansion or contraction that are induced by shocks to the economy. Sebastian and Volker (2012) identified that shocks causing macroeconomic fluctuations have been classified under two categories, real or nominal shocks. These shocks are, therefore, seen as drivers of business cycles that cause wave-like variations in macroeconomic variables. Hence, it becomes necessary for the drivers of these shocks to be identified and addressed in order to ensure sustainable industrial development.

The Nigerian economy is susceptible to both domestic and international shocks and these shocks can perturbate the outcome of any economy. Therefore, the research questions of the paper include the following: what are the drivers of the economy? To what extent do these shocks influence the economy? In particular what are the roles of technological and commodity trade shocks in the quest for industrialisation? Therefore, the main objective of this paper is to identify the shocks that are perturbing the Nigerian economy with a view to providing shock therapy to mitigate the effect of the shocks on the economy and industrialisation in particular. The first model is based on technological shocks and the second model on terms of trade shocks. Furthermore, the study documents the key stylised facts in relation to the contemporaneous movement, volatility and phase shift of the macroeconomic variables. In order to achieve the main objective, the paper makes use of the Bayesian Vector Autoregressive (BVAR) in estimating the deep parameters of the model. Being a dynamic general equilibrium approach, it will facilitate the understanding the interactions between the different agents in the economy.

In what follows, Section two provides a review of relevant literature, while Section three documents some stylised facts. The theoretical framework of the study is discussed in Section four. Section five presents the methodology of the study and Section six presents the results and discussion. The Summary, conclusion and recommendations of the study are highlighted in Section seven.

Literature Review

This section of the paper presents a review of relevant literature. Lall (1982) examined the level of technological activity in eight developing countries and the role of government policies towards strengthening industrial development. The study gathered data for analysis under the National technological capabilities framework. The major finding of the paper is that government policy affects all three components of technological development; incentives, capabilities and technological imports. Market-oriented policies that promote competition, specialization by comparative advantage, and free international flows of technology and capital, act as incentives; Policy interventions to promote physical and human capital development and technological effort is necessary to increase capabilities; and Technological imports from advanced countries is needed to promote technological development locally.

Ganley and Salmon (1997) investigated the disaggregated impact of monetary policy shocks on the output of 24 sectors of the UK economy, in order to determine the speed and degree of the reactions of firms in these sectors to an unexpected monetary tightening; and to examine whether these responses provide any evidence on the transmission mechanism of monetary policy using Vector autoregressive (VAR) approach. The results indicated that monetary policy has varying effects on the outputs of different sectors of the economy, at least in the short run. The range and timing of reductions in output reveal that some industries are more sensitive to tightening monetary policy conditions.

Bhattacharyya and Williamson (2009) explored Australian terms of trade and real exchange rate. The central aim was to examine how external price shocks affected resource allocation and the whole Australian economy by constructing an index of structural change and examining the manufacturing employment and output. The findings indicated that the economy experienced three major boom and bust periods. Furthermore, external price shocks in the form of terms of trade significantly affected the Australian economy. Simon and Awoyemi (2010) investigated the effect of manufacturing capacity utilisation on industrial development in Nigeria using co-integration and error correction mechanism as the tools of analysis. The study was able to find out that there is a positive long run relationship between manufacturing capacity utilisation and industrial productivity. However, the major drawback is the use of Johansen co-integration technique given that the key assumption of order of integration was not met.

Loto (2012) analysed the manufacturing sector of the Nigerian economy towards identifying whether the global economic downturn had a significant effect on the performance of the manufacturing sector using error correction approach. The results revealed that there was no significant difference before or after the event of the global economic crisis on the performance of the manufacturing sector. Similarly, Sola et al. (2013) examined the performance of the manufacturing sector in a quest for sustainable economic development in Nigeria using panel data analysis. The major finding of the work is that there is a positive relationship between the manufacturing sector performance and capacity utilisation.

Some Stylised Facts

Towards the establishment of business cycles and the documentation of some stylised facts between Industrial GDP (IGDP) and selected macroeconomic variables: household consumption (CONS), total investment (INV), government expenditure (GEX), total exports (EXM) and imports (IMP), an atheoretical technique is adopted in the form of the Hodrick-Prescott (HP) filter as used in the literature by Agenor *et al.,* (2000); Alege (2009); and Choudhary, Khan and Pasha (2017).

The HP filter is used for the purpose of examining three key statistical issues: first, is to examine the amplitude of fluctuations, that is, volatility and relative volatility. The former is derived from the percentage standard deviation of the series, while the latter is derived as a ratio of the percentage standard deviation of a series with respect to IGDP; second, is to determine the contemporaneous relationship of a series with IGDP. The aim is to ascertain whether a variable is pro-cyclical, countercyclical or acyclical which can be observed from the cross correlation. If the cross correlation is positive, negative or zero, then it is said to be pro-cyclical, countercyclical or acyclical, respectively. Third, is the issue of phase shift, that is, whether a variable changes before or after IGDP changes. Table 1 presents the results of the atheoretical method of analysis. The findings show that all the macroeconomic variables are much more volatile than IGDP indicating that shocks have the ability to leave a lasting impact on the economy. The cross-correlation reveals that there exists a strong pro-cyclical behaviour between household consumption and IGDP. This suggests that in the advent of a positive shock causing industrial output to rise, the volume of household consumption also tends to rise given the positive shock. It can also be observed that consumption is a lagging indicator in Nigeria which follows theoretical expectations. Investment and government expenditure also have a pro-cyclical relationship with industrial output (IGDP); however, investment is seen as a lagging indicator which is contrary to theoretical expectations. This observation suggests that investors are more or less sceptical or pessimistic about the growth of the industry, and would rather wait to see improvement in the sector before making any form of investment. Government expenditure, on the other hand, is a leading indicator for the industrial sector; this reflects the role the government plays towards the development of the industrial sector in Nigeria.

Total export and imports have a pro-cyclical relationship with IGDP. Furthermore, both variables are lagging indicators to the sector. The pro-cyclical relationship between the variables indicates that positive shocks causing a growth in the industrial sector leads to an increase in both exports and imports. The pro-cyclical relationship between imports and IGDP is not unexpected given that majority of the raw materials or equipments used in the sector are imported or purchased from abroad. Therefore, positive shocks leading to an increase in the demand and income of firms in the industry can also instigate the need for these firms to purchase more equipments and materials from abroad.

Table 1: Cyclical Behaviour of IGDP and Selected Variables

Variable	Vol.	Relative Vol.	Com. Correlation	Decision	Phase shift
IGDP	6.40%	-	-	-	-
CONS	10.43%	1.63	**0.46**	Pro-cyclical	Lagging
INV	19.20%	3.00	**0.36**	Pro-cyclical	Lagging

GEX	31.63%	4.94	**0.06**	Pro-cyclical	Leading
EXM	14.18%	2.22	**0.30**	Pro-cyclical	Lagging
IMP	24.71%	3.86	**0.41**	Pro-cyclical	Lagging

Source: Researchers' compilation using EViews 8.0

Note: Vol. represents the volatility of the cyclical component of the series; Relative vol. indicates the relative volatility of the series with respect to IGDP; Com. Correlation represents the contemporaneous correlation between IGDP and the variables.

Theoretical Framework

In order to examine the effects of technological and terms on trade shocks on industrial output in Nigeria, the real business cycle (RBC) theory is adopted as the theoretical framework of the study. The theory is linked to the paper by Kydland and Prescott (1982) who developed a model in order to examine how aggregate fluctuations in the United States economy responds to technology shocks. The paper was able to establish that technological shocks in the form of total factor productivity computed as the Solow residual is the cause of business cycles.

The key assumptions of the model are: an infinitely large number of similar individuals or households that take decisions on consumption, investment and labour supply over time. Furthermore these individuals are faced with budget and capital accumulation constraints that restrict them; firms in the economy seek to maximise profit given their cost constraints. Both firms and households operate within a competitive market system where prices are assumed to be given. According to McCallum (1988), the technological disturbance is the only source of macroeconomic fluctuations or business cycles in the economy.

Identified Real Shocks: Technology and Terms of Trade Shocks

Following the standard RBC model, as identified by Kydland and Prescott (1982), technological shock in the form of total factor productivity (TFP) is one of the identified real shock driving business cycles in the industrial sector in Nigeria. King and Rebelo (1999) noted that TFP is able to generate time series with similar patterns of persistence, co-movement and volatility of actual economies.

Changes in the terms of trade is the second real shock driving business cycles as identified by (Mendoza, 1995). Given that majority of developing economies are much more prone to variations in the terms of trade mainly as a result of their exports dominated by primary products it has the tendency to cause business cycles. Mendoza (1995) noted that the terms of trade shocks impacted upon aggregate economic activity in developed countries as a result of changes in the price of energy, while in developing countries, the effect was magnified by high export dependency on primary commodities.

Methodology

The study makes use of annual data from 1981 to 2015. The data were gathered from both domestic and international sources. The industrial gross domestic product (IGDP) was sourced from Central Bank of Nigeria Statistical Bulletin, while household final consumption (CONS); government final consumption (GEX); gross fixed investment (INV); total import (IMP) and total export (EXM), and terms of trade (TOT) were sourced from World Development Indicators (2016) published by the World Bank.

Two models are considered, the first model follows the work of Kyland and Prescott (1982) by incorporating technological shocks, whereas the second model considers only what happens to the economy in the advent of terms of trade shocks. The Bayesian vector autoregressive (BVAR) approach is used to estimate the impacts of these shocks using the impulse response analysis.

The use of the BVAR for this analysis emanates from the strengths of the technique over the standard VAR models. The BVAR model is able to overcome the problem of over-fitting commonly associated with VAR models where the lag structure is left unrestricted thereby leading to a heavily parameterised model (Ciccarelli and Rebucci, 2003). The BVAR model is able to overcome this problem by adopting a set of prior beliefs. The prior has certain assumptions about the data through which it basically makes an assumption about the way the system works expressed in a mathematical form. This, therefore, helps to make meaningful Bayesian predictions about the economy. For the purpose of this study the Litterman/Minnesota prior is adopted. Others prior distribution identified in the literature include: Diffuse prior, Normal-Diffuse prior, Normal-Wishart prior and the Natural Conjugate prior.

According to Ciccarelli and Rebucci (2003), the Litterman/Minnesota prior is based upon three statistical characteristics of time series data;

I. It assumes that there exists typical trending behaviour among macroeconomic time series data;

II. More recent values of a series contain much more information on the current value than past values of the series; and
III. The past value of a given variable contains more information on its current state than past values of other variables.

The application of these statistical characteristics gives rise to a multivariate random walk. Through the use of the Minnesota prior, the parameters of the model have the resulting effect:

I. The coefficients assigned to all lags other than the first one have a zero mean.
II. The number of lags influences the variance of the coefficients inversely.
III. The coefficient of the variables (x) in equation (y) is assigned a lower prior variance than those of variable (y).

Model Specification

The models with technological shock and terms of trade shocks are expressed in their implicit form, respectively as:

$$IGDP_t = f(CONS_t,\ INV_t,\ IMP_t,\ EXM_t, GEX_t, TFP_t) \quad (5.1)$$

$$IGDP_t = f(CONS_t,\ INV_t,\ IMP_t,\ EXM_t, GEX_t, TOT_t) \quad (5.2)$$

Where $IGDP_t$ is Industrial Gross Domestic Product at time t; $CONS_t$ is Household Consumption Expenditure at time t; INV_t is Gross Fixed Investment at time t; IMP_t is Total Import at time t; EXM_t is Total Export at time t; GEX_t is Government Final Consumption at time t; TFP_t is Total Factor Productivity at time t; and TOT_t is Terms of Trade at time t.

Given the assumption of a non-linear relationship between the dependent variable and the explanatory variables, the model can be explicitly written as:

$$IGDP_t = A(CONS_t^{\alpha 1},\ INV_t^{\alpha 2},\ IMP_t^{\alpha 3},\ EXM_t^{\alpha 4}, GEX_t^{\alpha 5}, TFP_t^{\alpha 6}\ \mu_t\ ) \quad (5.3)$$

$$IGDP_t = A(CONS_t^{\alpha 1},\ INV_t^{\alpha 2},\ IMP_t^{\alpha 3},\ EXM_t^{\alpha 4}, GEX_t^{\alpha 5}, TOT_t^{\alpha 6}\ \mu_t\ ) \quad (5.4)$$

In order to carry out the various estimation tests the model is linearised by taking the double log of both sides which is represented as:

$$LnIGDP_t = \alpha_0 + \alpha_1 LnCONS_t + \alpha_2 LnINV_t + \alpha_3 LnIMP_t + \alpha_4 LnEXM_t + \alpha_5 LnGEX_t + \alpha_6 LnTFP_t + \mu_t \quad (5.5)$$

$$\mathrm{LnIGDP_t} = \alpha_0 + \alpha_1 \mathrm{LnCONS_t} + \alpha_2 \mathrm{LnINV_t} + \alpha_3 \mathrm{LnIMP_t} + \alpha_4 \mathrm{LnEXM_t} + \alpha_5 \mathrm{LnGEX_t} + \alpha_6 \mathrm{LnTOT_t} + \mu_t \quad (5.6)$$

The vector autoregressive model (VAR) of this study is expressed following the specification of Wozniak (2016):

$$Y_t = \beta + \sum_{j=1}^{p} A_j Y_{t-j} + \mu_t \qquad t = 1,\ldots, T, \quad (5.7)$$

Where Y_t is a (N x 1) vector of endogenous variables, μ_t is a (N x 1) vector of error terms, β is an (N x 1) vector of the constant term, and A_j is an (N x N) square matrix of coefficients. The error term is assumed to be normally distributed with the mean set to a vector of zeros and with a covariance matrix Σ. This is denoted as:

$$\mu \sim N(0, \Sigma) \quad (5.8)$$

Model with Technological Shock

Equations 5.9 to 5.15 represent the reduced form of a VAR model incorporating the technological shock in the form of total factor productivity. The equations are represented in the logarithm form as follows:

$$\mathrm{LnIGDP}_t = \alpha_{10} + \sum_{j=1}^{P} \alpha_{11}^{j} \mathrm{LnCONS_{t-j}} + \sum_{j=1}^{P} \alpha_{12}^{j} \mathrm{LnINV_{t-j}} + \sum_{j=1}^{P} \alpha_{13}^{j} \mathrm{LnIMP_{t-j}} + \sum_{j=1}^{P} \alpha_{14}^{j} \mathrm{LnEXM_{t-j}} + \sum_{j=1}^{P} \alpha_{15}^{j} \mathrm{LnGEX_{t-j}} + \sum_{j=1}^{P} \alpha_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \alpha_{17}^{j} \mathrm{LnIGDP_{t-j}} + \mu_t^{\mathrm{RGDP}} \quad (5.9)$$

$$\mathrm{LnCONS}_t = \beta_{10} + \sum_{j=1}^{P} \beta_{11}^{j} \mathrm{LnIGDP_{t-j}} + \sum_{j=1}^{P} \beta_{12}^{j} \mathrm{LnINV_{t-j}} + \sum_{j=1}^{P} \beta_{13}^{j} \mathrm{LnIMP_{t-j}} + \sum_{j=1}^{P} \beta_{14}^{j} \mathrm{LnEXM_{t-j}} + \sum_{j=1}^{P} \beta_{15}^{j} \mathrm{LnGEX_{t-j}} + \sum_{j=1}^{P} \beta_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \beta_{17}^{j} \mathrm{LnCONS_{t-j}} + \mu_t^{\mathrm{CONS}} \quad (5.10)$$

$$\mathrm{LnINV}_t = \Omega_{10} + \sum_{j=1}^{P} \Omega_{11}^{j} \mathrm{LnCONS_{t-j}} + \sum_{j=1}^{P} \Omega_{12}^{j} \mathrm{LnIGDP_{t-j}} + \sum_{j=1}^{P} \Omega_{13}^{j} \mathrm{LnIMP_{t-j}} + \sum_{j=1}^{P} \Omega_{14}^{j} \mathrm{LnEXM_{t-j}} + \sum_{j=1}^{P} \Omega_{15}^{j} \mathrm{LnGEX_{t-j}} + \sum_{j=1}^{P} \Omega_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \Omega_{17}^{j} \mathrm{LnINV_{t-j}} + \mu_t^{\mathrm{INV}} \quad (5.11)$$

$$\mathrm{LnIMP}_t = \psi_{10} + \sum_{j=1}^{P} \psi_{11}^{j} \mathrm{LnCONS_{t-j}} + \sum_{j=1}^{P} \psi_{12}^{j} \mathrm{LnINV_{t-j}} + \sum_{j=1}^{P} \psi_{13}^{j} \mathrm{LnIGDP_{t-j}} + \sum_{j=1}^{P} \psi_{14}^{j} \mathrm{LnEXM_{t-j}} + \sum_{j=1}^{P} \psi_{15}^{j} \mathrm{LnGEX_{t-j}} + \sum_{j=1}^{P} \psi_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \psi_{17}^{j} \mathrm{LnIMP_{t-j}} + \mu_t^{\mathrm{IMP}} \quad (5.12)$$

$$\mathrm{LnEXM}_t = \phi_{10} + \sum_{j=1}^{P} \phi_{11}^{j} \mathrm{LnCONS_{t-j}} + \sum_{j=1}^{P} \phi_{12}^{j} \mathrm{LnINV_{t-j}} + \sum_{j=1}^{P} \phi_{13}^{j} \mathrm{LnIMP_{t-j}} + \sum_{j=1}^{P} \phi_{14}^{j} \mathrm{LnIGDP_{t-j}} + \sum_{j=1}^{P} \phi_{15}^{j} \mathrm{LnGEX_{t-j}} + \sum_{j=1}^{P} \phi_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \phi_{17}^{j} \mathrm{LnEXM_{t-j}} + \mu_t^{\mathrm{EXM}} \quad (5.13)$$

$$\mathrm{LnGEX}_t = \varphi_{10} + \sum_{j=1}^{P} \varphi_{11}^{j} \mathrm{LnCONS_{t-j}} + \sum_{j=1}^{P} \varphi_{12}^{j} \mathrm{LnINV_{t-j}} + \sum_{j=1}^{P} \varphi_{13}^{j} \mathrm{LnIMP_{t-j}} + \sum_{j=1}^{P} \varphi_{14}^{j} \mathrm{LnEXM_{t-j}} + \sum_{j=1}^{P} \varphi_{15}^{j} \mathrm{LnIGDP_{t-j}} + \sum_{j=1}^{P} \varphi_{16}^{j} \mathrm{LnTFP_{t-j}} + \sum_{j=1}^{P} \varphi_{17}^{j} \mathrm{LnGEX_{t-j}} + \mu_t^{\mathrm{GEX}} \quad (5.14)$$

$$\text{LnTFP}_t = \theta_{10} + \sum_{j=1}^{P} \theta_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \theta_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \theta_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \theta_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \theta_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \theta_{16}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \theta_{17}^{j} \text{LnTFP}_{t-j} + \mu_t^{\text{TFP}} \quad (5.15)$$

Model with Terms of Trade Shock

Equations 5.16 to 5.22 on the other hand presents the second model of the study which takes into account the terms of trade shock. The equations of the VAR system in the logarithm form for this study are thus presented as follows:

$$\text{LnIGDP}_t = \alpha_{10} + \sum_{j=1}^{P} \alpha_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \alpha_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \alpha_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \alpha_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \alpha_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \alpha_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \alpha_{17}^{j} \text{LnIGDP}_{t-j} + \mu_t^{\text{RGDP}} \quad (5.16)$$

$$\text{LnCONS}_t = \beta_{10} + \sum_{j=1}^{P} \beta_{11}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \beta_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \beta_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \beta_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \beta_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \beta_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \beta_{17}^{j} \text{LnCONS}_{t-j} + \mu_t^{\text{CONS}} \quad (5.17)$$

$$\text{LnINV}_t = \Omega_{10} + \sum_{j=1}^{P} \Omega_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \Omega_{12}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \Omega_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \Omega_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \Omega_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \Omega_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \Omega_{17}^{j} \text{LnINV}_{t-j} + \mu_t^{\text{INV}} \quad (5.18)$$

$$\text{LnIMP}_t = \psi_{10} + \sum_{j=1}^{P} \psi_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \psi_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \psi_{13}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \psi_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \psi_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \psi_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \psi_{17}^{j} \text{LnIMP}_{t-j} + \mu_t^{\text{IMP}} \quad (5.19)$$

$$\text{LnEXM}_t = \phi_{10} + \sum_{j=1}^{P} \phi_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \phi_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \phi_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \phi_{14}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \phi_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \phi_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \phi_{17}^{j} \text{LnEXM}_{t-j} + \mu_t^{\text{EXM}} \quad (5.20)$$

$$\text{LnGEX}_t = \varphi_{10} + \sum_{j=1}^{P} \varphi_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \varphi_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \varphi_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \varphi_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \varphi_{15}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \varphi_{16}^{j} \text{LnTOT}_{t-j} + \sum_{j=1}^{P} \varphi_{17}^{j} \text{LnGEX}_{t-j} + \mu_t^{\text{GEX}} \quad (5.21)$$

$$\text{LnTOT}_t = \theta_{10} + \sum_{j=1}^{P} \theta_{11}^{j} \text{LnCONS}_{t-j} + \sum_{j=1}^{P} \theta_{12}^{j} \text{LnINV}_{t-j} + \sum_{j=1}^{P} \theta_{13}^{j} \text{LnIMP}_{t-j} + \sum_{j=1}^{P} \theta_{14}^{j} \text{LnEXM}_{t-j} + \sum_{j=1}^{P} \theta_{15}^{j} \text{LnGEX}_{t-j} + \sum_{j=1}^{P} \theta_{16}^{j} \text{LnIGDP}_{t-j} + \sum_{j=1}^{P} \theta_{17}^{j} \text{LnTOT}_{t-j} + \mu_t^{\text{TOT}} \quad (5.22)$$

Given the equations above, the unknown parameters in the model to be estimated using the BVAR approach are α, β, Ω, ψ, ϕ, φ, θ, and Σ (variance-covariance matrix).

Results and Discussion

BVAR Stability Test

The BVAR stability test is carried out in order to make sure the system of equations specified in the model is stable (stationary) or not stable (non-stationary). This test is essential to ensure that the results obtained from the impulse response analysis to be valid. The Autoregressive (AR) roots analysis is adopted to check whether both models specified are stable for Nigeria. From the AR roots analysis, in the case where the modulus is less than one, then the model is considered to be stationary or stable. Where this is not so, then the model is considered to be explosive.

Table 2 represents the AR Roots Table for Nigeria with technological shocks. It can be seen that all the modulus are less than one, implying that the model with technological shocks is stable, and hence stationary. Therefore, the results obtained from the impulse response analysis are considered to be valid.

Table 2: AR Roots Table for Nigeria with Technological Shocks

Roots	Modulus
0.978516	0.978516
0.501125	0.501125
0.219829	0.219829
0.197248	0.197248
0.049780	0.049780
0.028202	0.028202
-0.016109	0.016109

Source: Researcher’s compilation using EViews 8.0

Table 3 on the other hand represents the AR Roots Table for Nigeria with terms of trade shocks. It can be seen that all the modulus are less than one, implying that the model with terms of trade shocks is stable, and hence stationary. Therefore, the results obtained from the impulse response analysis are considered to be valid.

Table 2: AR Roots Table for Nigeria with Terms of Trade Shocks

Roots	Modulus
0.931394	0.931394

0.539445	0.539445
0.238936	0.238936
0.125827	0.125827
0.041067	0.041067
-0.009374 - 0.010121i	0.013795
-0.009374 + 0.010121i	0.013795

Source: Researcher's compilation using EViews 8.0

Impulse Response

In this section, the results of the impulse response analyses (IRF) of the two models are presented and then compared. Figure 1 and Table 4 report the response of the macroeconomic variables to a one percent shock to technology, while Figure 2 and Table 5 present the response of the macroeconomic variables to a one percent shock to terms of trade.

From Figure 1, it can be seen that a shock to technology, total factor productivity, induces a positive effect on industrial output in Nigeria over the horizon. In particular, Table 4 shows us that a one percent shock to technology brings about a positive impact of about 15.5 percent and 23.8 percent on industrial output in the sixth and tenth period, respectively. Technology shocks also cause a positive effect on the other selected macroeconomic variables. It can be seen that it leads to an increase in the level of consumption in the economy which spurs the demand for goods and services causing significant investment to take place by manufacturing firms in other to meet up with this demand, ultimately ensuring that industrial output increases. The positive response of total exports and imports to a one percent technology shock is not surprising. As improvements in the level of technology bring about greater efficiency that makes industrial products more attractive and competitive. This potential leads to higher exportation of these products, however, given that majority of the industrial firms purchase raw materials and equipments from abroad, this gives reason to the positive effect upon total imports. Government spending, on the other hand, is seen to decline for the first two periods at the advent of a sudden shock to technology, but becomes positive in subsequent periods.

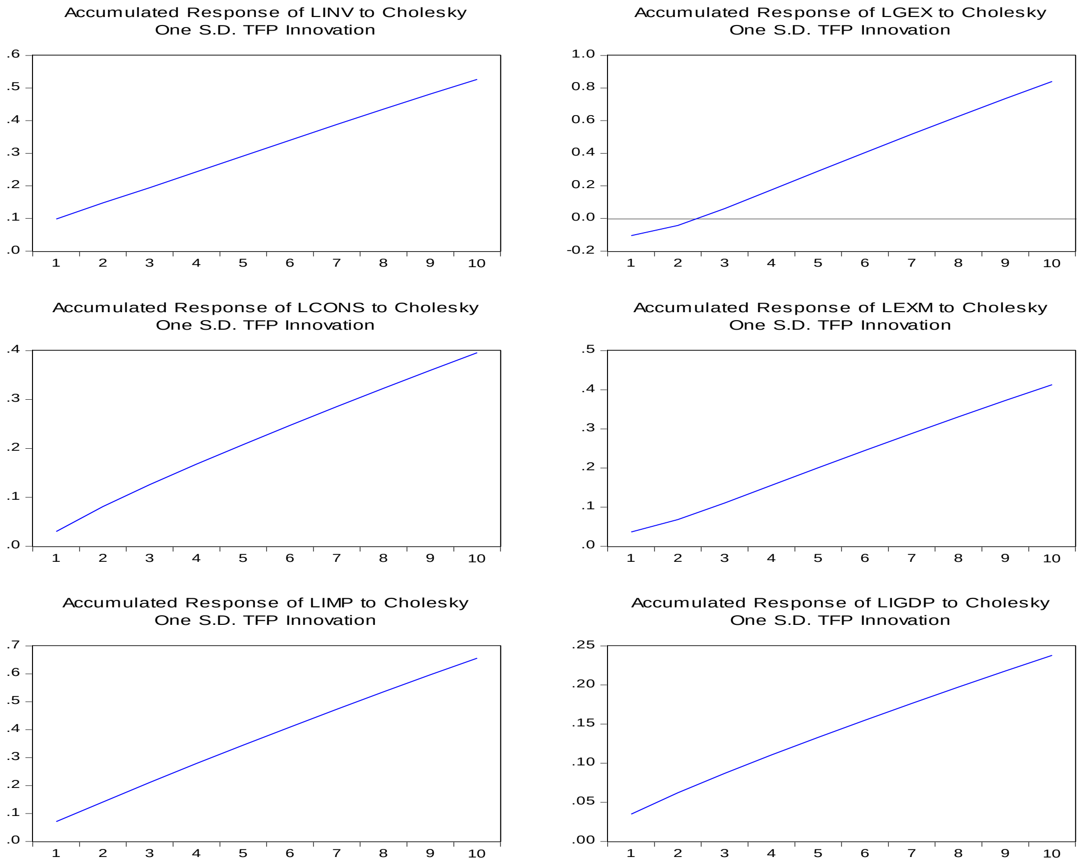

Figure 1: Impulse Response of the Macroeconomic Variables to a Technology Shock

Source: Researchers' compilation using EViews 8.0

Table 4: Impulse Response of the Macroeconomic Variables to a Technology Shock

Period	LINV	LGEX	LCONS	LEXM	LIMP	LIGDP
1	0.098023	-0.105471	0.030129	0.036523	0.070967	0.034911
2	0.147526	-0.042620	0.081125	0.068048	0.140994	0.062095
3	0.194384	0.060805	0.126020	0.110626	0.211014	0.086903
4	0.242761	0.174742	0.167738	0.155523	0.278644	0.110398
5	0.291649	0.290138	0.207910	0.200428	0.344722	0.133031
6	0.340254	0.404351	0.247071	0.244672	0.409534	0.155013
7	0.388182	0.516591	0.285371	0.288070	0.473102	0.176445
8	0.435258	0.626618	0.322851	0.330576	0.535399	0.197379
9	0.481410	0.734371	0.359533	0.372186	0.596411	0.217845
10	0.526614	0.839852	0.395430	0.412909	0.656140	0.237862

Source: Researchers' compilation using EViews 8.0

Similarly to the model with technology shock, a one percent shock to terms of trade leads to a largely positive impact on the selected macroeconomic variables. Examining the impact on industrial output, it can be observed that terms of trade shocks causes industrial output to rise over the horizon. In particular, it induces about 11.8 percent and 22.3 percent in the third and seventh period, respectively. This positive effect indicates that as the terms of trade improves; it tends to lead to an increase in real income causing business expectation to rise impacting the financial market in which the industrial sector can take advantage of as industrial output increases.

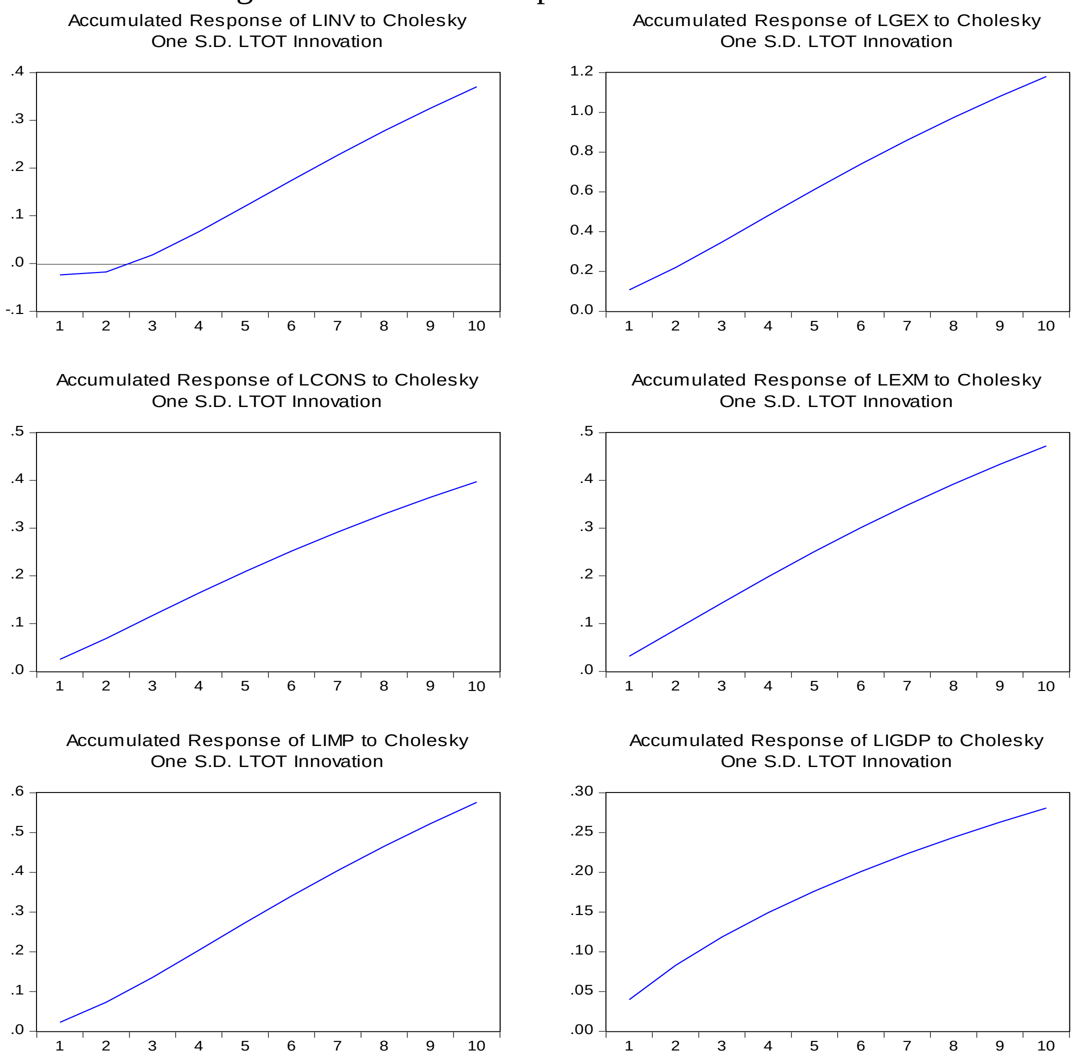

Figure 2: Impulse Response of the Macroeconomic Variables to Terms of Trade Shock

Source: Researchers' compilation using EViews 8.0

Table 5: Impulse Response of the Macroeconomic Variables to Terms of Trade Shock

Period	LINV	LGEX	LCONS	LEXM	LIMP	LIGDP
1	-0.023821	0.107105	0.025160	0.031844	0.022306	0.039697
2	-0.017678	0.219569	0.069021	0.087387	0.072819	0.082923
3	0.018105	0.347711	0.116801	0.143247	0.135302	0.118620
4	0.066669	0.480909	0.163926	0.198203	0.203714	0.149274
5	0.120087	0.612781	0.209105	0.251023	0.272898	0.176403
6	0.174262	0.739893	0.251851	0.301122	0.340249	0.200901
7	0.227108	0.860615	0.292016	0.348276	0.404541	0.223301
8	0.277617	0.974315	0.329614	0.392463	0.465260	0.243940
9	0.325357	1.080896	0.364735	0.433762	0.522266	0.263041
10	0.370197	1.180533	0.397500	0.472306	0.575605	0.280767

Source: Researchers' compilation using EViews 8.0

In comparison, we find out that both shocks generally induce a positive effect on industrial output in Nigeria. However, the results show that terms of trade shock leads to a much higher impact on the level of industrial output in Nigeria.

Summary, Conclusion and Recommendations

This paper was conducted in order to provide answers to three key research questions: what are the drivers of the economy? To what extent do these shocks influence the economy? In particular what are the roles of technological and commodity trade shocks in the quest for industrialisation? Following the theoretical framework of the Real Business Cycle that identified real shocks as the drivers of business cycles, the paper was able to empirically determine that business cycles exist within the industrial sector and real shocks in the form of technology and terms of trade shocks are drivers of the macroeconomic fluctuations witnessed in the sector. In addition, it was identified that these a positive shock to technology and terms of trade largely induces a positive effect on industrial output. Furthermore, the study also documented some salient stylised facts between industrial output and some selected macroeconomic variables. One major finding here is that all the variables have a pro-cyclical relationship with industrial output. That is, they tend to increase during periods of economic expansion and decline during periods of economic recession.

In a bid to provide a shock therapy taking into consideration the roles of technological and commodity terms of trade shocks, the paper makes the following recommendations: first, efforts should be made by the government to take advantage of new technologies being developed daily. This will help improve efficiency, thereby, allowing industrial firms to produce better quality products in a cost-effective manner translating into more competitive products in the international market as well as at home. Second, emphasis should be placed on infrastructural development in order to ensure that industrial products are not exhorbitant. Third, investment is seen to be a lagging indicator to industrial output which is contrary to expectations. This suggests that the low confidence in the industrial sector by investors. Therefore, there is the urgent need for the promotion of the industrial sector taking into consideration the diverse economic benefits the sector offers for sustainable development. The confidence can be improved by offering tax reliefs to firms in the industry towards reducing their cost of production. Furthermore, the government can offer financial aid in the procurement of the needed raw materials and equipments. Finally, it can be seen that a positive shock to commodity terms of trade induces a positive effect on industrial output. This calls for the need diversification of the export base of the entire economy that will translate into the growth of the industrial sector.

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