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Impact of Agricultural Variables on Gross Domestic Product (GDP) in Nigeria: A SARIMA Approach

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Abstract

The purpose of this study is to estimate the contribution of agricultural variables to the economic growth and development of Nigeria as a whole using quarterly data from first quarter of 2016 to second quarter of 2022. The data was sourced from National Bureau of Statistics Nigeria on fishery, forestry, crop production and livestock. Time series analysis was used for fitting decomposition model (additive and multiplication) with seasonal autoregressive integrated moving average (SARIMA). The result showed that the Gross Domestic Product (the total monetary value of goods produce in years) on livestock, fishery, forestry, and crop production in first quarter and fourth quarter is less than the quarterly average while on second quarter and third quarter is higher than the quarterly average. SARIMA model was used to test for the adequacy and the result of SARIMA $(1,0,1)x(1,0,1)_4$, SARIMA $(2,0,1)x(2,0,1)_4$, SARIMA $(2,0,1)x(2,1,1)_4$ were found to be adequate and any of these could be used for further forecasting. It is therefore recommended that there will be much gain if investment should be done on fishery, livestock, forestry, and crop production on the second and third quarter of the year.

Keywords: Livestock, Fishery, Forestry, Crop Production, Time Series, SARIMA, Decomposition.

Introduction

For so many years' agriculture has been associated with the production of essential food crops, at present, above, and beyond. farming includes forestry, fishing, fruit cultivation, poultry, bee keeping, livestock etc. today processing, marketing, and distribution of crops and livestock product etc. are all acknowledge as part of current agriculture. Thus, agriculture could be referred to as processing, promotion and distribution of agricultural products. It plays a vital role in every economy, is the backbone of the economic system of a giving society.

Through agriculture for decades, Nigeria economy has been experiencing growth despite oil boom, basically it provides food, raw material, employment opportunity to a very large percent of population, contribution to national revenue, source of livelihood, significant to international trade, marketable surplus, economic development, source of saving etc. Agriculture has remained a major sector of the Nigerian economy on which the government hopes to achieve food sufficiency and reduce unemployment (Anaebonam, 2014).

Gross Domestic Product (GDP) is an internationally recognized measure of economic size and strength (Oyedele, 2017). More GDP in Nigeria can stimulate the economy. At such, it led to economic prosperity and creation of employment, thereby by reducing the poverty rate of Nigerians. In Nigeria, the agricultural sector was neglected during the oil boom. In fact, the contribution of the sector to total GDP has fallen over the decades. From 1960 to 1970, the sector contributed 55.8% to GDP but fell drastically to 28.4% in 1971 to 1980. Fortunately, successive governments in Nigeria have beginning to give priority to agriculture. And in 1981 to 1990 the agricultural sector contribution to GDP rose to 32.3%; while in 1991 to 2001 and 2001 to 2009 the sector contributed 34.2% and 40.3% to GDP respectively (Mohammed, 2012). To be precise in 2008, economic activity in Nigeria was dominated by Agriculture, which accounted for 42.1% of GDP, followed by industry (22%), wholesale and retail trade (17.3%), services (16.8%) and, Building and construction (1.8%). The share of Agriculture in Nigeria's GDP increased by 11.6% points during the last twenty-five years, that is, from 30.5% in 1984 to 42.1% in 2008. While within the same period, the share of industry in Nigeria's GDP decline from 42.4% to 22% given a loss of 20.4% points (Ikoku, 2010).

Recently, the Government of Nigeria has made facilities available to help farmers in providing them fertilizers, and other farm inputs through the local and State governments. All these efforts are geared towards diversification of the economy. Anono (2012) examined the contribution of agriculture sector and petroleum sector to the economic growth and development of the Nigerian economy between 1960 and 2010. They reported that the agricultural sector contributed higher to GDP than the petroleum sector. Growth in the agriculture sector is determinant for the declining poverty and boosting economic development, especially when discussed in context of developing nations (Lee, An, & Kim, 2020).

Increasing food prices are expected to influence strongly the welfare outcomes of different groups of households particularly in developing countries, and thus their food security and poverty status. The choices of technologies by the farmers are also improved by applying such services as they help in improving the overall procedure of decision-making methods leading to a progressive household of such rural farmers due to an increase in the net revenue. However, many studies have shown that the educated farmers are more likely to earn more profit as compared to the uneducated farmers. Because the educated farmers are provided with the required knowledge as well as awareness about a specific situation more deeply and they can make their decisions accordingly which help them to obtain the required revenue for a better living. Different extension services are provided by NGOs as well as many private sectors especially in the developing countries' agricultural sectors to improve the overall "food security" as well as "crop productivity" (Sulewski, Wąs, Kobus, Pogodzińska et al., 2020).

The livelihood profile, which dominates in the developing world, and particularly in the rural areas, is dependent on the agricultural sector. While the majority possesses or rents, a small piece of land (that cultivates using traditional methods), the poorest part, is usually landless earning their livelihoods from irregular wage labor, which usually is related to agricultural activities. Rural household farms when do business, industry is formed, known as farming (Ali, 2019).

The motivating factor that brings about this study is the decline seen in several sector of the country, especially on the oil sector, and high rate of unemployment among the youth. And if government could re-strategize on agriculture, not only to feed the nation but also to increase agricultural export; for it will bring about great financial development and progress of a country which will help to accelerate a country's overall progress.

Aim and Objectives

The aim of this study is to estimate the true contribution of agricultural variable to the economic growth and development of a Nigeria as a whole.

Objectives:

i. To fit number of Autoregressive Integrated Moving Average (ARIMA) model to the variable.
ii. To fit decomposition model.
iii. To fit Seasonal Autoregressive Integrated Moving Average (SARIMA) model on variables.

Literature Review

Agriculture is broadly divided into four sub-sectors in Nigeria; crop production, fishing, livestock and forestry. Crop production remains the largest segment and it accounts for about 87.6% of the sector's total output. This is followed by livestock, fishing and forestry at 8.1%, 3.2% and 1.1% respectively. Agriculture remains the largest sector in Nigeria contributing an average of 24% to the nation's GDP over the past seven years (2013 –2019). In addition, the sector employs more than 36% of the country's labour force, a feat which ranks the sector as the largest employer of labor in the country (Oyaniran, 2020).

Other key sectors of the economy, such as health, education, and housing, also received huge recurrent figures. Compared to other sectors, public spending on agriculture in Nigeria is low, with less than 2 percent of total federal expenditure allotted to it from 2001 to 2005. This allocation is far lower than spending in other key sectors, according to a research paper by the International Food Policy Institute (Aderemi, 2020).

In 2014, AU Heads of State and Government met to review the Maputo Declaration in Equatorial Guinea – paving the way for Malabo Declaration. At the end of the Malabo meeting, they upheld the 10 percent public spending target and extended commitment to half the continent's poverty by 2025, (five years from now) through inclusive Agricultural Growth and Transformation Sustain Annual sector growth in Agricultural GDP at least 6 percent. They believed the initiative will create job opportunities for at least 30 percent of the youth in agricultural value chains and empower million rural dwellers. But till date, nothing has really changed; only a fraction of African nations have achieved the details of the treaty (Aderemi, 2020).

The Federal Department of Agricultural Extension was formed in 2012 and is now working on Nigeria's first legislated extension policy with the assistance of IFAD21. The goal of this new extension policy is to develop the private sector to provide services and the public sector to ensure quality control. The focus is therefore on promoting pluralistic delivery, and ensuring that extension services are demand-led, incorporate market needs, and target farmers who do not have access to markets today (Rechard & Olajide, 2020).

Ademola (2019) empirically assessed the impact of agricultural financing on the growth of Nigerian economy. The study revealed that the size and amount of credit available to agriculture of the total amount of credit granted by the government has not been able to impact on the level of economic growth in Nigeria.

Awe (2003) examined the mobilization of domestic financial resources for agricultural productivity in Nigeria using time series analysis model. The study reported a positive relationship between agricultural posture and government recurrent expenditure on agriculture, agricultural credit scheme and bank loan to agricultural sector in Nigeria. He recommended that the government recurrent expenditure on agriculture should be reviewed upward for enhanced agricultural productivity.

Ogen (2007) studied the agricultural sector and Nigeria's development as compared to the Brazilian agro-industrial economy, 1960-1995. The work concluded that Nigeria and other third world countries need to urgently develop their monumental agricultural potentials if they are to achieve rapid industrial and economic development.

Olurankinse and Bayo (2012) analyzed the impact of non-oil export on the growth of the Nigerian economy. The findings revealed that the non-oil export has a positive impact on the growth of the Nigerian economy during the period, although its performance in terms of output level and revenue generation was poor. They recommended the need to increase production in both the agricultural and the manufacturing sectors so as to enhance product availability.

Proper system should be maintained to obtain the desired goals. This helps in improving the overall production by the rural farmers leading to better incomes of the farmers. The farmers are the essence of the agricultural system of any country. Different policies are also being developed by different governments of the countries to promote the role of farmers in sustainable development. This promotes the risk taking behavior of the farmers for improved net revenue of farming (Ndem & Osondu, 2018).

Bakare (2012) reported that agriculture is one of the important economic sectors in Nigeria. The study suggested the need for the policy makers in Nigeria to proper policy that will promote agriculture to a sustainable level.

Olajide et al. (2012) investigated the interrelationship between GDP and agricultural output in Nigeria. The work revealed that there exists a positive and significant effect between agriculture and GDP in Nigeria.

Akpan (2012) carried out a comparative assessment of the practical impact of long years of policy practice produced for Nigeria's rural areas within the context of two distinguishing economic periods characterized by agricultural production and petroleum oil exploration. The result revealed that rural development in Nigeria has not been successful. The work concluded that challenge of leadership, absence of institutional capacity and political commitments are the main factors working against the development of rural areas.

Odetola and Etumnu (2013) investigated the contribution of the agricultural sector to economic growth in Nigeria using growth accounting framework and time series data from 1960 to 2011. The work reported that the agricultural sector has contributed positively and consistently to economic growth, therefore re affirming the sectors importance in the Nigerian economy.

Oni (2014) examined the role of agriculture in poverty reduction in Nigeria between 1980 and 2011. Oni reported that agriculture is the key driver of growth in recent years with high potential of reducing poverty among Nigerians. Evidence from Augmented Dicker Fuller (ADF) unit root test and Error Correction Model (ECM) revealed that per capita agriculture GDP, physical infrastructure per capita and social infrastructure per capita were positively and significantly related to poverty reduction while per capita non-agricultural GDP and inflation rate were negatively and insignificantly related to poverty reduction in Nigeria. The study recommended that government should provide the needed subsidy to Nigerian farmers with a view to transforming and adapting to the use of modern technology so as to increase productivity and reduce the level of poverty in Nigeria.

Many developing countries have promoted the trainings as well as educational programs for their rural farmers to make them aware of the current circumstances and to determine their own values to improve the agriculture system for the sustainable development as well as also for the economic growth of the country. New technologies are also being introduced in such rural areas of the developing countries so that proper steps could be taken initially before any hazardous incident might take place (Yu, Chen, Niu, Gao et al., 2021).

In Olajide, Akinalabi and Tijani, (2012) their result contradicted the result of Lawal, (2011). They used OLS regression model to analyze the relationship between GDP and agricultural output in Nigeria. They found out that there is positive and significant effect of agricultural sector on GDP in Nigeria. They also found that agricultural sector contributed 34.4% variation in GDP between 1970 and 2010 in Nigeria.

Many farmers especially of the rural areas around the globe are "risk-averse" individuals as they already have a lot to put on stake in obtaining the expected utility. Even though they obtain the required output they expected but they are not able to gain more than that due to their risk aversion behavior. According to the "expected utility theory", the risk averter are the ones who "always prefer the expectation E(X) to the random variable X-are characterizable by concave utilities" (Khaw, Li, & Woodford, 2021).

Ugwuoke, Ume and Ihedioha (2018); studied the effects of interest rate deregulation on agricultural financing in Nigeria (1970-2014). The study also specifically examined the trend in the rate of interest, volume of credit to agricultural sector and agricultural GDP contribution under the period (1970-2014). The results showed that interest rate has a strong influence in the volume of credit to the agricultural sector and it also has weak influence on the agricultural GDP contribution. It was also observed that interest rate has been fluctuating under the period (1970-2014) that have resulted to low productivity, and unemployment in agricultural sector but makes the financial institutions to be willing to disburse credit to the public. The agricultural GDP contribution has a downward and upward trend during the period which is as a result of the neglect of the government based on the discovery of oil.

Material and Methods

The data used for this study was extracted from National Bureau of Statistics [NBS] from first quarter of 2016 to second quarter of 2022. Time series analysis refers to the isolation of the components of time series so that the contribution of each component to the time series variable can be evaluated. This is often termed "*Decomposition of time series".*

Model Specification

ARIMA Model

Autoregressive moving average model. The general model introduced by Box and Jenkins (2015) includes autoregressive as well as moving average parameters, and explicitly includes differencing in the formulation of the model. Specifically, the three types of parameters in the model are: the autoregressive parameters (p), the number of differencing passes (d), and moving average parameters (q). In the notation introduced by Box and Jenkins, models are summarized as ARIMA (p, d, q); so, for example, a model described as (0, 1, 2) means that it contains 0 (zero) autoregressive (p) parameters and 2 moving average (q) parameters which were computed for the series after it was differenced once.

Mathematical formulation of ARIMA is (p ,d, q) $\Phi_P(L^s)\phi_p(L)z_t$

SARIMA Model

Seasonal Autoregressive Integrated Moving Average (SARIMA) Models. The ARIMA model is for non-seasonal non-stationary data. (Box and Jenkins, 1976) have generalized this model to deal with seasonality. Their proposed model is known as the Seasonal ARIMA (SARIMA) model. In this model seasonal differencing of appropriate order is used to remove non-stationarity from the series. A first order seasonal difference is the difference between an observation and the corresponding observation from the previous year and is calculated as;

$Z_t = Y_t - Y_{t-s}$. For monthly time series 12 = S and for quarterly time series 4 = S. This model is generally termed as the SARIMA$(p,d,q)\times(P,D,Q)^s$ model.

The mathematical formulation of a SARIMA$(p,d,q)\times(P,D,Q)^s$ model in terms of lag polynomials is given below

$$\Phi_P(L^s)\phi_p(L)(1-L)^d(1-L^s)^D y_t = \Theta_Q(L^s)\theta_q(L)\varepsilon_t,$$

$$i.e.\ \Phi_P(L^s)\phi_p(L)z_t = \Theta_Q(L^s)\vartheta_q(L)\varepsilon_t.$$

Results and Discussion

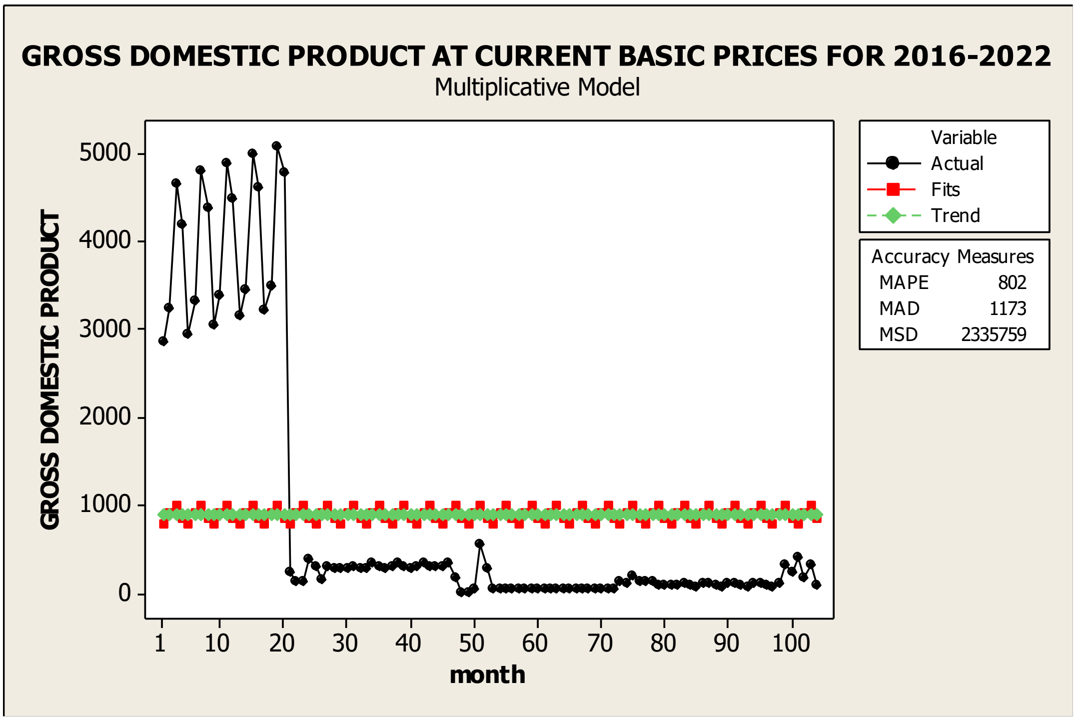
Multiplicative Model

Data	Gross Domestic Product
Length	104
Nmissing	0

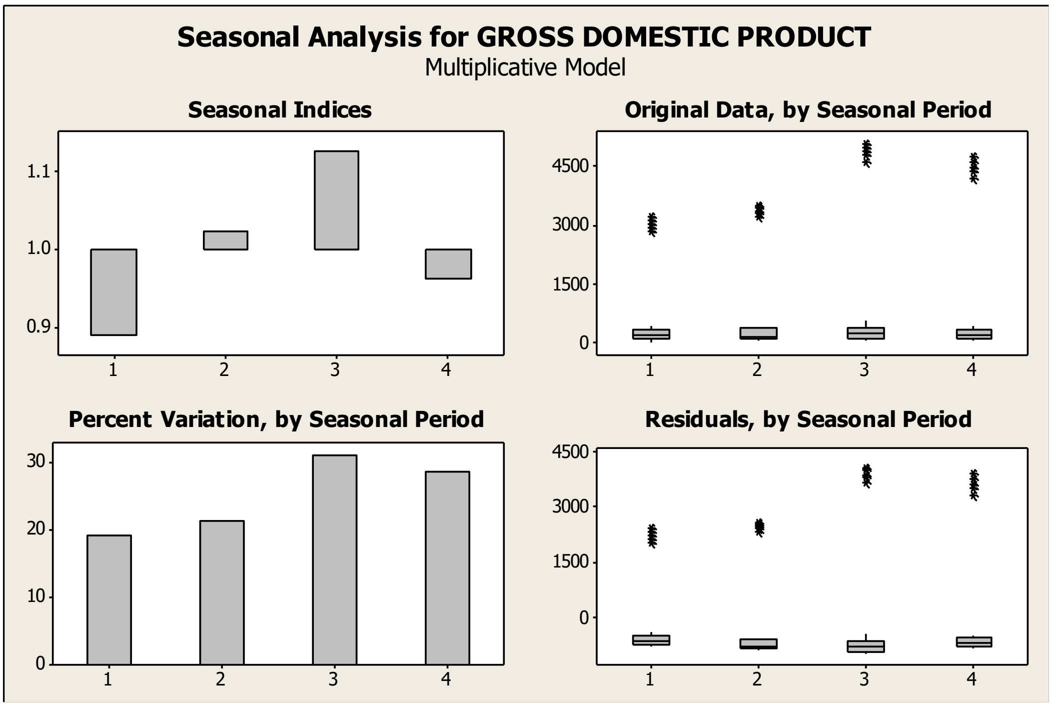
Seasonal Indices

Period	Index
1	0.88838
2	1.02261
3	1.12694
4	0.96207

The seasonal indices show that the GDP of Q1 is 11.162% less than the quarterly average , Q2 shows that 2.261% of the GPD is higher than the quarterly average, Q3 shows that 12.694% of GDP is higher than the quarterly average and Q4 shows that 3.793% of GDP is less than the quarterly average.



Source: Author's computation 2024



Source: Author's computation 2024

Time Series Decomposition for Gross Domestic Product

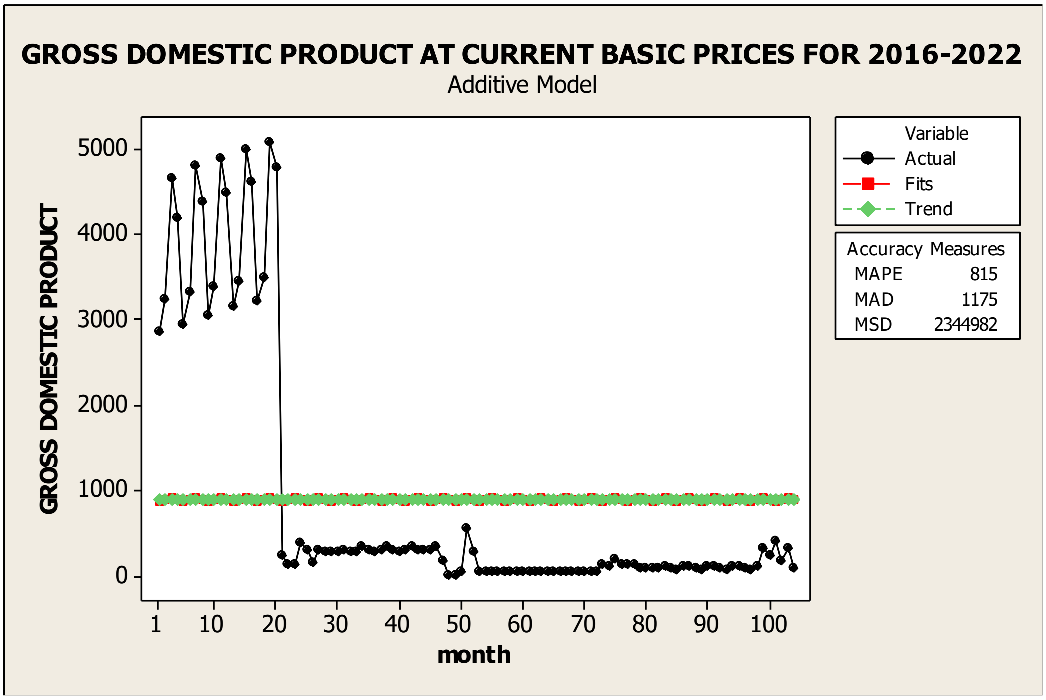
Additive Model

Data	GROSS DOMESTIC PRODUCT
Length	104
Nmissing	0

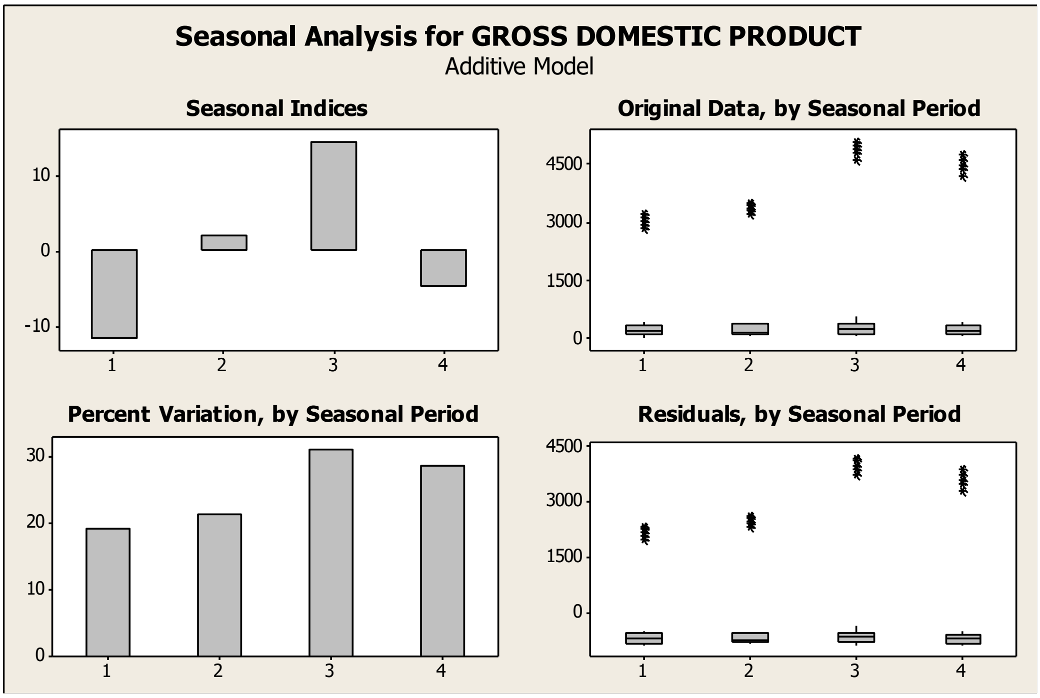
Seasonal Indices

Period	Index
1	-11.5662
2	1.9775
3	14.4137
4	-4.8250

The seasonal indices show that the GDP of Q1 is 11.5662% less than the quarterly average, Q2 shows that 1.9775% of the GPD is higher than the quarterly average, Q3 shows that 14.4137% of GDP is higher than the quarterly average and Q4 shows that 4.8250% of GDP is less than the quarterly average.



Source: Author's computation 2024



Source: Author's computation 2024

Testing for Adequacy of Data (SARIMA Model $(1,0,1)_4*(1,0,1)$)

Hypothesis 1

H_0: The model is adequate.

H_1: The model is not adequate.

Level of significance: α= 0.05

Test statistic: Q= n(n+2) $\sum_{j=1}^{k} r_j^2 \,/(n-j)(p-value)$

Decision rule: Reject H_o if p-value is < α value, otherwise do not reject.

Computation:

ARIMA Model: Gross Domestic Product

Final estimates of parameters

Type		Coef	Se Coef	T	P
Ar	1	0.7910	0.0775	10.20	0.000
Sar	4	0.9829	0.0368	26.70	0.000
Ma	1	-0.2115	0.1164	-1.82	0.072
Sma	4	0.5311	0.0936	5.67	0.000

Source: Author's computation 2024

Number of observations: 104

Residuals: SS = 22457028 (backforecasts excluded)

MS = 224570 Df = 100

Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Lag	12	24	36	48
Chi-Square	5.6	7.5	11.5	11.6
Df	8	20	32	44
P-Value	0.695	0.995	1.000	1.000

Source: Author's computation 2024

Since p-values are all greater than α value = 0.05, we therefore do not reject H_o and conclude that the model is adequate at 5% level of significant.

Hypothesis 2 (SARIMA MODEL $(2,0,1)_4$*(2,0,1))

H_0: The model is adequate.

H_1: The model is not adequate.

Level of significance: α= 0.05

Test statistic: Q = n(n+2) $\sum_{j=1}^{k} r_j^2 \,/(n-j)(p-value)$

Decision rule: reject H_o if p-value is < α value, otherwise do not reject.

Computation:

ARIMA Model: Gross Domestic Product

Final Estimates of Parameters

Type		Coef	SE Coef	T	P
AR	1	1.6384	1.4253	1.15	0.253
AR	2	-0.6748	1.1928	-0.57	0.573
SAR	4	1.1251	0.2178	5.17	0.000
SAR	8	-0.1446	0.2064	-0.70	0.485
MA	1	0.7752	1.4624	0.53	0.597
SMA	4	0.6340	0.1748	3.63	0.000

Source: Author's computation 2024

Number of Observations: 104

Residuals: SS = 22902424 (backforecasts excluded)

MS = 233698 DF = 98

Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Lag	12	24	36	48
Chi-Square	7.5	9.9	14.2	14.2
Df	6	18	30	42
P-Value	0.280	0.936	0.994	1.000

Source: Author's computation 2024

Since p-values are all greater than the α value =0.05, we therefore, do not reject H_o and conclude that the model is adequate and 5% level of significant.

Hypothesis 3 (Sarima Model $(2,0,1)_4$*(2,1,1))

H_0: The model is adequate.

H_1: The model is not adequate.

Level of significance: α= 0.05

Test statistic: Q = n(n+2) $\sum_{j=1}^{k} r_j^2\,/(n-j)(p-value)$

Decision rule: reject H_o if p-value is < α value, otherwise do not reject.

Computation:

Arima Model: Gross Domestic Product

Final Estimates Of Parameters

Type		Coef	Se Coef	T	P
Ar	1	0.3057	0.3613	0.85	0.400
Ar	2	-0.3062	0.1019	-3.01	0.003
Sar	4	1.1251	0.1562	7.20	0.000
Sar	8	-0.1385	0.1482	-0.93	0.352
Ma	1	0.2556	0.3733	0.68	0.495
Sma	4	0.7905	0.0962	8.22	0.000

Source: Author's computation 2024

Differencing: 1 regular difference

Number of observations: original series 104, after differencing 103

Residuals: SS = 23201644 (back forecasts excluded)

MS = 239192 DF = 97

Modified Box-Pierce (Ljung-Box) Chi-Square Statistic

Lag	12	24	36	48
Chi-Square	7.0	9.2	12.6	12.8
DF	6	18	30	42
P-Value	0.317	0.955	0.998	1.000

Source: Author's computation 2024

Since p-values are all greater than α value = 0.05, we do not reject H_0 and conclude that the model is adequate at 5% level of significant.

Measure of Accuracy

	MULTIPLICATIVE	ADDITIVE
MAPE	802	815
MAD	1173	1175
MSD	2335259	2344982

Source: Author's computation 2024

The seasonal indices show that the GDP of Q1 is 11.162% less than the quarterly average, Q2 shows that 2.261% of the GPD is higher than the quarterly average, Q3 shows that 12.694% of GDP is higher than the quarterly average and Q4 shows that 3.793% of GDP is less than the quarterly average. For stationarity time series, SARIMA models, the values of Ljung-box statistic for the three test of adequacy of data showed that all p-values are greater than the level of significance, which mean that the model is adequate. That is, SARIMA $(1,0,1)\times(1,0,1)_4$, SARIMA $(2,0,1)\times(2,0,1)_4$ SARIMA $(2,0,1)\times(2,1,1)_4$ are adequate for the purpose of this study. The accuracy measure showed that multiplicative model is best fit for the data used in this study using mean absolute percentage error (MAPE), mean absolute deviation (MAD) and mean square deviation (MSD).

Conclusion

This study examines the impacts of agricultural variables on the gross domestic products (GDP) in Nigeria using SARIMA, decomposition model and on the basis of the results, it showed that multiplicative model has the lesser value and serves as the best. The Gross Domestic product (GDP), that is, the total monetary values of goods produced in a year on livestock, fishery, forestry, crop production, in first quarter and fourth quarter are less than the quarterly average while GDP is typically higher than the quarterly average in Q2 and Q3 and less in others. SARIMA $(1,0,1)\times(1,0,1)_4$, SARIMA $(2,0,1)\times(2,0,1)_4$ And SARIMA $(2,0,1)\times(2,1,1)_4$ are found to be adequate .and could be used for further forecasting and prediction on GDP.

Recommendations

- It is recommended that the result be replicated on other agricultural data.
- The total monetary values of livestock, fishery, forestry and crop production in second quarter and third quarter is above the quarterly average so it is recommended that there will be much gain if investment should be done on fishery, livestock, forestry, and crop production on the second and third quarter of the year.

- It is also recommended that any of the fitted SARIMA models be use for forecasting GDP

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