Commodity Price Shock and Economic Performance: An Empirical Evidence for Nigeria

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Abstract

Interconnected economies in the world commodity market may cause external shocks that slow indigenous countries' economic growth and development. Nigeria is a commodity-dependent country, hence, commodity price shocks have harmed its institutional and fiscal framework for economic growth, despite efforts to save the economy. It is crucial to assess the effects of local and external commodity price volatility shocks on emerging nations' growth since they plunge millions into abject poverty. It is in this context, this study examines commodity price shock and economic performance with an empirical evidence for Nigeria. This study employs Multivariate Generalized Autoregressive Conditional Heteroscedasticity (MGARCH) to capture both gradual and unexpected changes in commodity price shock in Nigeria from 1980Q1 – 2021Q1. The results showed positive volatility shock effect on each variable caused by its past innovations while parameters of the independent variables indicated innovations of shock effects on economic performance. Also exports of other non-oil commodities can reduce dependence of real exchange rate on world commodity prices by having more diversified exports. The study recommends for diversification towards agricultural production to stabilize the real exchange rate of Naira from world commodity price shocks. Finally, Nigeria can protect her competitiveness from fluctuations in world commodity prices by being more opened to external trade.

Keywords: Commodity Price, Shock, Multivariate GARCH, Economic Growth.

JEL Classification: E31; E32; F43

1. Introduction
Over the years, several events highlighted the complex and volatile relationship between the global commodity markets and economic activities in emerging market of developing

economies, particularly in Africa. The global economy is the interwoven of world countries affected by each other through different types of economic activities in international trade relationship which tend to influence countries domestic performance in terms of economic growth and development. Any sudden turbulence in the activity of the global economy may propagate as external shocks to respective indigenous countries there by retarding their economic performance. Existing evidence suggests that the recent economic growth volatility relative to the boom in commodities particularly before the COVID 19, was caused by China and its insatiable appetite for commodities (Yu, 2011). An open economy like Nigeria that is free to international trade and is too small to individually influence global activity will perceive this sudden turbulence as external shock, hence, bringing disruption in Nigeria's domestic economic activities.

Elbadawi & Ndulu (1996) provided support for the notion that external shocks exert an indirect influence on economic growth by prompting policy adjustments that frequently exacerbate subpar economic performance. During the late 1990s, there was a notable and prolonged surge in global commodity prices. Despite experiencing a significant decline in 2014, commodity prices were mostly influenced by the drastic drop in crude oil prices. However, they have subsequently witnessed a partial rebound, aligning with the cyclical resurgence of the global economy. In contrast to a conventional price cycle, this occurrence has been identified as a "super cycle," which refers to a prolonged increase in commodity prices driven by demand, perhaps spanning decades rather than years (Jacks, 2013, Cuddington & Jerrett, 2008).

One of the concerns for policymakers is how commodity price volatility could spill over into price levels of goods and services other than commodities, precisely, on general economic activities. Hence, the Nigerian economy is not an exception. Several efforts have been made by the United Nations for addressing economic growth volatility following the establishment of price stabilization schemes. Many different international commodity agreements were adopted with the sole aim to stabilize prices in order to contend economic growth performance especially of developing countries; such include international agreements on sugar, coffee, cocoa, and natural robber established in 1954, 1962, 1972 and 1980 respectively, (UNCTAD 2017, Ferraro & Peretto, 2017). Considering the inherent characteristics of the Nigerian economy, particularly with regard to the adverse consequences of fluctuations in commodity prices on both economic growth and welfare, it becomes imperative to devise strategic policy measures aimed at effectively mitigating the escalating menace of unemployment. The resolution of this issue necessitates prompt and focused efforts by policymakers to implement a range of initiatives that can facilitate rapid solutions to the problem of volatility in the short term. The growth trajectory of many African countries is heavily influenced by developments in the commodity sector. The correlation between international commodity

prices and economic performance is significant and intricate (Bruckner and Ciccone, 2010). Commodity prices provide significant economic incentives that influence decisions pertaining to governmental expenditure, employment, consumption, resource allocation, and trade. The relationship between reliance on commodities and macroeconomic indicators is a fundamental element of fiscal policy. Therefore, the fluctuations in commodity prices frequently influence the developmental outcomes of nations in sub-Saharan Africa (UNCTAD, 2017).

According to the World Bank (2015), between 1990 -1999, the proportion of commodities in the export composition of sub-Saharan Africa had an increase from 57% to 76% over the period of 2010-2014. A comparable phenomenon, but with a lesser degree of spread, has been observed in the region of North Africa. The level of dependence has been notably significant for countries that export oil, as seen by the fact that oil constituted over 90% of exports in 2015 for the three major oil producers, namely Algeria, Angola, and Nigeria. Commodity-exporting nations, aside from the subject under discussion, have exhibited a lesser degree of dependence on commodity exports. In the three main oil-exporting countries, oil has constituted a significant proportion of fiscal income, ranging from approximately 50% to 66% for the year 2015. The observed substantial decrease in oil prices since 2014 has directly and significantly impacted fiscal income. The effect on gross domestic product (GDP) was generally less pronounced, as commodity production typically represents a smaller proportion of overall production compared to exports. Oil constituted between 10% and 33% of the Gross Domestic Product (GDP) in Algeria, Angola, and Nigeria. Hence, it can be observed that the decline in commodity prices has had a mitigated effect on GDP growth due to presence of other sectors, namely agriculture and services. However, it is important to note that these sectors have also had indirect repercussions from the sectors directly impacted by the decrease in commodity prices (Foreso, Yuan, & Yang, 2015).

According to Gunu & Kilishi (2010), Nigeria is classified as one of the nations that heavily relies on commodities for its economic sustenance. Over time, the nation's capacity to establish a robust institutional and fiscal structure conducive to achieving sustainable economic growth has been consistently hindered by external market shocks, despite significant endeavours to revive the economy. During moments of economic downturn, the efficacy of expansionary fiscal policies is often hindered in the nation, since the government frequently engages in impulsive underspending. This is due to the inherent challenges associated with government intervention in influencing commodities prices and rents. The increase in Nigeria's state debt in 2015 can be attributed to the large decline in worldwide market prices (Proshare, 2018). In view of the preceding review, it is evident that there is paucity of empirical findings on the nature and extent of commodity price shock in the performance of Nigerian economy. Hence, the thrust of

this study is hinged on examining and enhancing the understanding of the linkages between commodity prices and economic growth in Nigeria. Therefore, the relative impact among the variables of the study can be analyzed in order to capture the most important propagating highest shock to the economy. To this end, this research intends to examine the commodity price shock and economic performance with an empirical evidence for Nigeria, by exploring these shocks for policy purposes and other relevant information. Other specific objectives for this study include; analyzing the nature and extent of commodity price shock that affects economic performance in Nigerian using MGARCH. The study also uses longer time series data than those of previous studies on developing economies like Nigeria, which enables the study to use estimation techniques that are more appropriate in the study.

However, the analysis of commodity price shock and its impact on economic performance is important because of its consequences on the development of the economy. It will give an insight on how well the Nigerian economy is doing. Therefore, estimating shock of commodity prices is important in order to analyze the effect of the shocks on the aggregate growth rates in order to know whether the shock leads to some instability in the growth process by enlarging the disequilibrium in the fiscal or the external sectors. It is evident that understanding commodity price shock transmission mechanisms is essential for both international investors and policy makers (Mensi et al., 2013, Wright, 2001 and Deaton, 1999), especially for designing more appropriate policies for the long-run growth of Nigerian economy.

2. Literature Review

According to Masson (2014), the occurrence of commodity booms often leads to increase in capital inflows and the accumulation of foreign currency debt by local borrowers. However, this excessive accumulation of debt becomes problematic when the bust phase of the commodity cycle occurs. The phenomenon of rapid expansion in domestic lending, typically expressed in foreign currency, has repeatedly intensified the buildup of precarious debt (Koh et al., 2020). According to Ostry et al. (2010), the influx of capital can lead to a concurrent increase in the real value of the domestic currency. This can occur either through nominal currency appreciation or domestic inflation. As a result, the non-tradable sector may experience a decline in competitiveness, hence impeding economic diversification. Frequently, episodes of increased capital inflows and excessive risk tolerance among lenders during periods of rising prices establish the foundation for systemic financial crises when commodities prices experience a downturn. The phenomenon of capital flight exacerbates the adverse economic consequences associated with a decline in commodity prices. Baffes & Kabundi. (2021), noted that commodity markets exhibit heterogeneity with regards to the factors that drive them, their pricing dynamics, and their macroeconomic implications for emerging market and developing

economies (EMDEs). Policy makers frequently exhibit tendency to perceive commodities as homogeneous entities. Consequently, they may misread the underlying factors that drive fluctuations in prices and fail to fully comprehend the subsequent consequences. This, in turn, might result in the formulation of inadequate policy measures as a response. In order to develop effective policy measures, it is imperative to possess a comprehensive understanding of the variances that exist across commodity markets. However, this study defines Commodity price behaviour as nature and patterns of commodity price changes that indicate the complex and volatile relationship between commodity markets and economic activity.

The study conducted by Medina & Soto (2014) noted that, the volatility experienced in numerous open economies, such as Nigeria, can be attributed to the significant impact of swings in commodity prices. The transmission mechanism of these oscillations is contingent upon the manner in which fiscal and monetary policies are implemented. In numerous economies, taxes levied on the production and exportation of commodities constitute a significant portion of national revenues. When there is an increase in the pricing of exported commodities, the public budget restriction becomes less restrictive, allowing for greater flexibility in expanding public expenditure. According to Saggu & Anukoonwattaka, (2015), there are three factors that mitigate global commodity price shock in the recent years which are as follows: Demand side factors; which include china's transition to 'new normal' of lower and more sustainable growth, continued Eurozone stagnation and Greek instability and lower growth across commodity exporting economies among others. Supply side factors, these include shale- energy boom in United states, opec's strategy shift towards price targeting to maintain market share, export bans on certain minerals and record agricultural harvests in the united states. Monetary factors, these include lowering commodity prices in dollar-denominated goods and services through the United States' dollar appreciation and expected interest rate tightening by the monetary authorities.

Commodity price shock is seen as change to fundamental macroeconomic variables or relationships that has a substantial effect on macroeconomic outcomes and measures of economic performance, such as unemployment, consumption, and inflation through the transmission channels of goods and services. Shocks are often unpredictable and are usually the result of events thought to be beyond the scope of normal economic transactions (Baffes and Kabundi, 2021). Several research investigations, together with anecdotal accounts, suggest the existence of shared patterns in global commodity prices. The phenomenon of significant correlation observed in the pricing of several commodities that appear to be unconnected may appear perplexing, considering the multitude of distinct factors influencing supply and demand within each respective market. Pindyck & Rotemberg (1990) characterized the occurrence as "excess co-

movement" within the realm of commodities prices. This study regards commodity price shocks as price booms and burst that had a heterogenous impact across economic environment which can lead to pro-cyclical patterns in public spending to intensify global inflationary pressures and indirectly create credit booms and busts in EMDEs by amplifying macroeconomic effects on the general economic system.

Nnanna, Englama & Odoko, (2004), refers economic growth to capacity of an economy to augment the output of products and services by utilising the available capital stock and other sources of production inside the economy. Therefore, it encompasses the augmentation of per capita income, resulting in achievement of superior quality of life comparable to that of developed nations (Todaro & Smith, 2011; Ughulu & Ajayi, 2020). From a theoretical perspective, it may be argued that economic growth plays a pivotal role in driving the trajectory of economic development (Sen, 1983).

The measurement of economic performance serves as an indicator of a nation's economic growth, reflecting an expansion in the economy's ability to generate products and services over time. Typically, the measurement of economic growth entails assessing the percentage fluctuations in real GDP, which represents the whole tangible production of a country. Measurement can be conducted in either nominal or real terms, with the latter being modified to account for inflation. In conventional practice, the assessment of overall economic performance and expansion is typically conducted through utilization of gross national product (GNP) or gross domestic product (GDP), but alternative measures are occasionally employed (Barro & Martin, 2004). The customary approach involves quantifying rate of growth in real gross domestic product (RGDP) as percentage typically in per capita terms. However, the concept of economic growth in this study, pertains to the progressive augmentation of real production per unit of resources or the overall wealth of a nation over a given period.

Empirical Literature
Commodity prices have become volatile over past two decades and their recent sharp decline has decreased the consumer price index inflation rates for most economies. Following the global oil price collapse of 2014, food production costs declined but the diversion of food commodities to biofuel production remained in place. Arigoni (2020) study different sources of real commodity price movements originating at global level with their effects on resource-rich economies using Australia and South Africa as illustrative instances using structural VAR with sign restriction. Findings show that considerable share of volatility in domestic business cycle(s) has to be attributed to world shocks. Also found identification of world trade shocks proves to be a key point of the empirical analysis, being the main drivers of real commodity prices and commodity currencies fluctuations (exchange rate). The study recommend that

disentangling tradable sector between commodity and non-commodity will be crucial point to enlarge comprehension of the different channels through which world shocks operate.

In a separate investigation conducted by Tiawara & Nathalie (2015) titled "The Impact of Commodity Prices on African Economic Growth," the objective was to analyze the influence of commodity prices on the economic well-being of African nations through utilization of a panel regression model. The findings of this study indicated that the outcomes were inconclusive, with the estimates demonstrating statistical insignificance. Nevertheless, the analysis of the impulse response functions suggest that a rise in commodity prices is more likely to have positive effect on African economies rather than causing detrimental impacts. On the other hand, Dehn (2000) previously presented the proof. The individual conducted an analysis on the volatility and disturbances in commodity prices, examining their potential implications on economic growth. The objective of the study was to analyze the impact of ex post shocks and ex ante pricing uncertainty on economic growth through the utilization of the GARCH Model. The data indicate that negative shocks have a significant impact on growth, regardless of investment. This shows that adjustment occurs through significant reductions in capacity utilization.

In their study, Álvarez, Edward, and Wlasiuk (2015) conducted an analysis on the relationship between Commodity Boom and Latin American Economic Growth, employing the Error Correction Model. The primary aims of the study were to examine the influence of commodity price levels on economic growth, with a specific emphasis on the Latin American region during the current commodities boom. Additionally, the study sought to investigate whether alterations in the policy framework have mitigated the vulnerability to fluctuations in commodity prices. The analysis revealed that there is a negative impact on long-term economic growth as a result of rises in commodity prices. However, it was observed that in the near term, these price increase generally have a favourable effect. The authors contended that, in the context of the recent economic upturn, the influence of commodity prices exhibited distinct qualitative characteristics in Latin America compared to past occurrences and other regions globally. Additionally, it was discovered that countries with low fiscal procyclicality experience a greater impact from rises in commodity prices.

On cross-country research, Ramey and Ramey (1995) conducted an assessment of relationship between volatility and economic growth in a dataset comprising 92 nations. The findings of the study indicate a positive correlation between higher levels of volatility and lower rates of economic growth in countries. Similarly, a study conducted by Addison and Ghoshray (2013) investigated the relationship between agricultural

commodity price shocks and economic growth in sub-Saharan Africa. The authors employed a Vector Autoregression (VAR) model to analyze impact of these shocks on GDP per capita growth in the region. The findings revealed that fluctuations in commodity prices had an asymmetric effect on economic growth in sub-Saharan Africa. There are modest differences between the studies conducted by Addison and Ghoshray and that of Ramey and Ramey, which can be attributed to variations in the selection of control variables employed. The utilisation of a linear model in the majority of existing investigations may have contributed to the amplification of contradicting results. The examination of this topic will be conducted through the utilisation of the business cycle model, which is a theoretical framework produced by the New Keynesian School. This model aims to describe the phenomena of volatility in Africa's economic conditions.

The study conducted by Ingram (2014) titled "Concentration of Commodity Price Changes at the End of the Cycle" examines the phenomenon of commodity price fluctuations. The primary aims of the study were to investigate novel methodologies for analyzing the cyclical patterns of global commodity prices and to examine the impact of various shocks on the behaviour of these prices. The investigation employed a Markov-switching model that incorporated time-varying conditional probability estimates. The findings indicate that in periods of increased commodity prices, there is a tendency for accelerated growth to manifest predominantly in the latter stages of the boom. Similarly, the majority of price declines tend to occur during the latter stages of economic downturns.

Zhang, Hu, Jiao & Wang (2022) conducted a study that employed Bibliometrics analysis to investigate the impact of commodity price changes on macroeconomic operations, production activities, and the welfare and security of individuals. The study aimed to explore the prevailing trend of commodity prices. The study revealed that the focal points of research in this particular topic are mostly centered on four key areas: the examination of variables that influence commodity prices, the analysis of how price fluctuations affect the macro economy, the development of commodity price forecasts, and the investigation of the financialization of commodities. The study suggests potential avenues for future research in this domain, which originated from investigations into oil shocks four decades ago. These future directions may entail further exploration of the influence of various factors and the corresponding strategies that can be employed to address emergencies on commodity prices. Additionally, there is a need to continue advancing more effective approaches for forecasting commodity prices.

Cashin et al. (2002) conducted an analysis on the cyclical patterns of booms and slumps in global commodity prices, employing the Bry and Boschan (1971) algorithm for this

purpose. The researchers' discoveries demonstrate an asymmetry in the cycles of commodity prices, leading to the emergence of several established patterns regarding the behaviour of real commodity prices. Furthermore, the evidence supports the notion that the effects of price declines during economic downturns tend to persist for a longer duration compared to periods of price booms. The findings indicate that these occurrences are frequently characterised by extended periods of stagnation, interspersed by sudden and significant increases. Similarly, Deaton & Laroque (1992) observed a downward trend in the long term, whereas Grilli & Yang (1988) contended that fluctuations in commodity prices exhibit a prolonged persistence spanning multiple years.

Hence, the period from mid-2014 to 2016 witnessed a notable decrease in commodity prices, which presented considerable obstacles for economies reliant on commodity exports, notably for Nigeria, a tiny open economy. The significant terms of trade shock linked to a substantial decline in global commodity prices had prompted inquiries on the sustainability of fixed exchange rate systems. In recent times, the COVID-19 pandemic and the necessary containment measures have caused substantial disruptions in various economic sectors, notably the travel, tourism, and hospitality industry. These disruptions have contributed to a decline in commodity prices, a significant decrease in foreign exchange earnings, and a decrease in economic activity in many countries that heavily rely on commodity exports (Al-Sadiq, Bejar & Ötker 2021).

Theoretical Framework
The theoretical framework of the study is based on development of RBC by Kydland & Prescott (1982), King and Rebelo (1999) and more recently Rebelo (2005) as well as Bhattacharya & Kar (2011) who examine shocks, economic growth and the Indian economy using RBC as their theoretical foundation. In evaluating RBC theoretical model, Kydland and Prescott (1982), introduced an idea to dynamic general equilibrium model by unifying business cycle and growth theory which must be consistent with the empirical regularity of long-term growth. According to CBN (2016), Business cycle is the swing in economic activities. It is the pattern of expansion, contraction, and recovery of an economy. A business cycle is generally classified by changes in GDP (in terms of the value of goods and services produced by a country over a period of time). It is usually expressed as boom and bust that occurred in an economy. Boom cycle is characterised by high positive growth, measured by indicators such as rising employment, high GDP growth, and high consumption spending, all in real terms. It is also characterised by an efficient market, rising housing prices and increasing wages. However, negative GDP growth, high unemployment rate, low savings and investments are features of a bust cycle. Business cycles may exhibit peculiar features depending on the fundamentals of the economy.

3. Methodology

This study uses ARCH model by Engel (1982) which can be generalized to an ARCH (p) model in resolving problem of negative estimates. The ARCH model resembles more of a moving average specification than an autorregression. Hence Bollerslev (1986) developed the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model. The GARCH model is a parsimonious model that use the lagged conditional variance terms as autoregressive terms. While efficiency of estimation is improved in the GARCH model, it can also be used to capture long lagged effects. The GARCH model is used here particularly to observe the mean reverting process of the shock on commodity prices and economic growth. It captured the conditional and time-varying variance as well as the behavior of the conditional variance of the commodity prices riskiness on Nigeria's economic growth.

The study utilizes quarterly time series data covering the period from 1980Q1 - 2021Q1. The data is mainly sourced from the statistical bulletin of the Central Bank of Nigeria (2018, 2019 & 2020) National Bureau of Statistics (2018 & 2019) and World Development Indicators (World Bank, 2018 & 2019). The choice of period is based on data availability that will permit empirical analysis of the impact of commodity price shock on economic performance in Nigeria. Due to time constraint, inadequate financial capacity and further unforeseen circumstances, the study is limited to Nigeria.

The dependent variable for the study is economic growth as economic performance while industrial price level, crude oil price level, export price index of goods and services, import price index of goods and services exchange rate and interest rate levels are the exogenous variables in the model.

This study examines impact of shock between commodity price variables using Multivariate Generalized Autoregressive Conditional Heteroschedasticity (MGARCH). The MGARCH model used can best capture both gradual and unexpected changes in commodity price levels and analyze the impact of commodity price shock on economic performance. In order to have a valuable insight into the dataset, the study presents a descriptive statistics and trend analysis of the variables used. For the purpose of this study, unit root test using Augmented Dickey-Fuller (ADF) (1997; 1981) are considered. Autocorrelation test, heteroscedasticity and stability test are carried out on the estimated model. The lagrangian multiplier (LM) is used to determine the direction of influence and causality between the variables in the model. It shows directional relationship between dependent and independent variables.

Table 1: Variables Operationalsation

Variable	Proxies	Notation	Measurement	Apriori Expectation
Economic Performance	Real GDP Growth rate	$RGDP_t$	Gross domestic Product (GDP) Growth rate	
Industrial Production	Real value manufacturing sector output	$INDP_t$	total output production by the industrial establishments	Positive
Crude Oil Production	Real value of daily crude oil production	$COILP_t$	index of export price of crude oil	Positive
Export of Goods & Services	Real value of export of goods & services	EXP_t	exports of goods and services in nominal Naira	Positive
Import of Goods & Services	Real value of import of goods & services	IMP_t	imports of goods and services in nominal Naira	Negative
Exchange Rate	Real value of US dollar exchange ratr to Naira	$EXCR_t$	End point return quarterly values of US dollar to Naira	Negative
Interest Rate	Domestic level of interest rate	$INTR_t$	Fixed banking lending rate by CBN	Negative

In order to achieve objectives for this study, we follow the work of Lee, et al. (1995) using univariate generalized autoregressive conditional heteroscedasticity (GARCH, 1, 1) model. Also the equation for the study is modeled following the similar work of Upreti (2015) Abounoori and Nademi (2010) and Akpan and Abang (2013) as follows; Economic performance = Real Gross Domestic Product. Therefore, following Upreti (2015) and Oyalabu & Oyalabu (2023), the estimated equation for the study is therefore modeled as;

$$RGDP_t = f\,(INDP_t,\ COILP_t,\ EXP_t,\ IMP_t,\ EXCR_t,\ INTR_t)\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ 1$$

The empirical mathematical equation of the model is written as;

$$RGDP_t = \alpha_o + \beta_1 INDP_t + \beta_2 COILP_t, + \beta_3 EXP_t, + \beta_4 IMP_{t\,+} \beta_5 EXCR_t, + \beta_6 INTR_t \ldots\ldots\ldots\ 2$$

The econometric equation for the study is modeled as;

$$RGDP_t = \alpha_o + \beta_1 INDP_t + \beta_2 COILP_t, + \beta_3 EXP_t, + \beta_4 IMP_{t\,+} \beta_5 EXCR_t, + \beta_6 INTR_t + \varepsilon_t \ldots.. 3$$

Error term is assumed to be normally independent and identically distributed with zero mean and constant variance i.e ($\varepsilon_t \sim NIID(0,\ I_k)$). Thus, the empirical equation of the study is formulated as;

$$RGDP_t = \alpha_o + \beta_1 INDP_t + \beta_2 COILP_t, + \beta_3 EXP_t, + \beta_4 IMP_{t\,+} \beta_5 EXCR_t, + \beta_6 INTR_t + \varepsilon_t \ldots.. 4$$

Whereby; $RGDP_t$ = Real Gross domestic product, $INDP_t$ = Industrial production, $COILP_t$ = Real Crude oil production (Export level), EXP_t = Real Export (Agricultural goods, Raw

materials, Solid minerals, Manufactured goods, other oil products and Energy goods), IMP_t = Real Import (Agricultural goods, Raw materials, Solid minerals Manufactured goods, Energy goods and other oil products), $REXR_t$ = Real exchange rate of the naira and $INTR_t$ = Real Interest rate, ε_t = Error term assumption to be normally distributed with zero mean and constant variance and they are the impulse, innovations or shocks, a_o = parameter to be estimated, $\beta_1 - \beta_6$ = long term parameter estimators and t = time period. Given equation (4) in log form we have;

$RGDP_t = a_o + \beta_1 logINDP_t + \beta_2 logCOILP_t, + \beta_3 logEXP_t, + \beta_4 logIMP_t + \beta_5 logEXCR_t, + \beta_6 logINTR_t + \varepsilon_t$…………………………………………………………………………...… 5

The MGARCH model, also known as the multivariate generalised autoregressive conditional heteroskedasticity model, is a statistical model used to analyse and forecast the volatility of many time series simultaneously. In recent years, there has been significant research on multivariate GARCH models, with various specifications explored in the existing literature (Bauwens, Laurent & Rombouts, 2006). For a comprehensive overview, readers are referred to the work of Boussama (1998, 2006), which provides a detailed discussion on strict stationarity and Geometric Ergodicity. This paper will examine various multivariate GARCH (MGARCH) models, namely the BEKK, CCC, and DCC models.The BEKK model, proposed by Baba, Engle, Kraft, and Kroner, is a widely used econometric model in the field of finance.

Baba, Engle, Kraft and Kroner (BEKK) Model. In order for estimated multivariate GARCH model to be considered reasonable, it is necessary for the parameter ε_t to exhibit positive definiteness over all values of the disturbances. Engle, Forcard, and Fabozzi (2005) introduced quadratic formulation to guarantee positive definiteness of the parameters. The model referred to BEKK model which was introduced by Brooks et al. in 2003. The aforementioned model exhibits a notable degree of parsimony and is well-suited for a broad range of assets due to its parameter count increasing in a linear fashion with the number of assets. The BEKK model is presented in the following form**.**

$$E_t = C_0\,C_0 + \sum_{k-1}^{K} \sum_{i-1}^{q} A_{ki}\;E_{t-1}\;E_{t-1}\;A_{ki} + \sum_{k-1}^{K} \sum_{i-1}^{p} B_{ki}\;\Sigma_{t-1}B_{ki} \quad\text{…………..6}$$

Where C_0 is lower triangular matrix, A_{ki} and B_{ki} are N × N parameter matrices. Based on the symmetric parameterization of the model, E_t is almost surely positive definite provided that $C_0 \times C_0$ is positive definite (Tsay, 2005). Engle and Kroner (1995) proved that the necessary condition for the covariance stationarity of the BEKK model is that the eigenvalues, that is the characteristic roots of;

$\sum_{k-1}^{K} \sum_{i-1}^{q}(A_{ki} \otimes A_{ki}) + \sum_{k-1}^{K} \sum_{i-1}^{p}(B_{ki} \otimes B_{ki})$ …………………………………...…… 7

Equation (7) should be less than one in absolute value. Thus, the process can still render stationary even if there exists an element with a value greater than one in the matrix.

4. Result

Table 2 and figure 1 shows the descriptive statistics and the trend analysis of the variables. The period of the analysis is 41 years and the variables used are abbreviated as $RGDP_t$ (Real Gross domestic product), EXP_t (Real Export), IMP_t (Real Import) $REXR_t$ (Real exchange rate of the naira), $INTR_t$ (Real Interest rate), $INDP_t$ (Industrial production) and $COILP_t$ (Real Crude oil production).

Table 2: Descriptive Statistics

Variables	LGDP	LIMPT	LEXPT	LINDS	INTR	EXRATE	LCOIL
Mean	11.1197	1.1093	1.2466	1.4536	0.3859	103.4655	1.6133
Median	11.0212	1.1198	1.3107	1.4503	3.8427	106.4643	1.6724
Std. Dev.	0.4100	0.1819	0.1859	0.0746	12.4070	104.4806	0.2331
Skewness	0.1788	-1.4689	-0.7136	-0.2695	-2.2958	0.9333	-0.0629
Kurtosis	1.4582	5.3159	2.6940	2.4357	10.2950	3.0377	1.6730
Jarque-Bera	17.2228	96.2114	14.6454	4.1870	510.8117	23.9660	12.2156
Probability	0.0002	0.0000	0.0007	0.1233	0.0000	0.0000	0.0022
Observations	165	165	165	165	165	165	165

Source: Authors' computation

Figure 1: Time Trend Analysis of the Variables
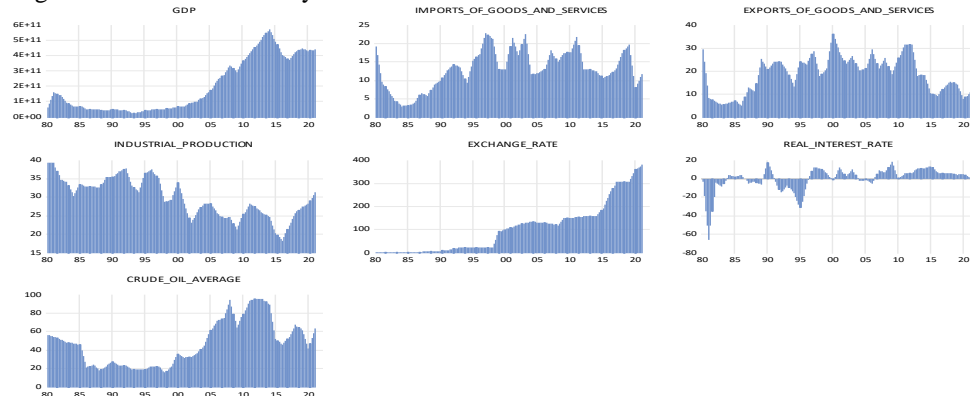
Source: Authors' computation

Table 3 Correlation Matrix

Variables	LGDP	LIMPT	LEXPT	LINDS	INTR	EXRATE	LCOIL
LGDP	1.000						
LIMPT	-0.0562	1.0000					
LEXPT	-0.5168	0.6837	1.0000				
LINDS	-0.5776	-0.2745	0.1258	1.0000			
INTR	0.3405	0.4438	0.2025	-0.3932	1.0000		
EXRATE	0.8066	0.1920	-0.3466	-0.5263	0.4020	1.0000	
LCOIL	0.8958	-0.2215	-0.4724	-0.5324	0.2299	0.5591	1.0000

Source: Authors' computation

The result in table 3 above shows nature and extent of relationship among the study variables. The GDP which is the measure of a country's economic output, exhibits a strong positive correlation with exchange rates (0.8066) and crude oil averages (0.8958). This suggests that as GDP increases, the exchange rates and crude oil averages also tend to rise. On the other hand, GDP shows a moderate negative correlation with industrial production (-0.5776). This implies that as GDP increases, industrial production tends to decrease. Imports and exports, two key components of international trade, demonstrate a strong positive correlation of 0.6837. This indicates that higher levels of imports are often associated with higher levels of exports. Furthermore, exports have a negative correlation with exchange rates (-0.3466) and crude oil prices (-0.4724).

Table 4: Unit Root Test

	Test at level		Test at first difference		Order of Integration
Variables	ADF test	PP test	ADF test	PP test	
LGDP	-0.4708	-0.4704	-6.1686**	-6.2048**	I(1)
LIMPT	-3.8879	-3.4170	-	-	I(0)
LEXPT	-3.1572*	-2.5875*	-	-4.6039	I(1)
LINDS	-2.1464	-2.2663	-9.9485*	-10.0513**	I(1)
INTR	-4.6138*	-3.7992*	-	-	I(0)
EXRATE	-1.4335	-0.3396	-4.3421**	-4.3349*	I(1)
LCOIL	-2.6284	-1.2228	-4.3434*	-4.5751*	I(1)

*Note: **indicates stationary 5% level of significance.*
Source: Authors' computation

Table 4 presents the result of Augment Dickey Fuller and Phillips Perron unit root test, it clearly shows that imports and interest rate are stationary at level i.e I(0) process while other variables employed such as gross domestic product, export, industrial output price level, exchange rate and crude oil price are stationery at first difference i.e I(1) process.

Therefore, there is mixture of order of integration among the variables employed in the study.

Table 5: Arch Effect Test

Statistics	
F-statistic	282.7705
Prob. F(1,162)	0.0000
Obs*R-squared	104.2658
Prob. Chi-Square(1)	0.0000

Source: Authors' computation

Given the values of F and R-squared statistic and their corresponding p-values above, there is evidence not to accept null hypotheses of constant variance, which denotes ARCH effect presence in return series. This provides justification for applying DCC, VECH or BEKK-GARCH models to account for the heteroscedasticity in the series.

The result of table 6 presents Multivariate GARCH model, in the mean equation, the estimated coefficient of moving average terms c_1 and c_2 for gross domestic product and imports returns is positive and statistically significant at 5% level. From the variance equation, the estimated constant terms of the gross domestic product volatility (c_3) and co-variance (c_5) equations are statistically significant, this suggest that the volatility spillover effect of imports will cause an innovation in the gross domestic product in Nigeria for the period under study.

Table 6: Estimated BEKK-GARCH

	Parameters	Coefficient	Std. Error	z-Statistic	Prob.
Mean	C(1)	0.1742	0.0054	32.4774	0.0000
Equation	C(2)	0.2581	0.0177	14.5432	0.0000
Variance	C(3)	-0.9737	7.1367	-0.1364	0.5772
Equation	C(4)	0.1099	0.3260	0.3371	0.0007
	C(5)	0.0523	0.3279	0.1596	0.0013
Log likelihood		302.6978			
Avg. log likelihood		0.9173			
Akaike info criterion		-3.4509			
Log likelihood		302.6978			
Avg. log likelihood		0.9173			
Schwarz criterion		-3.1121			
Hannan-Quinn criter.		-3.3133			

Source: Authors' computation

Table 7 indicate that the shock of parameters under exports $(E1_{11}, E1_{12}$ and $E1_{22})$, shocks from industrial output $(E2_{11}, E2_{12}$ and $E2_{22})$, the parameters of interest

rate $(E3_{11}, E3_{12} \text{ and } E3_{22})$, parameters of exchange rate $(E4_{11}, E4_{12} \text{ and } E4_{22})$ and variable crude oil price parameters $(E5_{11}, E5_{12} \text{ and } E5_{22})$ each variable indicates its own shock and its effect on gross domestic product in Nigeria for the period under study.

Figure 2 Conditional Variance

Table 7 Parameter estimate of the Scalar BEKK model

	LEXPT	LINDS	INTR	EXRATE	LCOIL
E1(11)	0.6245	0.0235	0.3094	0.9532	0.8385
Std. E	(7.9443)	(8.5996)	(1.1025)	(4.4652)	(0.0002)
P-value	0.9998	0.9963	0.7649	0.0448	0.9784
E1(1,2)	0.1438	-0.7783	-0.8235	0.0098	-0.2526
Std. E	(0.0008)	(0.0010)	(1.6331)	(2.7834)	(0.0007)
P-value	0.9997	0.9926	0.5884	0.1506	0.9994
E1(2,2)	0.0862	0.0002	0.3512	0.7936	0.7024
Std. E	(0.0010)	(0.0009)	(1.1485)	(2.3686)	(0.0002)
P-value	0.9954	0.7912	0.0393	0.4487	0.9997

Note: standard errors are in bracket
Source: Authors' computation

Conditional Correlation

Cor(LGDP,LIMPORTS)
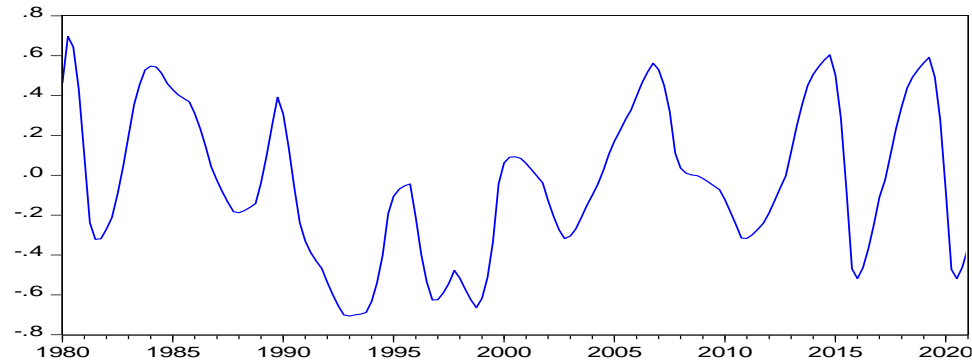
Source: Authors' computation

Figures 2 plotted above, shows conditional variance and conditional covariance of two returns series over time. The two series exhibit high volatility in 1985, 2005, 2014 and 2019, coinciding with the COVID-19 which necessitated the total lock-down of the economy.

Table 8: Post Estimation Test for MGARCH

Residual serial correlation LM tests		
Lags	LM-Stat	Prob
1	309.0834	0.2502
2	590.4131	0.6713
3	842.6487	0.9504
Residual Normality tests		
Jarque-Bera	116.4926	0.0000
Df	4	

Source: Authors' computation

From table 8 above, it is clear the model is free from serial correlation because the p-values are greater than 5% while Normality test indicates that we cannot reject the null hypothesis because its p-value is less than 5%.

5. Conclusion and Recommendations

The point labored in this research is to demonstrate how a shock in global commodity prices impacts the Nigeria's economy. The research has demonstrated how commodity prices are potentially important determinant of Nigeria's economic growth. It also demonstrated how commodity price shocks can influence the evolution of some macroeconomic variables. The study shows positive volatility shock effect on each variable affected by its own past innovations. The parameters for import, export, industrial production, interest rate, exchange rate, crude oil and GDP are statistically significant at 5%. The volatility of all the independent variables in the study cause an innovations of shock effects on gross domestic product. The effect of export and exchange rate are positive and statistically insignificant. For import, industrial production, interest rate and crude oil, the effect is negative and statistically significant except for crude oil production. The volatility shock effect is 97%, 14%, 78%, 82%, 1.2% and 26% for Import, export and exchange rate industrial production, interest rate and crude oil respectively. Given the variance equation of -0.973 in C_4, it suggests that an increase in commodity price will result a very significant negative impact on economic performance in Nigeria.

Based on the findings, it is recommended that developing economies like Nigeria should focus on enhancing both economic diversification and private investment to foster economic growth. Policies that promote technological innovation, research and development, and efficient resource allocation are very essential to improve domestic output. Simultaneously, measures to reduce trade barriers, encourage exports, and attract foreign investments are necessary to boost trade openness, which in turn may stimulate economic expansion. The government and the private sector must invest in

education and training, in order to improve the quality of the workforce and boost productivity. Improvement in infrastructure is also essential to make it easier for businesses to operate and for trade expansion which will lead to increased efficiency. Government must reduce trade barriers to make it easier for Nigerian businesses to compete in the global market. Government and private sector must promote innovation by providing incentives for research and development, and by creating a supportive environment for start-up businesses. Lastly, government must strengthen institutions that will help to create a more predictable and stable business environment in the economy which will provide favourable exchange rate for the economy.

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