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MULTIVARIATE TIME SERIES MODELLING OF NIGERIAN GROSS DOMESTIC PRODUCT (GDP) AND SOME MACROECONOMIC VARIABLES

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ABSTRACT: *This paper focused on modelling Nigeria's Gross Domestic Product and some macroeconomic variables, which include, Agriculture, Crude Oil/Mineral Gas and Telecommunication using different classes of multivariate time series models. Multi-Dependent Linear Regression Model (MLRM), Vector Autoregressive Model (VARM) and Multivariate Autoregressive Distributed Lag Models (MARDLM) have been fitted to the multivariate time series. The basic statistics of the estimates and errors reveal the competitiveness of VARM and MARDLM. This was also evidently using the model selection criteria. But the mean square error of forecast places VARM on a higher comparative advantage than MARDLM. The results of the Granger causality tests showed that Crude Oil/Mineral Gas granger causes Gross Domestic Product and also granger causes Agriculture, but not vice versa in each case. This paper establishes the fact that Crude Oil/Mineral Gas is a good predictor of Gross Domestic Product and Agriculture as a major contributor to the nation's economic development. The need to consistently juxtapose causal relationships between major economic sectors and Gross Domestic Product is vehemently advocated for proper evaluation of sectorial contributions and formulation of economic driven policy in the country.*

KEYWORDS: GDP, Agriculture, Crude Oil, MLRM, VARM, MARDLM, Telecommunication.

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INTRODUCTION

There is no dispute the fact that the growth and stability of a nation's economy lie on its Gross Domestic Product (GDP) as a measure of economic wealth and its relationship with key economic sectors. Nigerian Economy is said to be a mixed and emerging market with numerous expanding economic sectors such as oil & gas, manufacturing, finance, service, communications, technology and entertainment sectors, etc, both private and public (frankfurt.de. 2020). It is ranked as the 27th-largest economy in the world in terms of GDP, and the 24th-largest in terms of purchasing power parity (World Bank, 2020). Fondly called the giant of Africa, Nigeria has the largest economy in Africa and the most populous nation in West Africa. This paper considers multivariate time series analysis of the gross domestic product and three economic sectors such as oil & gas, agriculture and communication.

Petroleum production and export play a dominant role in Nigeria's economy and account for about 90% of her gross earnings. Crude oil/mineral gas has always been the mainstay of the Nigerian economy despite the government's efforts to diversify into agriculture, mining and other sectors. Even though the sector is less than 10% of the country's GDP, it contributes about 65% of Government revenue and 88% of Nigeria's foreign exchange earnings, thereby, having tremendous impacts on the other sectors of the economy (Ajayi, 2019). Nigeria has been Africa's largest oil producer for a long time and holds the second-largest oil reserves in Africa (after Libya) and the 10th largest oil reserves in the world (NBS, 2010). Nigeria is ranked as the largest producer of crude oil in Africa, and contributes less than 10 per cent of Nigeria's gross domestic product (GDP), with approximately 80 per cent and 90 per cent contributions to the Federal Government's revenue and Nigeria's export earnings respectively (NBS, 2010). Notwithstanding its minimal contribution, there is a strong relationship between Nigeria's GDP and crude oil production, as every drift in the production of crude oil has an effect on the country's GDP. This is evident in the fall of crude oil production and price in 2014/2015, the recent effect of the Covid-19 pandemic on the global market, reduction in Nigeria's foreign reserves and weakening of the naira against the dollar. The MDG's Vision 20:2020 projected Nigeria to be among the top 20 economies in the world with a minimum GDP of $900 billion and per capita income of no less than $4000 per annum by the year 2020. When Vision 20:2020 was documented in 2009, Nigeria was placed 44th in world GDP ranking (two years later Nigeria's GDP was ranked 36th, then after re-basing its GDP moved up to 22nd in 2015). Nigerian GDP data in 2014 showed a GDP of $454 billion (2012) and $510 billion (2013). The 2014 figures were 'rebased' data using an updated and improved methodology. Nigeria's economy contracted after the oil price plunge and by 2019 the GDP ranking fell to 26th (WDI, 2021). The drop in the GDP is accounted for by the significant drift in crude oil production and prices. Although oil is largely an enclave sector in Nigeria, having a few forward and backward linkages with the GDP and the rest of the economy, it remains a decisive force for the economic performance in recent times.

Agriculture has been an important sector in the Nigerian economy in the past decades and is still a major sector in terms of domestic production despite the oil boom. Basically, it provides employment opportunities for the Nigerian teeming population, eradicates hunger and poverty, improves nutrition and general well-being of the population as well as contributes to the economic growth of the nation. Economic history provides us with ample evidence that the agricultural sector is fundamental for economic growth, especially in developing countries (Woolf and Jones, 1969; Oluwasanmi, 1966; Eicher and Witt, 1964). Ukeje (2003) submitted that in the 1960‟s, agriculture contributed up to 64% to the total GDP but gradually declined

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in the 70‟s to 48% and it continued in 1980 to 20% and 19% in 1985. This was a result of the oil glut of the 1980s. The large subsistent agricultural sector has not kept up with rapid population growth, and Nigeria, once a large net exporter of food, now imports some of its food products, though mechanization has led to a resurgence in manufacturing and exporting of food products, and the move towards food sufficiency (FAO, 2020. It still remains one of Nigerian's macroeconomic indicators, providing employment for about 35% of the population as of 2020 (World Bank 2020). As reported by the FAO (2020), agriculture is still the foundation of the Nigerian economy, and the main source of revenue despite the presence of crude oil in Nigeria. In the third quarter of 2019, the sector grew by 14.88% year-on-year in nominal terms with a decline of 3.44% points from the third quarter of 2018. The largest driver of the sector remains Crop Production as it accounts for 91.6% of the sector in the third quarter of 2019 with a quarterly growth which stood at 44.12%. The agriculture sector contributed 29.25% to overall real GDP during the third quarter of 2019 (NBS, 2019), and is the main source of livelihood for most Nigerians.

According to the Nigerian Communication Commission (NCC), the telecommunication sector was one of the sectors whose performance lifted the country out of recession in 2020, contributing 12.45% to the country's GDP. It grew by 17.64% in quarter 4 of 2020 from 17.36% in quarter 3 and 10.26% in quarter 4 of 2019 (NBS, 2020). Being the major driver of the digital economy agenda of the government, it has continued to provide the needed digital support to the nation's economy especially during the Covid 19 pandemic. This steady growth has impacted positively on all the sectors of the economy contributing to the nation's GDP. However, the high dependence on crude oil has created some challenges to the economy due to price fluctuation and other global issues which have reduced impacts of other sectors that can be leveraged to contribute meaningfully to the economic system of the nation.

As the world is facing a global turndown due to the adverse effect of the pandemics and other issues, statisticians and other economic stakeholders in recent times have been applying Multivariate Time Series (MTS) in analyzing different macroeconomic variables. Multivariate time series analysis is used when one wants to model and explain the interactions and co-movements among a group of macroeconomic indicators (Onwukwe et al, 2014**).** It has more than a one-time-dependent variable; each variable depends not only on its past values but also on other variables which are used for forecasting future values. The multivariate view is central in economics, where single variables are traditionally viewed in the context of relationships to other variables (Onwukwe et al 2014). In forecasting and even in economics, multivariate models are convenient in modelling interesting interdependencies and achieving a better fit within a given data or economic indicator. Most of the multivariate time series models have a good comparative advantage in forecasting future values.

In this research, the interest is to study the relation of gross domestic product and some macro-economic variables (crude oil, agriculture and telecommunication) in Nigeria with different classes of multivariate time series models for the period (2010 - 2019).

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REVIEW OF LITERATURE

Crude Petroleum

The petroleum industry has assumed a primate position in the Nigerian economy, pushing Nigeria to the forefront of the global industry, making the country the 6th largest exporting and 7th largest producer of oil in the world (Lukeman 2003). Revenue from the petroleum sector comprising export earnings, petroleum profits tax and royalties has grown steadily over the years. Between 1970 and 1998, earnings from oil rose from 75.3% to a peak of 84.1% of the total federal generated Revenue (CBN, 1998). Also, IMF estimates showed Nigeria's earnings from Crude oil increases from the US $8,500 billion in 1989 and to $10.600 billion in 1990. By 1995, these earnings had declined to $7,001 billion and declining further to $5.276 billion in 1998. However, crude oil prices increased steadily in the new millennium following the implementation of strict production quotas imposed by OPEC on member countries to stem the flow of excess crude oil in the global marketplace. As a result of the dominant role played by the oil sector in the nation's economy, economic performance has been linked to oil prices in the past three decades. This unenviable development has inspired the current administration to diversify the nation's economy away from its dependence on crude oil by harnessing natural gas, bitumen and other solid minerals. In the year 2000, Nigeria experienced oil windfall that improved the growth rate of GDP by 4.8 % compared to the previous year. The unexpected boom in the international market helped to propel the growth performance of the entire economy (UNECA, 2005). Oil prices rose from $18.00 a barrel in 1999 to $28.00 in 2000. Also, the OPEC quota for Nigeria increased from 1.885 million barrels a day in March to 2.033 million in April, 2,091 million in July, 2,157 million in October and 2,178 million in November. Of the total daily production, around 1.88 million barrels a day were exported from 1.66 million in 1999. Although oil is largely an enclave sector in Nigeria, having a few forward and backward linkages with the rest of the economy, however, it remains a decisive force for economic performance. Its impact is transmitted through the income effect, mediated through public spending and imports. In recent times, oil GDP is clearly more volatile than non-oil GDP. Due to the volatility of oil prices, the sector often experiences rapid growth in value-added on year followed by an equally rapid decline in the next, with the trend usually reflected in volatile growth for the economy as a whole. Hence, there is some impact of oil production on Nigeria gross domestic product.

Agriculture

The relationship between agriculture and economic development, especially in Nigeria cannot be overemphasized. According to (Gallup et al., 1997; Thirtle, et al 2003; Awokuse (2008); Irz et al., (2001), there is an established relationship between the agriculture sector and economic growth. There is no dispute the fact that about 70% of the Nigerian population are gainfully employed in the agricultural sector. The importance of agriculture to the Nigerian economy is evident in the nation's natural endowments in production factors – extensive arable land, water, human resources, and capital. Exploring the nation's productive advantage in this sector is the fastest way to stimulate growth in the economy. Iganiga and Unemhilin (2011) and Oji-Okoro (2011) opined that agricultural output is significantly influenced by government capital expenditure. Olajide et al. (2012) on analyzing the relative impact of agriculture on economic growth between 1970 and 2010, found a positive causal relationship between GDP and agricultural output in Nigeria.

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Agriculture contributes 40% of the Gross Domestic Product (GDP) and employs about 70% of the working population in Nigeria (CIA, 2011). Agriculture is also the largest economic activity in the rural area where almost 50% of the population live. The sector has several untapped potentials for growth and development in the availability of land, water, labour and its large internal markets. It is estimated that about 84 million hectares of Nigeria's total land area have the potential for agriculture; however, only about 40% of this is under cultivation (FMARD, 2012). In 1960, petroleum contributed 0.6% to GDP while agricultural contribution stood at 67%. However, by 1974, shares of petroleum had increased to 45.5% almost doubling that of agriculture which had decreased to 23.4% (Yakub, 2008). It should be clarified that this pattern was not an outcome of increased productivity in the non-agricultural sectors as expected of the industrialization process; rather it was the result of low productivity due to negligence of the agriculture sector (Christaensen & Demery, 2007). According to CBN (2012), between 1960 and 2011, an average of 83.5% of agriculture GDP was contributed by the crop production subsector, making it the key source of agriculture sector growth. The food production role in the sector depends largely on this subsector as all the staples consumed in the nation comes from crop production, 90% of which is accounted for by small-scale, subsistent farmers. The major crops cultivated include yam, cassava, sorghum, millet, rice, maize, beans, dried cowpea, groundnut, cocoyam and sweet potato. The second-largest is the livestock subsector contributing an average of 9 .2% between 1960 and 2011. This sector is the largest source of animal protein including dairy and poultry products. The economic importance of the subsector is therefore evident through food supply, job and income creation as well as provision of hide as raw material. Despite this, the sub-sector has been declining in its contribution to economic growth, Ojiako and Olayode (2008).

Several studies have focused on understanding the sectorial contribution between agriculture and Nigerian economic growth, yet there is some disagreement. While some researchers have argued that agriculture is the foundation of economic growth (Gollin, et al 2002; Thirtle, et al 2003), others claim that the linkages agriculture has with other sectors are too weak and its innovative structures inadequate for promoting economic growth (Ranis and Fei, 1961; Jorgenson, 1961). However, the univariate and bivariate relationship between the agriculture sector and other sectors should not be a competition but rather be viewed as interdependent where supply and demand in sectors can be accommodated through strengthened linkages (Adelman, 1984; Sabry, 2009). As argued by advocates of agriculture-led growth (ALG), the development of the agricultural sector is a prerequisite to industrialization through an increase in rural incomes and provision of industrial raw materials, provision of a domestic market for industry and above all, the release of resources to support the industry (Schultz, 1964; Timmer, 1995). However, agriculture as one of the macroeconomic variables relates with other macroeconomic variables to accommodate and strengthen linkages (Sabry, 2009). Neglecting the agricultural sector in favour of the industrial sector will only lead to slow economic growth and inequality in income distribution. Johnston and Mellor (1961) examined the roles of agriculture in five inter-sectoral linkages, namely; food, labour, market, domestic savings and foreign exchange. The most basic of these roles is the supply of food for both domestic consumption and export. Direct contributions of food production can be through income generated from sales of farm produce and returns from economic activities related to production, or indirectly from increased capacity to partake in any form of economic activity through improved diet. Adesope (2010) used a correlation matrix to find out that the production of major staples in Nigeria contributed significantly to GDP growth between 1990 and 2001. An increase in the Nigerian population without a corresponding increase in the food supply in

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proportion to increased demand has negative effects on industrial profits, investment and economic growth. The most direct contribution of agriculture as one of the major macroeconomic indicators is the increase in incomes of farmers and therefore their purchasing power.

Furthermore, as the population increases, failure to increase food supply in proportion to increased demand has negative effects on industrial profits, investment and economic growth (Johnston & Mellor, 1961). Hazell and Roell (1983) asserted that in the early stages of development, rising incomes of rural/farming households is essential to providing a market for domestically produced goods and services via strengthened purchasing power. The most direct contribution of agriculture to economic growth is the increase in the incomes of farmers and therefore their purchasing power (Irz et al, 2001). Results of several studies, including Gallup et al. (1997) and Thirtle et al. (2001), showed that an increase in agriculture growth results in an increase in the income level of the poorest of the population. Also results from cross-country regressions among developing countries show that a $1 increase in GDP results in significantly more poverty reduction when the growth is in agriculture rather than other sectors (Lipton, 2012). Agriculture, therefore, contributes to economic growth by increasing the incomes of the majority of the population thereby strengthening their saving capacity.

Communication

The Nigerian telecommunication sector is one of the largest sectors that has contributed tremendously to the gross domestic product of Nigeria. The sector has experienced a strong multinational presence and has over the years contributed immensely to Nigeria's economy and the lives of Nigerians. The advancement of mobile phone usage from basic phone telephony to new enhanced services and the introduction of new technology within diverse sectors of the country have seen the sector grows massively. The sector has experienced rapid growth and helps in e.g. easier banking services (bank mobile apps) and access to e-learning platforms to Nigerians.

The total revenue accruing to the government in form of tax from the telecom sector has increased tremendously after the liberalization of the sector. Licensing fees rank high among the direct ways in which mobile operators contribute to the economy of their host countries. In Nigeria, since the introduction of GSM in 2001, the government has received more than $2.5bn from spectrum licensing fees. In 2007 alone, the Nigerian government received a total of more than $1bn from the sale of licenses. The operating licensing fees are of two categories. The first category is national mobility, the licensing fee for this amount to 260 million naira. The second category is regional mobility, and the licensing fee ranges between 33 million naira and 9 million naira, depending on the state (NCC, 2006). Pyramid (2010) curtained that telecommunication tax contribution to the total tax received in Nigeria in 2006 was 35% (total tax comprised import duties, employment taxes, value-added tax and companies income tax). For example, in 2005 MTN paid ₦9.8 million tax to the Federal Government of Nigeria, while the company's workers paid about ₦1.1 billion as taxes to the government. In the same year, the company paid ₦34.8 billion to the government in the form of license fees, duties, taxes, and other statutory payments to the government at various levels, and this amounted to a cumulative tax of ₦150 billion paid to the Federal Government of Nigeria by MTN right from its inception to 2007 (Bottomline, 2007). Also, the Federal Government has earned over ₦242 billion from spectrum licensing fees (NCC, 2006).

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Foreign direct investment (FDI) in the country has been boosted since the introduction of GSM services in Nigeria, mobile operators together have invested several billion dollars in infrastructure deployments, network rollouts, upgrades and expansions. To support the mobile infrastructure, operators have also embarked on building backbone networks. These consist predominantly of fibre-optic cables, base stations and satellite connections, transmitting traffic between cities and to other countries. MTN's famous Yellow Bahn fibre optic cable, for example, is more than 5,500km (3,400 miles) long. The contribution of the telecom sector to Real GDP has improved significantly. In the first quarter of the year 2000, telecom contributed merely 0.76% to real GDP, however, the contribution increased to 2.17% and 3.51% in the last quarter of 2007 and 2009 respectively. As of 2010, the contribution of telecom to real GDP was put at 8.2 per cent (Adesanya, 2011, Business Day, 2011). These results reflected the rising status of the telecom sector as the contributor to Nigeria's gross domestic product (GDP).

Review of Model Applications

Most macro-economic researchers frequently work with multivariate time series models such as Vector autoregressive (VAR), Vector error correction model (VECM) and other related models. This section reviews the theoretical and empirical studies that investigate the relationship between several macroeconomic variables and gross domestic product (GDP). Extensive theoretical and empirical works have been carried out on the study of these economic indicators. Empirical evidence is Liu, X.. et al (2012) on VAR analysis, involving Granger – causality test, impulse responses and forecast error variance decompositions with statistics packages/software. A work done by Odusola et al (2001) examined the link between the naira depreciation, inflation and output in Nigeria, adopting vector autoregressive (VAR), which revealed that its exchange rate system does not necessarily lead to output expansion, particularly in short term. Evidence from impulse response functions and structural VAR models suggested that the impacts of the lending rate and inflation on the output were negative. While most previous studies focused more on the determinants of inflation, using an explanatory variable, our deviates by adopting the vector error correction mechanism (VECM) which eliminates the need to develop explicit economic models and thus impose prior restrictions on the relationships among different economic variables than is possible in conventional econometric analysis. Dmyto (2000.) found the vector autoregressive (VAR) model suitable in establishing the relationship between CPI, money supply and exchange rate in Ukraine. The results showed that exchange rate shocks significantly influence price level behaviour. Furthermore, the study found that money supply responds to positive shocks in the price level. The study contributes to the sizable literature on IT using an overly sophisticated vector error correction model (VECM) with a complex identification structure.

Batten et al (2010) modelled monthly price volatility of four precious metals (goal, silver, platinum and palladium) as well as examined the macroeconomic determinant of these volatilities. They used the approximate conditional standard deviation (GARCH) model and the vector autoregressive (VAR) method to measure block exogeneity causality tests to conduct the empirical test and determine the volatility linkages between various macro-economic variables and the market. A study by Gemechu et al (2017) examined the Components of GDP and outputs of economic sectors (Agriculture, industry and service) to the GDP of the Ethiopian Economy, the trend of GDP, the causal relationship among GDP, agricultural, industrial and service sectors output for Ethiopia using time series data and obtained forecasts of the GDP for Ethiopia using Vector Autoregressive (VAR) models. The cointegration relations among the series were identified by applying Johansen's cointegration tests, while potential causal

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relations were examined by employing Granger's causality tests. Moreover, the short-run interactions among the variables were determined through the application of impulse response analysis and variance decomposition. The results of the research imply the existence of short-term adjustments and long-term dynamics in the GDP and three economic sectors output. Blancard and Perotti (1999), in his study of the macroeconomic effects of fiscal policy (taxes and government spending), argued that the tax code and spending rules impose tight constraints on the way that taxes and spending vary within the quarter, and they used these constraints to identify exogenous in taxes and spending necessary for causal analysis. Albu (2006) used the VAR models to investigate the impact of investment on GDP growth rate and the relationship between interest rate and investment in the case of the Romanian economy. In a further development, Marta et al (2004) examined monetary policy in Albania during the transition periods, and the estimates from a vector autoregressive (VAR) model of key macroeconomic variables which included money growth, inflation, exchange rate, remittance and the trade balance, demonstrated the weak link between money supply and inflation up to mid-2000. Doroshenko (2001) considered the relationship between money supply and inflation and between money supply and GDP. The findings confirm a long-run relationship between money growth and inflation. The period of monetary expansion and high inflation in the decade of 1990s was accompanied by a contraction of output.

METHODOLOGY

This section deals with the time series models adopted for the work. This paper focuses on the Vector Autoregressive (VAR) model, Multi-Dependent Linear Regression Model (MLRM), Multivariate Autoregressive Distributed Lag Model (MARDLM) with an estimation of parameters. The macroeconomic variables considered in this work include GDP(Y_{1t}), Agriculture sector(Y_{2t}), Crude Petroleum / Mineral Gas(Y_{3t}) and Telecommunication sector(Y_{4t}) in Nigeria. Notwithstanding the fact that GDP is presented as the endogenous variable, every exogenous variable is expressed as a function of the time lag of both the endogenous and exogenous variables.

Multi-Dependent Linear Regression Models (MLRM)

Multi-Dependent Linear Regression Models (MLRM) takes the form,

$$Y_{jt} = \delta_j + \sum_{j=1}^{m} \sum_{k=1}^{n} \varphi_{jk} Y_{kt} + \epsilon_{jt} \quad (1)$$

where, $Y_{jt(j=1,\dots,m)}$ represents a set of response variables, $Y_{kt(k=1,\dots,n)}$ represents predictor variables, ϵ_{jt} error terms associated with Y_{jt}, φ_{jt} are coefficients of the predictor variables, while δ_j are model constants. The models are linear in their present form, and it is called a multi-dependent linear regression model because every variable in the models is expressed as a linear dependent on other predictor variables. The model for each response variable is the already known multiple linear regression model.

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Vector Autoregressive Models (VARM)

$$Y_{jt} = \omega_j + \sum_{i=1}^{p} \sum_{j=1}^{m} \sum_{k=1}^{n} \varphi_{i.jk} Y_{kt-i} + \epsilon_{jt} \quad (2)$$

where, $Y_{jt(j=1,\ldots,m)}$, ω_j and ϵ_{jt} are as described above, $Y_{kt-i(k=1,\ldots,n;\ i=1,\ldots,p)}$ represents predictor lag variables, $\varphi_{i.jt}$ are coefficients of the predictor lag variables, Gujarati and Porter (2009).

Multivariate Autoregressive Distributed Lag Models (MARDLM)

Given (1) and (2) above, Multivariate Autoregressive Distributed Lag Model is obtained by aggregation of Multi-Dependent Linear Regression Model (MLRM) and Vector Autoregressive Model (VARM), which produces

$$Y_{jt} = \gamma_j + \sum_{i=0,\ i=1}^{p} \sum_{j=1}^{m} \sum_{k=1}^{n} \varphi_{i.jk} Y_{kt-i} + \epsilon_{jt} \quad (3)$$

where, Y_{jt} is an $m \times 1$ vector matrix, $\varphi_{i.jk}$ (i =1,…, p, j=1,…,m, $k = 1, \ldots, n$) are matrices of coefficients, $\gamma_j = (\delta_j + \omega_j)$ is an $m \times 1$ vector of constants and ϵ_{jt} error term, $\epsilon_{jt} \sim iid(0, \sigma_\epsilon^2)$. Each j^{th} variable is time-dependent and a linear function of other time variables, $\gamma_{j(j=1,\ldots,m)}$ are constants, Y_{kt} are predictor time variables associated with parameters φ_{jk} and ϵ_{jt} error term, $\epsilon_{jt} \sim iid(0, \sigma_\epsilon^2)$. From the above model, each subscripted "k" in Y_{kt} defines a contributor (predictor term) to each subscripted "j" in Y_{jt} with the associated parameters φ_{jk} indicating the contribution of "k" to "j", Usoro (2019).

Granger Causality Test

Given two-time variables say Y_{1t} and Y_{2t}, Granger causality investigates the proposition that Y_{1t} causes Y_{2t} or Y_{2t} causes Y_{1t}, on the assumption that the information relevant for the prediction of each macroeconomic time variable is contained in the associated variable. If Y_{1t} granger causes Y_{2t} then the changes in Y_{1t} should precede changes in Y_{2t} in a regression of Y_{1t} on Y_{2t} including their past /lagged values. Then we can say Y_{1t} granger causes Y_{2t} ($Y_{1t} \rightarrow Y_{2t}$) and vice versa.

HYPOTHESIS: The following null hypotheses are proposed:

H_{01}: Y_{it} does not cause Y_{jt} ($Y_{it} \rightarrow Y_{jt}$ is not significant), for $i \neq j$.

H_{02}: Y_{jt} does not cause Y_{it} ($Y_{jt} \rightarrow Y_{it}$ is not significant), for $i \neq j$.

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F – STATISTICS.

In the granger causality test, the F statistics are used to test for the level of significance.

$$F = \frac{(RSSR - RSSUR)/m}{RSSUR\ /(n-k)} \quad (4)$$

Equation (4) above follows f distribution with m and (n-k) degree of freedom (df). RSSR is the residual sum of squares in the restricted regression, RSSUR is the residual sum of squares in the unrestricted regression, m is the number of lags in $Y_{1t}, Y_{2t}, Y_{3t}\ and\ Y_{4t}$ terms and k is the number of parameters estimated in the unrestricted regression.

DECISION RULE: H_0 rejected if computed "F" is greater than $F_{m,n-k}$ at the chosen level of significance, otherwise, accept H_0.

ANALYSES, RESULTS AND FINDINGS

Multiple Time Plot and Correlogram

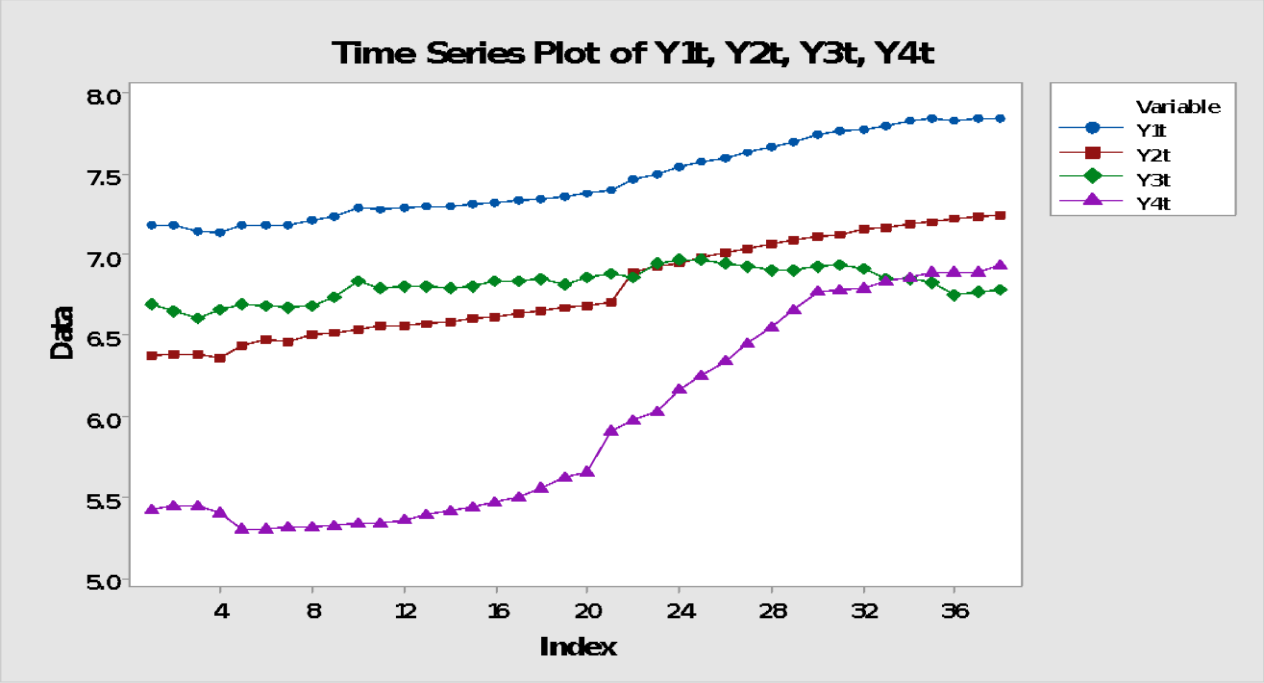

Figure 1: Time plot of GDP, Agriculture, Crude petroleum and Telecommunication.

The above time plot shows an increase in each of the macroeconomic variables for the period under study.

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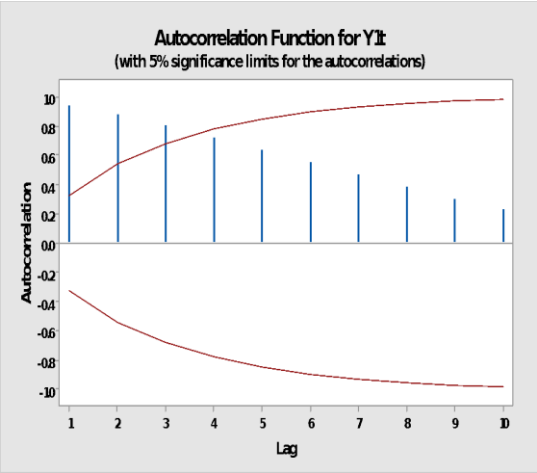

Figure 2: ACF of GDP (Y_{1t}).

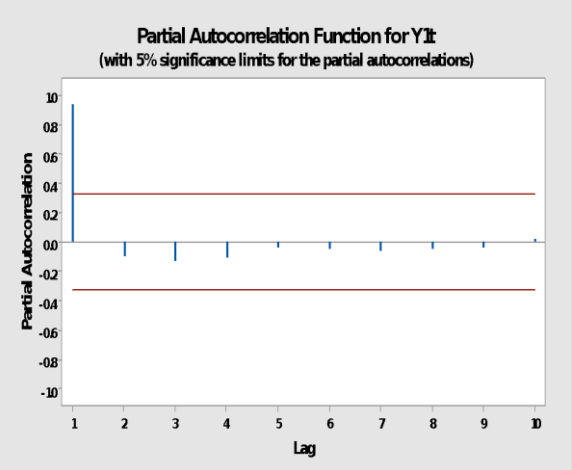

Figure 3: PACF of GDP (Y_{1t})

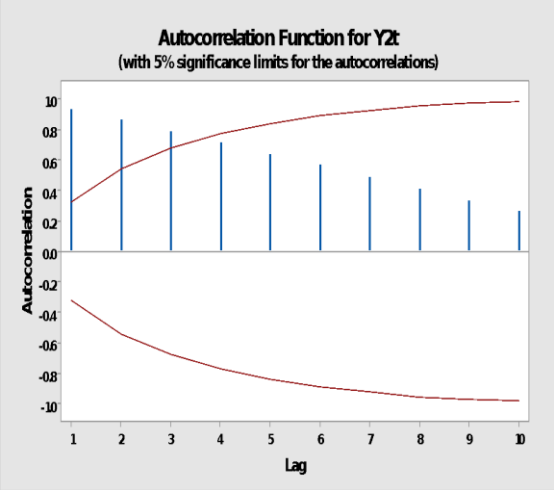

Figure 4: ACF of Agriculture (Y_{2t}).

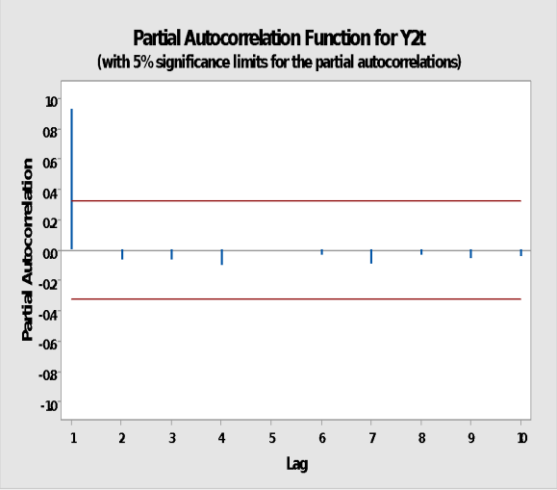

Figure 5: PACF of Agriculture (Y_{2t}).

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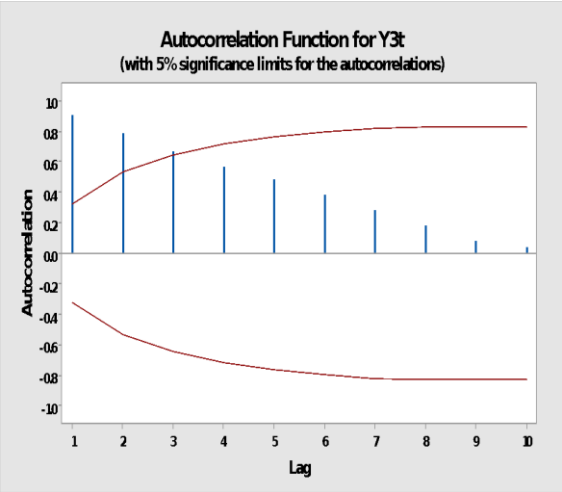


Figure 6: ACF of Crude Petroleum (Y_{3t}) (Y_{3t}).

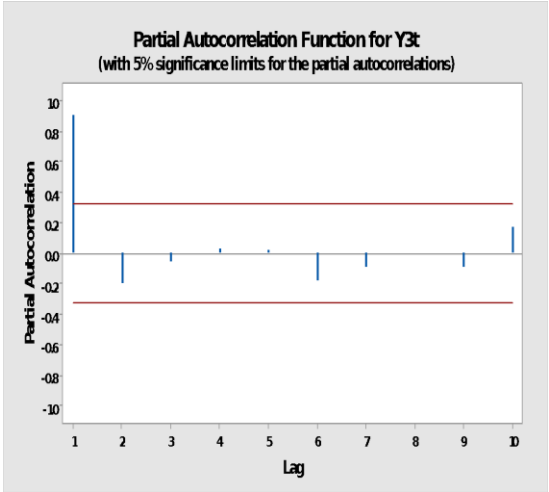
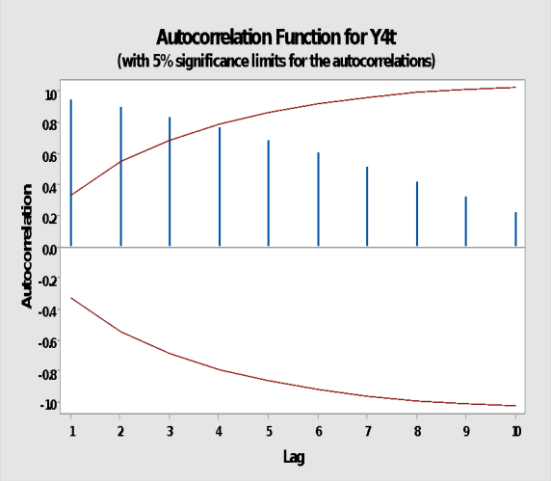


Figure 7: PACF of Crude Petroleum



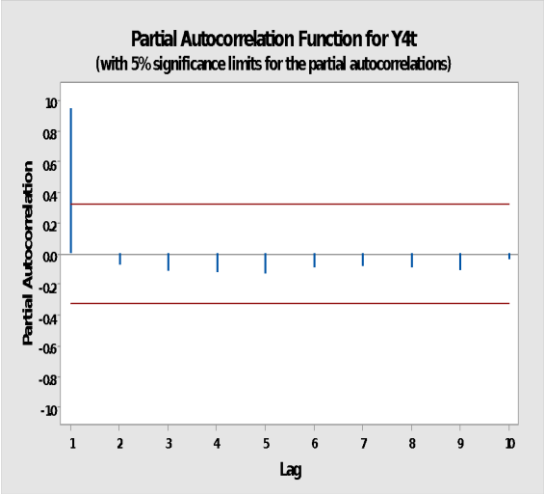


Figure 8: ACF of Telecommunication (Y_{4t}). Figure 9: PACF of Telecommunication (Y_{4t}).

Figures 2,…,9 represent autocorrelation and partial autocorrelation functions of the four macroeconomic variables. Each partial autocorrelation function exhibits a significant spike at the first time lag. These suggest a maximum of two lags for each predictor variable.

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ESTIMATION OF MODELS

Estimates of Multi-Dependent Linear Regression Model (MLRM)

Matrix representation of equation "1" for GDP (Y_{1t}), Agriculture (Y_{2t}), Crude Oil (Y_{3t}) and Telecommunication (Y_{4t}) is given below,

$$(Y_{1t}\ Y_{2t}\ Y_{3t}\ Y_{4t}) = (\delta_1\ \delta_2\ \delta_3\ \delta_4) + (0\ \varphi_{12}\ \varphi_{13}\ \varphi_{14}\ \varphi_{21}\ 0\ \varphi_{23}\ \varphi_{24}\ \varphi_{31}\ \varphi_{32}\ 0\ \varphi_{34}\ \varphi_{41}\ \varphi_{42}\ \varphi_{41}\ 0)(Y_{1t}\ Y_{2t}\ Y_{3t}\ Y_{4t}) + (\epsilon_{1t}\ \epsilon_{2t}\ \epsilon_{3t}\ \epsilon_{4t}) \quad (5)$$

From "5", $j = 1, \dots, 4; k = 1, \dots, 4;\ \varphi_{jk} = 0, if\ j = k$. Equation "5" is a set of multi-response linear regression models which are predicated upon zero lag predictor variables. Parameters of the models are estimated through Ordinary least squares as shown in the following Table 1.

Table 1: Estimates of coefficients and other parameters of MLRM

Term	Coeff.	SE Coeff.	t	p		Term	Coeff.	SE Coeff.	T	p
Est (Y_{1t})						**Est (Y_{3t})**				
Const.	3.2000	0.3170	10.10	0.000		**Const.**	4.74	1.430	3.320	0.002
Y_{2t}	0.6130	0.0760	8.06	0.000		Y_{1t}	-0.496	0.436	-1.14	0.263
Y_{3t}	-0.0740	0.0650	-1.14	0.263		Y_{2t}	1.037	0.285	3.64	0.001
Y_{4t}	0.1014	0.0328	3.09	0.004		Y_{4t}	-0.2107	0.0891	-2.37	0.024
Est (Y_{2t})						**Est (Y_{4t})**				
Const.	-3.257	0.624	-5.220	0.000		**Const.**	-8.54	2.53	-3.370	0.002
Y_{1t}	1.071	0.133	8.06	0.000		X_{1t}	2.162	0.700	3.09	0.004
Y_{3t}	0.2703	0.0743	3.64	0.001		X_{2t}	0.433	0.595	0.73	0.471
Y_{4t}	0.355	0.0487	0.73	0.471		X_{3t}	-0.671	0.284	-2.37	0.024

Details of the estimates for each of the response multiple linear regression models with "t" and "p" values are provided in Table 1.

Estimation of Vector Autoregressive Model (VARM)

Matrix representation of equation "2" for GDP (Y_{1t}), Agriculture (Y_{2t}), Crude Oil (Y_{3t}) and Telecommunication (Y_{4t}) is given below,

$$(Y_{1t}\ Y_{2t}\ Y_{3t}\ Y_{4t}) = (\omega_1\ \omega_2\ \omega_3\ \omega_4) + (\varphi_{1.11}\ \varphi_{1.12}\ \varphi_{1.13}\ \varphi_{1.14}\ \varphi_{1.21}\ \varphi_{1.22}\ \varphi_{1.23}\ \varphi_{1.24}\ \varphi_{1.31}\ \varphi_{1.32}\ \varphi_{1.33}\ \varphi_{1.34}\ \varphi_{1.41}\ \varphi_{1.42}\ \varphi_{1.43}\ \varphi_{1.44})(Y_{1t-1}\ Y_{2t-1}\ Y_{3t-1}\ Y_{4t-1}) + (\varphi_{2.11}\ \varphi_{2.12}\ \varphi_{2.13}\ \varphi_{2.14}\ \varphi_{2.21}\ \varphi_{2.22}\ \varphi_{2.23}\ \varphi_{2.24}\ \varphi_{2.31}\ \varphi_{2.32}\ \varphi_{2.33}\ \varphi_{2.34}\ \varphi_{2.41}\ \varphi_{2.42}\ \varphi_{2.43}\ \varphi_{2.44})(Y_{1t-2}\ Y_{2t-2}\ Y_{3t-2}\ Y_{4t-2}) + (\epsilon_{1t}\ \epsilon_{2t}\ \epsilon_{3t}\ \epsilon_{4t}) \quad (6)$$

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Equation “6” is a set of VAR models, which are functions predictor lad responses variables.

We present the Least Square parameter estimates of Equation “6” in Table 2.

Table 2: Estimates of coefficients and other parameters of VARM

Term	Coeff.	SE Coeff.	T	p		Term	Coeff.	SE Coeff.	t	P
Est (Y_{1t})						Est (Y_{3t})				
Const.	1.058	0.431	2.45	0.021		Const.	2.531	0.969	2.61	0.014
Y_{1t-1}	1.037	0.312	3.33	0.003		Y_{1t-1}	-0.802	0.700	-1.15	0.262
Y_{1t-2}	-0.383	0.298	-1.28	0.210		Y_{1t-2}	0.224	0.670	0.34	0.740
Y_{2t-1}	0.093	0.122	0.76	0.452		Y_{2t-1}	0.762	0.275	2.78	0.010
Y_{2t-2}	0.165	0.135	1.22	0.233		Y_{2t-2}	-0.168	0.303	-0.55	0.585
Y_{3t-1}	0.019	0.118	0.16	0.871		Y_{3t-1}	0.891	0.264	3.37	0.002
Y_{3t-2}	-0.066	0.105	-0.63	0.534		Y_{3t-2}	-0.180	0.235	-0.77	0.449
Y_{4t-1}	0.1141	0.0578	1.97	0.059		Y_{4t-1}	0.066	0.130	0.51	0.616
Y_{4t-2}	-0.097	0.0616	-1.58	0.127		Y_{4t-2}	-0.114	0.138	-0.82	0.418
Est (Y_{2t})						Est (Y_{4t})				
Const.	0.438	0.819	0.54	0.597		Const.	-1.10	1.40	-0.78	0.440
Y_{1t-1}	0.250	0.592	0.42	0.676		Y_{1t-1}	-0.51	1.01	-0.50	0.618
Y_{1t-2}	-0.035	0.566	-0.06	0.951		Y_{1t-2}	-0.024	0.969	-0.02	0.980
Y_{2t-1}	0.895	0.232	3.85	0.001		Y_{2t-1}	0.362	0.398	0.91	0.370
Y_{2t-2}	-0.180	0.257	-0.70	0.489		Y_{2t-2}	0.250	0.439	0.57	0.575
Y_{3t-1}	0.250	0.224	1.12	0.274		Y_{3t-1}	0.243	0.383	0.64	0.530
Y_{3t-2}	-0.307	0.199	-1.54	0.134		Y_{3t-2}	-0.029	0.340	-0.09	0.932
Y_{4t-1}	0.479	0.110	4.36	0.000		Y_{4t-1}	1.080	0.188	5.74	0.000
Y_{4t-2}	-0.431	0.117	-3.69	0.001		Y_{4t-2}	-0.162	0.200	-0.81	0.426

Table 2 displays parameter estimates of VARM models for GDP, Agriculture, Crude Oil and Telecommunication.

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Estimation of Multivariate Autoregressive Distributed Lag Models (MARDLM)

The above models combine MLRM and VARM to produce the following form of models,

$$(Y_{1t}\ Y_{2t}\ Y_{3t}\ Y_{4t}) = (\gamma_1\ \gamma_2\ \gamma_3\ \gamma_4) + (0\ \varphi_{12}\ \varphi_{13}\ \varphi_{14}\ \varphi_{21}\ 0\ \varphi_{23}\ \varphi_{24}\ \varphi_{31}\ \varphi_{32}\ 0\ \varphi_{34}\ \varphi_{41}\ \varphi_{42}\ \varphi_{41}\ 0)(Y_{1t}\ Y_{2t}\ Y_{3t}\ Y_{4t}) + (\varphi_{1.11}\ \varphi_{1.12}\ \varphi_{1.13}\ \varphi_{1.14}\ \varphi_{1.21}\ \varphi_{1.22}\ \varphi_{1.23}\ \varphi_{1.24}\ \varphi_{1.31}\ \varphi_{1.32}\ \varphi_{1.33}\ \varphi_{1.34}\ \varphi_{1.41}\ \varphi_{1.42}\ \varphi_{1.43}\ \varphi_{1.44})(Y_{1t-1}\ Y_{2t-1}\ Y_{3t-1}\ Y_{4t-1}) + (\varphi_{2.11}\ \varphi_{2.12}\ \varphi_{2.13}\ \varphi_{2.14}\ \varphi_{2.21}\ \varphi_{2.22}\ \varphi_{2.23}\ \varphi_{2.24}\ \varphi_{2.31}\ \varphi_{2.32}\ \varphi_{2.33}\ \varphi_{2.34}\ \varphi_{2.41}\ \varphi_{2.42}\ \varphi_{2.43}\ \varphi_{2.44})(Y_{1t-2}\ Y_{2t-2}\ Y_{3t-2}\ Y_{4t-2}) + (\epsilon_{1t}\ \epsilon_{2t}\ \epsilon_{3t}\ \epsilon_{4t}) \quad (7)$$

Where $\gamma_j = (\delta_j + \omega_j)$ for i=1,2,3,4; j=1,2,3,4.

Equation "7" is a set of multiple response models, which are linear functions of both zero and nonzero predictor lag variables and only lag terms of each response variable in a given multivariate linear model.

We present the estimates in Table 3,

Table 3: Estimates of coefficients and other parameters of MARDLM

Term	Coeff.	SE Coeff.	T	p		Term	Coeff.	SE Coeff.	t	P
Est (Y_{1t})						Est (Y_{3t})				
Const.	0.196	0.230	0.85	0.403		Const.	0.343	0.659	0.52	0.607
Y_{2t}	0.3532	0.0484	7.29	0.000		Y_{1t}	2.347	0.327	7.18	0.000
Y_{3t}	0.2908	0.0405	7.18	0.000		Y_{2t}	-0.857	0.174	-4.93	0.000
Y_{4t}	0.0257	0.0283	0.91	0.372		Y_{4t}	-0.0729	0.0803	-0.91	0.373
Y_{1t-1}	1.195	0.151	7.90	0.000		Y_{1t-1}	-3.057	0.524	-5.83	0.000
Y_{1t-2}	-0.435	0.141	-3.09	0.005		Y_{1t-2}	1.091	0.417	2.62	0.015
Y_{2t-1}	-0.4539	0.0814	-5.57	0.000		Y_{2t-1}	1.337	0.220	6.09	0.000
Y_{2t-2}	0.2708	0.0684	4.18	0.000		Y_{2t-2}	-0.691	0.197	-3.51	0.002
Y_{3t-1}	-0.3340	0.0684	-4.88	0.000		Y_{3t-1}	1.077	0.164	6.55	0.000
Y_{3t-2}	0.0957	0.0522	1.83	0.079		Y_{3t-2}	-0.291	0.147	-1.98	0.059
Y_{4t-1}	-0.1022	0.0497	-2.06	0.051		Y_{4t-1}	0.288	0.141	-1.98	0.053
Y_{4t-2}	0.0926	0.0370	2.50	0.020		Y_{4t-2}	-0.268	0.105	-2.56	0.017
Est (Y_{2t})						Est (Y_{4t})				
Const.	-0.228	0.547	-0.42	0.680		Const.	-1.00	1.65	-0.61	0.540
Y_{1t}	1.951	0.268	7.29	0.000		Y_{1t}	1.30	1.43	0.91	0.372
Y_{3t}	-0.857	0.119	-4.93	0.000		Y_{2t}	-0.725	0.502	-0.91	0.373
Y_{4t}	-0.0794	0.0656	-1.21	0.238		Y_{3t}	-0.455	0.502	-0.91	0.378
Y_{1t-1}	-2.283	0.487	-4.69	0.000		Y_{1t-1}	-2.04	1.99	-1.02	0.317
Y_{1t-2}	0.842	0.351	2.40	0.025		Y_{1t-2}	0.55	1.18	0.47	0.645

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Y_{2t-1}	1.189	0.158	7.50	0.000		Y_{2t-1}	1.238	0.839	1.46	0.153
Y_{2t-2}	-0.580	0.161	-3.59	0.001		Y_{2t-2}	-0.171	0.604	-0.63	0.532
Y_{3t-1}	0.753	0.167	4.51	0.000		Y_{3t-1}	0.805	0.666	1.21	0.239
Y_{3t-2}	-0.287	0.117	-2.45	0.022		Y_{3t-2}	-0.249	0.392	-0.63	0.532
Y_{4t-1}	0.3812	0.0998	3.82	0.001		Y_{4t-1}	1.310	0.274	4.79	0.000
Y_{4t-2}	-0.3217	0.0722	-4.45	0.000		Y_{4t-2}	-0.401	0.283	-1.41	0.170

Table 4: Descriptive Statistics for the Estimates and Errors of GDP Using VARM and MARDLM

Variable	N	Mean	SE. Mean	St. Dev	Variance	Sum of Squares
VARM (FITS)	36	7.4753	0.0401	0.2406	0.0580	2013.7141
VARM (RESI)	36	-0.0000	0.0020	0.0122	0.0002	0.0052
MARDLM (FITS)	36	7.4753	0.0401	0.2409	0.0580	2013.7182
MARDLM (RESI)	36	-0.0000	0.0009	0.0054	0.0000	0.0010

The above descriptive statistics in Table 4 reveal the equal comparative advantage of VARM and MARDLM models in the estimation of GDP (Y_{1t}). Hence, both VARM and MARDLM are suitable multivariate models for modelling Nigeria GDP and other macroeconomic variables.

Granger causality test

Table 5: Granger Causality

S/N	GRANGER CAUSALITY	OBSERVATION	DECISION
1	$Y_{1t} \rightarrow Y_{2t}$	Not Significant	H_0 *accepted*
2	$Y_{2t} \rightarrow Y_{1t}$	Not Significant	H_0 *accepted*
3	$Y_{1t} \rightarrow Y_{3t}$	Not Significant	H_0 *accepted*
4	$Y_{3t} \rightarrow Y_{1t}$	**Significant**	H_0 *rejected*
5	$Y_{1t} \rightarrow Y_{4t}$	Not Significant	H_0 *accepted*
6	$Y_{4t} \rightarrow Y_{1t}$	Not Significant	H_0 *accepted*
7	$Y_{2t} \rightarrow Y_{3t}$	Not Significant	H_0 *accepted*
8	$Y_{3t} \rightarrow Y_{2t}$	**Significant**	H_0 *rejected*
9	$Y_{2t} \rightarrow Y_{4t}$	Not Significant	H_0 *accepted*
10	$Y_{4t} \rightarrow Y_{3t}$	Not Significant	H_0 *accepted*
11	$Y_{3t} \rightarrow Y_{4t}$	Not Significant	H_0 *accepted*
12	$Y_{4t} \rightarrow Y_{3t}$	Not Significant	H_0 *accepted*

The results of the above Granger Causality tests in Table 6 indicate Crude Oil/Mineral Gas granger causes Gross Domestic Product and Agriculture, but not vice-versa, explaining the unit-directional relationship between Crude Oil/Mineral Gas and each of Gross Domestic

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Product and Agriculture. Hence, Crude Oil/Mineral Gas has sufficient preceding information for the prediction of Nigeria's Gross Domestic Product and Agriculture.

DISCUSSION

Time series analysis of Nigeria Gross Domestic Product and some macroeconomic variables using different classes of multivariate time series models was the focus of this research. The multiple time plots in figure 1 indicated an increase in the values of each macroeconomic variable for the period under study. This was followed by the autocorrelation and partial autocorrelation functions in figures 2,…,9. The correlograms exhibited autoregressive patterns with significant cut off at the first lag of the partial autocorrelation functions of the multivariate time series. The autoregressive pattern suggested Vector Autoregressive Models (VARM) after considering Multi-Dependent Linear Regression Models (MLRM) in the preliminary stage. The aggregation of the two models MLRM and VARM produced Multivariate Autoregressive Distributed Lag Models (MARDLM). The analysis revealed significant contributions of at least two macroeconomic variables to each sector in the MLRM. As shown in Table1, Agriculture (Y_{2t}) and Telecommunication (Y_{4t}) contributed significantly to Gross Domestic Product (Y_{1t}); Gross Domestic Product (Y_{1t}) and Crude Oil/Mineral Gas (Y_{3t}) contributed significantly to Agriculture (Y_{2t}); as well as Agriculture (Y_{2t}) and Telecommunication (Y_{4t}) to Crude Oil/Mineral Gas (Y_{3t}) and finally, Gross Domestic Product (Y_{1t}) and Crude Oil/Mineral Gas (Y_{3t}) to Telecommunication (Y_{4t}). VARM estimates in Table 2 showed a few significant parameters, while MARDLM in Table3 display more significant contributions of the predictor lag and non-lag terms to each response variable. The general observation from the study has it that each sector has contributed significantly to at least two sectors as evident in the results. The adoption of the model selection criteria suggested VARM and MARDLM be on the same comparative advantage in the estimation of parameters and fitting of each macroeconomic variable. The need for the Granger Causality test was to investigate the predictive capacity of each other in a pair of two macroeconomic variables. The F-Statistic which involved Residual Sum of Squares Restricted (RSSR) and Residual Sum of Squares Unrestricted (RSSUR) revealed that Crude Oil/Mineral Gas has granger caused Gross Domestic Product ($Y_{3t} \rightarrow Y_{1t}$) and has also granger caused Agriculture ($Y_{3t} \rightarrow Y_{2t}$). Notwithstanding the outcome in the granger causality tests, every sector has been revealed to have a significant contribution to one or two sectors under study. But the granger causality tests further revealed the fact that only Crude Oil/Mineral Gas has sufficient information and capacity to provide forecasts for Gross Domestic Product and Agriculture.

CONCLUSION

The findings in this work still placed Crude Oil/Mineral Gas on a high premium, not only as a good predictive factor to GDP and other macroeconomic variables in this work but as a major driver of the economy in Nigeria. In our recommendation, this paper advocates the need to consistently juxtapose causal relationships between major economic sectors and Gross Domestic Product for proper evaluation of sectorial contributions and formulation of economic driven policy in the country. Secondly, the emphasis on diversification of the Nigerian economy which has become a major challenge, concern and discourse by the Nigerian

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government and stakeholders should still gain prominent priority and remain policy trust of government towards making every economic sector a major driver of sustainable economic development in Nigeria.

REFERENCES

Adelman, I. (1984): Beyond Export-Led Growth. *World Development*, 12, 973-986.

Adesanya, A. (2011). Telecoms Overtakes Banking, Real Sector in Contribution to GDP. *Business Day* February 17.

Adesope, O. M. (2010): Agriculture share of the Gross Domestic Product and its Implications for Rural Development. Published Report and Opinion, 2(8): 26-31.

Ajayi, Wale.(2019): Nigerian Oil and Gas Update, April 2019. https://home.kpmg/ngen/home/insights/2019/04Nigerian-Oil-and-Gas-Update.html

Albu, L. (2006): "Trends in the interest rate-investment-GDP growth relationship". *Romanian J. Econ.* Forecast No. 2.

Awokuse, T. (2008): Does Agriculture Really Matter for Economic Growth in Developing Countries? *American Agricultural Economics Association Annual Meeting*. Milwaukee, WI.

Batten J. A., Ciner C. and Lucey, B. M. (2010): The Macroeconomic Determinants of Volatility in Precious Metals Markets.

Blancard, O. J. and Perotti, R. (1999): "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output" NBER Working Paper.

Bottom-line (2007). *MTN and Tax,* Issue N0. 72, December-January. Central Intelligence Agency, Available:https://www.cia.gov/library/publications/the-worldfactbook/rankorder/2244rank.html.

Business Day (2011): Nigeria Telecoms Earn 1.34 Trillion Naira in 2010. Business Day Newspaper April 12.

CBN Statistical Bulletin (2012), Volume 3, December 2012.

Christaensen, L. and Demery, L. (2007): "Down to Earth-Agriculture and Poverty Reduction in Africa". Washington, DC: World Bank.

CIA 2011, "*Rank Order – Area". The World Factbook. Central Intelligence Agency.*

Dickey, D. A. and Fuller, W. A. (1969): "Distribution of the estimators for Autoregressive time series with a unit root". *Journal of the American Statistical Association.* 74: 427-431.

Dmyto, Holod. (2000): "The relationship between price level, money supply and exchange rate in Ukraine" A thesis submitted to the National University of keiv-mohyla Academic.

Doroshenko. I (2001): "Monetary policy of economic growth in the transitional economy, Shevchenko national policy of economic university Kyir" PhD dissertation.

Eicher, Carl Keith and Witt. (1964): Agriculture in Economic Development. New York: McGraw-Hill.

FAO (2020) "Nigeria at a glance | FAO in Nigeria | Food and Agriculture Organization of the United Nations". www.fao.org. Retrieved 2020

Federal Ministry of Agriculture and Rural Development (2012): Commercial Feasibility Study Report for the Establishment of Rice Processing Mills in Nigeria. *Accenture*, Nigeria, 79pp.

Article DOI: 10.52589/AJMSS-0BVPBD9K
DOI URL: https://doi.org/10.52589/AJMSS-0BVPBD9K

Frankfurd de (2020) "*Nigeria Economy". Nigeria-consulate-frankfurt.de. Retrieved 28 May 2020.*
Gallup, J., Radelet, S. and Warner, A. (1997): Economic Growth and the Income of the Poor CAERII Discussion Paper No. 36. Harvard Institute for International Development, Boston, MA.
Gemechu, M., Jema, H., Belaineh, L. and Mengistsu, K. (2017): Impact of participation in vegetables' contract farming on household's income in the central rift valley of Ethiopia. *American Journal of Rural Development*, 5(4), 90-96. https://doi.org/10.12691/ajrd-5-4-1.
Gollin, D., Parente, S.L. and Rogerson, R. (2002): "The role of agriculture in development" *American Economic Review* 92(2): 160-164.
Gujarati, Damodar N.and Porter, Dawn C. (2009): Basic Econometrics, Fifth Edition. McGraw-Hill Irwin, London.
Hazell, P. B. R. and Roell, Ailas (1983):" Rural growth linkages: household expenditure patterns in Malaysia and Nigeria". *Research Reports* 41, International Food Policy Research Institute (IFPRI).
Iganiga, B. O. and Unemhilin, D. O. (2011):" The Impact of Federal Government Agricultural Expenditure on Agricultural Output in Nigeria". *Journal of Economics*, 292):81-88.
Irz, X., Lin, L., Thirtle, C., and Wiggins, S. (2001): Agricultural Productivity Growth and Poverty Alleviation. *Development Policy Review*, 19(4), 449-466.
Johnston, B. G. and Mellor, J. W. (1961): "The Role of Agriculture in Economic Development". *American Economic Review* 87(2): 566-593.
Jorgenson, Dale. (1961): "The Development of a Dual Economy." *The Economic Journal* 71, no.282: 309-334.
Liu, X., Swift, S., Tucker, A., Cheng, G. and Loizou, G. (2012): "Modelling multivariate time series".Birkbeck College, University of London Mallet Street, London WCIE 7Hx, UK (www.ifs.tuwien.ac.at/.../idamap99.09.pdf).
Lukeman R. (2003): Capacity Growth in the Nigeria Petroleum Industry. A keynote Address Proceedings of the SPC 26th *Nigeria Annual International Conference and Exhibition,* Lagos, Nigeria pp. 4-9.
Marta, M.; Peter, S. and Anita, T. (2004): "Inflation, exchange and the role of monetary policy in Albania" working paper. 88.
Michael Lipton (2012): Learning From Others: Increasing Agricultural Productivity for Human Development in Sub-Saharan Africa, UNDP Africa Policy Notes, United Nations Development Programme, Regional Bureau for Africa.
NBS 2019. Nigerian Gross Domestic Product Report Q3 2019, National Bureau of Statistics. https://www.nigerianstat.gov.ng/pdfuploads/GDP_Report_Q3_2019.pdf.
NCC (2006). Licensing Framework for Unified Access Service in Nigeria. Retrieved July From: http://www.ncc.gov.ng/RegulatorFramework/unifiedLicensingFramework.htm.
Odusola A. F and Akinlo. A. E (2001): "Output inflation and exchange rate in developing Countries" An application to Nigeria.
Ojiako I. and Olayode, G. (2008):" Analysis of Trends in Livestock Production in Nigeria: 1970-2005". Volume 8, Pages 114-120.
Oji-Okoro, I. (2011): "Analysis of the contribution of agricultural sector on the Nigerian Economic Development." *World Review of Business Research*, 1(1), 191-200.
Olajide, O. T., Akinlabi, B. H. and Tijani, A. A.(2012): Agriculture Resource and Economic Growth in Nigeria. *European Scientific Journal*, 8,22-30.

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Oluwasanmi, H. A. (1966): Agriculture and Nigerian Economic Development. Ibadan, London: Oxford U.P.

Onwukwe et al, (2014). A multivariate time series modelling of Major economic indicators in Nigeria.

Pyramid Research (2010). Impact of Mobile Services in Nigeria. Available at: www.pyramidresearch.com.

Ranis, G. and Fei, J.C.H. (1961): "A Theory of Economic Development". *American Economic Review*, Vol.51, pp, 533-565.

Sabry, S. (2009): Poverty Lines in Greater Cairo. Underestimating and Misrepresenting Poverty. Human Settlements Working Paper Series: *Poverty Reduction in Urban Area*. 21, pp 1-48. London. IIED.

Schultz, T. W., (1964): Transforming Traditional Agriculture. New Haven: Yale University Press.

Thirtle, C, Lin, L. and Piesse, J. (2003): "The impact of Research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America" *World Development*, 31(2):1959-1975.

Timmer, C. P., (1995): "Getting agriculture moving: do market provide the right signals?" Food Policy 20(5): 455-472.

Ukeje, R. O. (2003): Macroeconomics: An Introduction, Port Harcourt Davidson Publication.

UNECA (2005): Annual Report 2005: United Nations Economic Commission for Africa.

Usoro, Anthony E. (2019): Modelling Passengers Traffic Status of Obong Victor Attah International Airport, Uyo, Nigeria. World Journal of Applied Science and Technology, Vol.11, No.1, 35-44.

WDI (2021): World Bank Development Indicator: the primary world bank collection of development indicators, July 2021.

Woolf, S.S and Jones, E. I. (1969): Agrarian Change and Economic Development: The Historical Problem London: Methuen.

World Bank, 2020. "Employment in agriculture (% of total employment) (modelled ILO estimate) Nigeria". Work Bank Data, World Bank. 2020. Retrieved 24 November 2020.

Yakub, M. U. (2008): The impact of oil on Nigeria's economy; the boom and the bust cycles. *Bullion*, 32(2), 41-50.

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