

Empirical Analysis of Causal Linkage between Agricultural Output and Real GDP: Evidence from Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author IK conceived the research idea, developed the introduction and literature sections, while author SEN designed the methodology and managed the analyses of data. Both Authors discussed the findings, drew conclusion, read and approved the final manuscript.

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ABSTRACT

The agricultural sector is pivotal in poverty alleviation, job creation and food supply. In recent times the performance of the sector leaves more to be desired as its proportion in aggregate output fluctuated as output expands. This study empirically analysed the causal linkage between the agricultural sector output and economic growth in Nigeria using annualized time series data covering 1981 to 2018. Data were analysed using the Granger causality test, vector autoregression, and impulse response and variance decomposition econometric tools. The empirical results indicate that agricultural output did not perfectly interlink with economic growth. The causality test revealed that economic growth precedes agricultural sector output in a uni-directional manner, while the impulse response analysis indicated that economic growth does not respond swiftly to innovations in agriculture. The findings of our study did not corroborate the predictions of agriculture-led growth theorized by Kuznets (1968).

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1. INTRODUCTION

The lingering quest for global growth and development could be achieved or forfeited in agriculture. Jatuporn et al. [1] described the agricultural sector as a ‘primer engine’ that supports other economic sectors for ‘workforce transformations’ and ‘raw material input’, while [2-4] regarded the agricultural sector as the source of poverty alleviation, employment, food security and economic prosperity.

However, the ability of the agricultural sector to achieve these economic benefits remains highly limited among Sub-Saharan African countries, of interest to this study is the case of Nigeria. Endowed with a total landmass of 923,768 km², rich in vegetation, topography and climatological conditions [5,6], with 38.4 percent utilized for arable purposes, 7.4 percent for permanent crops, forest occupies 9 percent and 45.2 percent for non-agricultural purposes [7]. Furthermore, the agricultural sector employed about 38 percent of the total working population and accounted for 26.1 percent of GDP in 2018 [8].

Despite the favourable climatological condition for agriculture, Nigeria tops the world importers and consumers of agricultural products such as

rice, rubber, fresh fruits, vegetables, toothpick, cereals, chicken meat, fishery products, and dairy. However, she exports an insignificant proportion of her agricultural products due to poor quality, storage facility deficiency, lack of expertise, poor value addition and a disequilibrium between local demand for and supply of agricultural products. The gap in agricultural products requirements and its local production has continued to widen, as shown in the growing difference between non-oil exports and its imports counterpart presented in Fig. 1.

Although the agricultural sector occupies a strategic position in Nigeria’s economic growth plans, its contributions to employment, poverty alleviation, inputs to other sectors and economic growth and development has been far from impressive. Despite this worrisome situation, majority of studies [6,9-11] on the agricultural sector and economic growth have concentrated on its impact and not causality. This study, therefore, employs dynamic econometric techniques to determine the linkages between agricultural sector output and real GDP in Nigeria. The broad objective of this study is to ascertain whether a causal relationship exists between the agricultural sector and economic growth episodes. Also, study examines if agricultural sector output precedes real GDP or otherwise, and determined the time frame it takes agricultural sector output to influence real GDP.

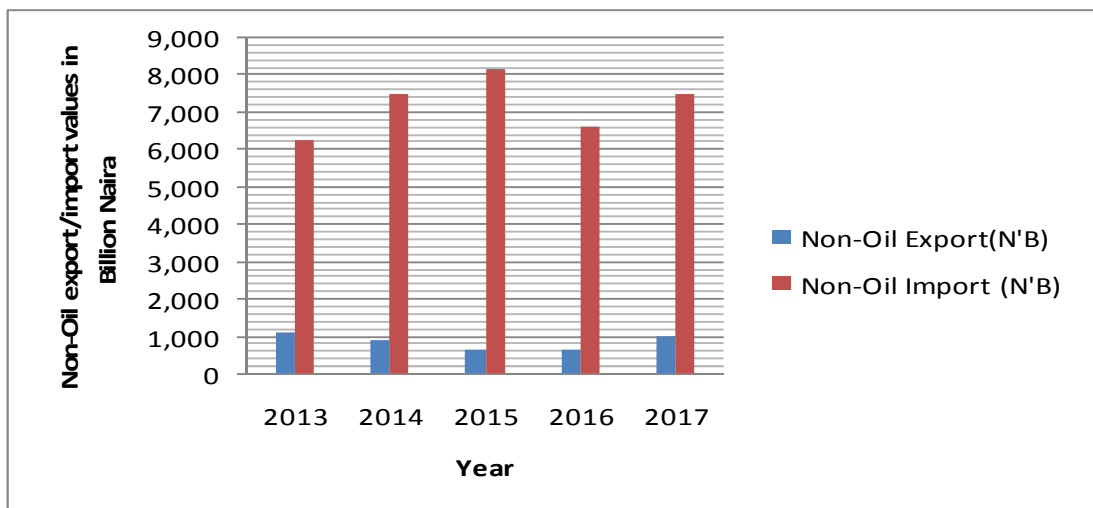


Fig. 1. Non-oil export/import values from 2013- 2017

Source: Authors’ compilation from CBN data

The rest part of this paper is structured as follows; section two details out the relevant literature review. Section three discusses data and methodology; section four focuses on empirical results. Section five concludes the study with summary of finding and policy implications.

2. LITERATURE REVIEW

Studies on the agricultural sector and economic growth abound in the literature. However, existing studies focused more on the impact of the agricultural sector on economic growth, while lesser consideration accorded possible lead-lag linkages between agriculture and growth.

Rahman and Hossain [12] examined the causal relationship between agriculture and economic growth for Bangladesh economy using the Vector Autoregression (VAR) approach, and the study documented a unidirectional causation flow from agriculture to economic growth. Awokuse and Xie [2] used the directed acyclic graphs inductive algorithm causation to analyse the role of agriculture in economic growth for a panel of Brazil, Chile, Mexico, China, Indonesia, Thailand, South Africa, Kenya and Cameroon. Accurately, a causal linkage running from economic growth to agriculture recorded in Chile and Mexico, but in Brazil, the study reports a lack of causal link. In Asian, all economies investigated exhibit causal flow from agriculture to economic growth. At the same time, South Africa and Kenya experience a flow of activities from economic growth to agriculture which differs from what is obtainable in Cameroon where agriculture precedes economic growth. Also, McArthur and McCord [13] evaluated the role of agricultural inputs in the process of nations' structural transformation using regression analysis. The study covered East Asia, South Asia, Latin America and Sub-Saharan Africa; the panel data analysis results showed that agriculture has a strong positive impact on economic growth/structural change across the border. However, a review of this study indicates that causal linkage analysis neglected as the focus was impact using regression analysis. [14] adopted the bi-variate Vector Auto-Regression (VAR) and Granger Causality techniques to examine how trade in agricultural products affected growth in the East African Community States. The empirical results indicate the absence of any unique relationship between agricultural trade and economic growth amongst the countries covered by the study.

In Nigeria, a flurry of studies [15,16,17,18,11] have investigated the agricultural sector and economic growth majorly to ascertain the effects or impact of the former on the latter. The reviewed literature clear reveals that most studies on agriculture and economic growth focused on impact and neglected causality; this depicts the gap this paper intends to close.

This study adopted the Kuznets agriculture-led growth theory of 1968 as its framework. Earlier works like [13] utilized the Kuznets theory to triangulate their studies. The Kuznets theory proposed four channels through which agricultural output affects economic growth. One, a forward linkage effect (agriculture providing food and raw materials to non-agricultural production). Two, a backward linkage effect (agriculture consuming industrial products such as insecticide or tractors). Three, inter-sectoral transfers (agriculture contribute to taxes and cheap labor to other sectors). Four, foreign exchange effect (through agricultural exports). Again, 'another mechanism may be that increased farmer incomes improve health outcomes, thus increasing worker productivity, decreasing child mortality, reducing total fertility rates, increasing investment per child, and decreasing demographic pressures'. The hypotheses of this study were proposed based on the tenets of the Kuznets theory.

Khan and Ansari [19] studied the contribution of agriculture to economic growth in Uttar Pradesh, India. The study employed a long-run co-integrating analysis and found that agricultural development drives economic growth. Based on their findings, they suggested the public investment in irrigation, credit to farmers and the supports for micro and small agro-based industrialists as the strategic actions to achieve economic growth in India. In another analysis, Batabyal, Kourtit and Nijkamp [20] investigated the roles of rural and urban agro-tech in attaining steady state in economic growth. Of the studies on agriculture and economic growth, none to the best of our knowledge analysed their dynamic and causal relationship for Nigeria within the period investigated.

3. DATA AND METHODOLOGY

This study examines the causal nexus between economic growth and agricultural output in the Nigerian economy. The scope of the study is Nigeria within the period of 38 years from 1981-

2018. Annual time series data extracted from the Central Bank of Nigeria's statistical bulletin covering 38 years from 1981 to 2018 were analysed using the vector autoregression (VAR) technique and the Granger Causality test which are dynamic in approach and superior to the simplified ordinary least square approach employed by the majority of previous studies in the literature. The variables for which data were collected included; the value of agricultural output (AGRI) and real gross domestic product (RGDP) measured in Billion Naira from their contributions to the national output.

The general VAR model is expressed as follows:

$$z_{1t} = \alpha_1 + \alpha_{11}z_{1t-1} + \alpha_{12}z_{2t-1} + \beta_{11}z_{1t-2} + \beta_{12}z_{2t-2} + \epsilon_{1t} \quad (1)$$

$$z_{2t} = \alpha_2 + \alpha_{21}z_{1t-1} + \alpha_{22}z_{2t-1} + \beta_{21}z_{1t-2} + \beta_{22}z_{2t-2} + \epsilon_{2t} \quad (2)$$

The compact form of the above VAR equations is expressed in the equation below.

$$z_t = \Omega + \alpha_1 z_{t-1} + \beta_2 z_{t-2} + \mu_t \quad (3)$$

Where

Ω depicts an $n \times 1$ Column vector

α_j s are the $n \times n$ square metrics

μ_t is an $n \times 1$ column vector of serially uncorrelated vector of innovations variable which is identically, independently and symmetrically distributed of zero mean and constant variance $\{\mu_t \sim iidn(0, \sigma^2)\}$.

If z_t is a column vector ($n \times 1$) matrix which encompasses all the logged variables in the model, the VAR model establishes a link between the current z_t , its lags (z_{t-i}) and the white noise variable (μ_t).

Furthermore, the Granger causality test is employed to estimate equations 4 and 5 to establish the empirical linkages between AGRI and RGDP.

$$\log RGDP_t = \alpha_0 + \sum_{t-1}^n \alpha_1 \log RGDP_{t-1} + \sum_{t-1}^n \beta_2 \log AGRI_{t-1} + \mu_t \quad (4)$$

$$\log AGRI_t = \alpha_0 + \sum_{t-1}^n \alpha_1 \log AGRI_{t-1} + \sum_{t-1}^n \alpha_2 \log RDGP_{t-1} + \epsilon_t \quad (5)$$

Equations 4 and 5 produce the following hypotheses are drawn

$$H_0 = \sum_{t-1}^n \beta_i = 0, \text{ and } \sum_{t-1}^n \alpha_i = 0 \quad (6)$$

The H_0 states that there is no causality between AGRI and RGDP

$$H_1 = \sum_{t-1}^n \beta_i \neq 0, \text{ and } \sum_{t-1}^n \alpha_i \neq 0 \quad (7)$$

While H_1 states otherwise, that is, causality exists between AGRI and RGDP. From equations 4 to 5, if the estimates β_2 and α_2 are statistically significant; it indicates the existence of a bi-directional relationship between AGRI and RGDP. But if β_2 is statistically significant and α_2 is not, a unidirectional causal relationship exists running from AGRI to RGDP and if α_2 is statistically significant and β_2 is not, a unidirectional relationship exists flowing from RGDP to AGRI.

4. RESULTS AND DISCUSSION

Table 1 presents the summary of the unit root results from the Dickey-Fuller tested (DF), Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) techniques. The study the null hypothesis which stipulated non-stationarity in data series at 1%, 5% and 10% significance levels, and the Mackinnon critical values for the tests are summarized in Table 2.

The DF tests results show that all the variables are non-stationary at levels; thus, the null hypothesis is accepted at 5% significance level. However, the ADF results in the first-difference series confirm that the series is stationary after first difference. This position is strongly affirmed by the results of the Phillips-Perron stationarity test at 10% significance level. In sum, the pre-test estimation reveals that the series would produce reliable results at the first difference.

Table 3 shows the lag selection criteria employed in the selection of optimal lag for the parsimonious dynamic VAR model. The criteria include the sequential modified LR test, final prediction error test, Akaike information criterion, Schwarz information criterion and the Hann-Quinn information criterion. Interestingly, the results from the different criteria unanimously affirmed a one-period lag as optimal lag for the VAR model estimation.

The paper uses the VAR and Granger causality techniques to ascertain the existence of forward-backward linkages between innovations in agricultural output and economic growth. This study varied from previous studies [15,17,18] on

Table 1. Unit root tests: Nigerian AGRI and RGDP data (1981 – 2018)

Series	DF test at levels		ADF test in first difference			PP test in first difference				
	No trend	With trend	No trend	Lag	With trend	Lag	No trend	Lag	With trend	Lag
LogAGRI	0.67	-1.85	-5.85***	2	-5.77***	2	-5.85***	2	-5.77***	2
LogRGDP	-0.01	-1.81	-3.39**	2	-3.31*	2	-3.27**	2	-3.21*	2

Source: Author's computation using eviews 10.

Note: *, **, *** respectively indicates the rejection of the null hypothesis of unit root at 10%, 5% and 1%

Table 2. Mackinnon critical values for rejection of the hypothesis of unit root

Critical value	ADF test in first difference		PP test in first difference	
	No trend	With trend	No trend	With trend
1% level	-2.63	-3.77	-3.63	-4.23
5% level	-1.95	-3.19	-2.94	-3.54
10% level	-1.61	-2.89	-2.62	-3.20

Source: Mackinnon (1996)

Table 3. VAR Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	68.5703	NA	6.83e-05	-3.915904	-3.826118	-3.885285
1	178.323	200.1380*	1.36e-0*	-10.1366*	-9.867318*	-10.044*
2	181.4604	5.351128	1.43e-07	-10.08590	-9.636974	-9.932806
3	182.5904	1.794832	1.71e-07	-9.917085	-9.288583	-9.702748
4	185.0670	3.642006	1.90e-07	-9.827471	-9.019398	-9.551895

* indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion; Source: Computed by authors using eviews 10

agriculture and economic growth that employed multiple regressions and the autoregressive distributed lag models. In this study, we examined the empirical causal linkages between agricultural sector output and real GDP following using the dynamic VAR and Granger causality approaches in line with previous studies [14].

Table 4 presents the Granger's causality test results based on the optimal lag obtained in Table 3. The result reveals that a uni-directional relationship exists between agricultural sector output and real GDP. The one-way causation runs from economic growth to agricultural sector growth as revealed by the F-statistic value, which is significant at 10%. This further means the rejection of the H_0 that economic growth does not granger cause agricultural output. Also, the F-statistic value for the second hypothesis implies the acceptance of the null hypothesis that agriculture does not granger cause economic growth in Nigeria. This implies that the agricultural sector feeds on the expansion in national output occasion by other sectors of the economy but does not drive economic growth. These findings could be justified by the

fact that the Nigerian agricultural sector has not taken its rightful position in providing food, inputs, employment and income based on the Kuznets theory, thus, the mechanism through which agricultural sector output influences economic growth is weak.

To establish the impact of the agricultural sector output on economic growth, the study utilized the coefficients of VEC and VAR estimated to derive of impulse responses.

The result of the vector error correction estimates on the relationship between agricultural sector output and economic growth proxied by RGDP in Nigeria. The result shows that one period of lag in agriculture output has an adverse effect on current agriculture output level and current level of aggregate demand (RGDP). This implies that the agricultural sector output in past periods does significantly serves as input in the current period in the agricultural sector. It further connotes that the agricultural sector output does not stimulate economic growth. This can be attributed to the fact that the

final demand sector utilizes the majority of the agricultural sector outputs. This limits the amount of inputs flows from the agricultural sector to other productive sectors like the industrial sector that would transform into national output expansion and growth. Besides, one period lag in RGDP has a positive impact on the current level of agricultural output and current RGDP level. It means that last year's economic performance determine this year's agricultural output and growth.

The coefficient of the vector error correction mechanism conforms to a priori expectation of a negative and significant coefficient. It implies that it takes about 10 months and 2 weeks for disequilibrium in the agricultural sector output to adjust back to equilibrium. This high speed of adjustment can be linked to high feed on channels of the agricultural sector on economic growth propelled by other sectors of the economy.

Table 4. Pairwise granger causality tests

Null Hypothesis:	Obs	F-Statistic	Significance level
D(LOGRGDP) does not Granger Cause LOGAGRI	36	3.62631	*
D(LOGAGRI) does not Granger Cause LOGRGDP		0.65669	

Source: Author's computation using eviews 10.

Note: *, ** and *** denote rejection of the null hypothesis at 10%, 5% and 1% levels of significance respectively—source: Author's computation using eviews 10.0. $\Delta x \Rightarrow \Delta y$ implies sector x granger causes sector y

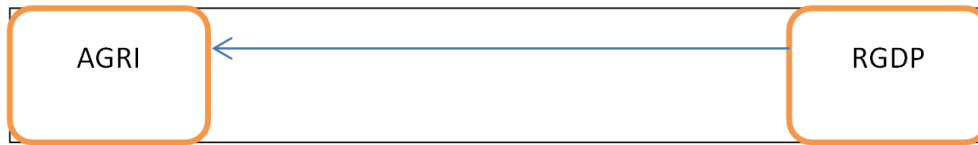
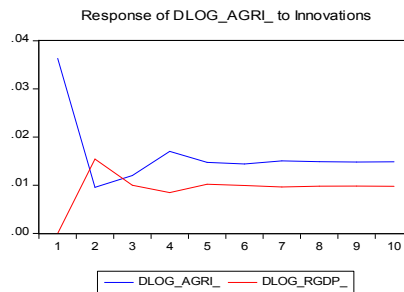


Fig. 2. Direction of causality between AGRI and RGDP

Source: Authors' computation using Eviews 10

Response to Cholesky One S.D. (d.f. adjusted) Innovations



Response of DLOG_RGDP_ to Innovations

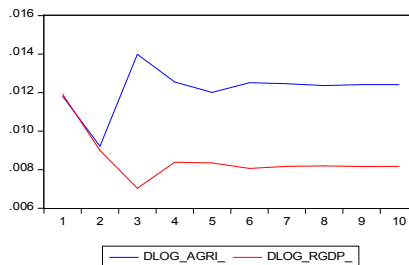


Fig. 3. Impulse response graph

Source: Authors' computation using Eviews

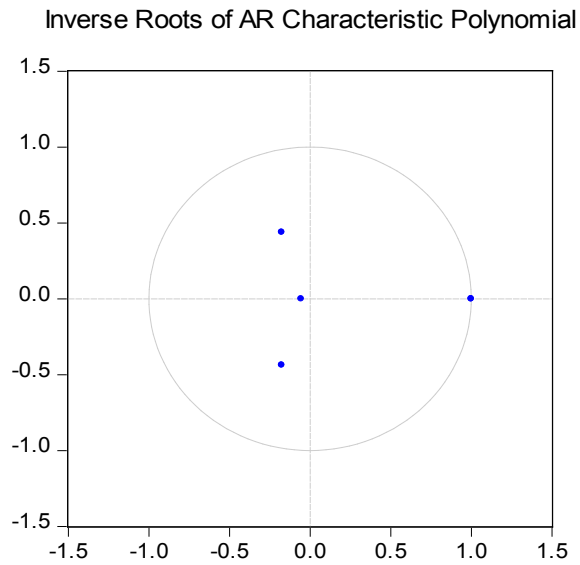


Fig. 4. AR inverse root graph
 Source: Authors computation using Eviews

Fig. 3 presents the Impulse Response Function (IRF); the standard deviation in the model is expressed in percentage for both variables. The horizontal axis of the IRF indicates the number of periods that have passed after the impulse has been given while the vertical axis reveals how the variables responded to innovations. The result in panel 1 shows that one percent innovation in economic growth produces positive responses of 0.0363, 0.0096, 0.0120, 0.0170, 0.0147, 0.0144, 0.0150, 0.0149, 0.0148 and 0.0149 percent in the agricultural sector output from the first to the tenth period respectively. This indicates that innovations due to output expansion have a positive impact on agricultural sector output at all times.

The AR inverse root test is used to determine the reliability and stability of the impulse response from the estimated VAR model. Fig. 4 reveals that all the roots of the polynomial are within the unit circle. This means that the estimated VAR models and the impact from the derived impulse response are stationary, stable and reliable. And as such, the results of the dynamic econometric techniques are suitable for relevant policy suggestions.

The variance decomposition results show the portion of the forecast error variance in agricultural sector output that is due to its innovation and innovations in RGDP expansion and vice versa. The own shocks of the

agricultural sector constitute a significant source of variation in its forecast error in the time horizon, ranging from 100% to 76.07%. After 10 years, variation in the agriculture sector output is accounted for by changes in RGDP by (23.92%). Interestingly, the agricultural sector predominantly accounts for the variations in its sector.

5. FINDINGS

Notably, the findings of the study indicated that it takes about one year for economic growth to significantly stimulate growth in agricultural output. However, the agricultural sector does not stimulate output growth. This situation could be adduced to lack of capacity development in the sector, poor innovation, inadequate budgetary allocation and the artificial barriers to credit accessibility by farmers. These challenges make the agricultural sector undeveloped, unstructured and poorly linked with aggregate output, hence, the need for the formulation of agricultural sector programme and policy guide that would remove the structural rigidities, reduce insanity (do the same thing repeatedly and expecting different results) in agricultural practices and encourages a paradigm shift from agriculture to agribusiness with enormous value addition to primary products which could translate into better input for industries, improved business for trade and services, high income to farmers and agribusiness promoters and higher job creation that could culminate in

economic growth. Also, the weak linkage between the agricultural sector and RGDP could be addressed by abridging the knowledge gaps between farmers and agricultural research institutes which if properly harnessed will put Nigeria on the path of sustainable development in agriculture and agribusiness and in economic growth.

The findings of this paper that agricultural sector output does not precede economic growth but economic growth precedes agricultural sector output disagree with earlier reports [15,17,18, 14,12] that agriculture stimulates economic growth. The lack of supports for these earlier works can be attributed to methodological differences. However, our empirical results lend credence to the works of [2] that found that economic growth precedes agricultural output for Chile and Mexico.

6. CONCLUSION

The study analysed the empirical linkages between agricultural (AGRI) output and economic growth (RGDP) for the Nigerian economy using yearly data from 1981 to 2018. The study was prompted by the need to examine the behaviour and nature of the interactions between agricultural output and aggregate demand sector measured by real gross domestic product (RGDP). Interestingly, the empirical result revealed that there is a unidirectional causal relationship that runs from real national output to agricultural output (AGRI). This implies that AGRI does not precede economic growth but growth precedes agricultural sector development.

In light of the findings and conclusion, the study strongly recommends the pursuit of multiple sectoral growth approach to economic growth to develop the agricultural sector. Also, current agricultural development policies and strategies are not effective enough to propel economic growth in the country, thus, modern agricultural development techniques and manpower development in the sector is vehemently suggested.

Research efforts in the future should investigate the dynamic linkages between economic growth and all other sectors of the Nigerian economy, including agriculture, industry, service, building & construction and the trade sectors. Such analysis would reveal the sector that causes growth and those that hinders growth in the economy. The policy implications from such study would be

profound especially in this current state of the economy that requires optimization in resource allocation to sectors that have the potential to drive growth in other sectors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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