Received: 2 April 2020 | Revised: 3 June 2020 | Accepted: 5 July 2020

DOI: 10.1002/pa.2271

ACADEMIC PAPER

WILEY

Revisiting the economic growth and agriculture nexus in Nigeria: Evidence from asymmetric cointegration and frequency domain causality approaches

Mary Oluwatoyin Agboola[1] | Festus Victor Bekun[2,3] | Olawumi Abeni Osundina[4,5] | Dervis Kirikkaleli[6]

[1]Dar Al Uloom University, Riyadh, Saudi Arabia

[2]Faculty of Economics Administrative and Social sciences, Istanbul Gelisim University, Istanbul, Turkey

[3]Department of Accounting, Analysis and Audit School of Economics and Management, South Ural State University, Chelyabinsk, Russia

[4]Department of Economics, Babcock University, Ilishan-Remo, Nigeria

[5]Department of Economics, Eastern Mediterranean University, Famagusta, Turkey

[6]Faculty of Economic and Administrative Sciences, Department of Banking and Finance, European University of Lefke, Mersin, Turkey

Correspondence
Dervis Kirikkaleli, Faculty of Economic and Administrative Sciences, Department of Banking and Finance, European University of Lefke, Lefke, Northern Cyprus, TR-10 Mersin, Turkey.
Email: dkirikkaleli@eul.edu.tr

The contribution of different agricultural subsectors to economic growth in Nigeria is investigated and further suggests policy implications for investing in each of these subsectors. To this end, Johansen cointegration test and Gregory–Hansen test for cointegration with regime shift, vector error correction model (VECM), dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS), Granger causality, and frequency domain causality test are employed for data from 1981 to 2016. This paper further highlights the long and causal dynamics between the selected agricultural subsector, namely forestry, crop production, fishery and livestock, and economic growth. Findings from time and frequency domain causality tests indicate a one-way causality running from various subsectors of agriculture to economic growth in Nigeria, meaning how various subsectors of agriculture are important for predicting economic growth. In addition, there is 54% speed of adjustment from the error correction model, suggesting a need for diversification of the economy into the agricultural sector as a means for sustainable economic growth in the face of the continuous plunge in the global oil price. In the long-run, the effect of forestry, crop production, and fishery on economic growth is statistically significant and positive. These outcomes have inherent policy implication(s), which are elucidated in the concluding section.

JEL CLASSIFICATION
O13; Q32; Q33

1 | INTRODUCTION

The challenges faced by humankind have not greatly changed; they are still anchored on the three major basic needs of life: shelter, clothing, and food. Ensuring the basic level of food security has continually been a challenge within African countries, of which Nigeria is not an exception. Nigeria is reputed as Africa's most populous country with a huge population of over 170 million people. Unfortunately, most of its citizens have access to less than the minimum daily calorie requirement, due to living on less than the minimum required two dollars per day. To escape this food insufficiency, it is important for the country to look inward to achieve sustained food security; and to do that the agricultural sector needs to be revamped.

Economic growth is the heartbeat of economic development in any country and is measured via the growth rate of a country's national income; a higher national income should translate to higher benefits for the citizens. Despite the significance of agriculture to economic growth, there are two opposing schools of thought about the relationship between agriculture and economic growth. Some have argued that agriculture should be the bedrock of economic growth (Alola & Alola, 2018; Gollin, Parente, & Rogerson, 2002; Lawal, 2011; Mishra & Dash, 2014; Odetola & Etumnu, 2013; Oluwatoyese & Applanaidu, 2014; Thirtle, Lin, & Piesse, 2003; Timmer, 1995); in contrast, Jorgenson (1961), Ranis and Fei (1961), Dercon (2009) and Gollin (2010) maintain that the causal relationship between agriculture

and economic growth is very weak, poorly established, inconsequential, and the evidence, although of great interest, can hardly be used to establish the actual drivers of economic growth.

Despite the opposing views of the aforementioned schools of thought, for Nigeria, agriculture contributed over 60% to the gross domestic product in the early 1960s—this was before the discovery of oil (Lawal, 2011). Agriculture is described as the rearing of animals and cultivation of land for the purpose of meeting man and animal's food needs, as well as supply of raw materials for industrial purpose. It includes forestry, fishery, crop production, livestock, processing, and marketing of those agricultural products (see Gokmenoglu, Bekun, & Taspinar, 2016; Mabuza, Taeb, & Endo, 2008; Ssozi, Asongu, & Amavilah, 2019; Uduji, Okolo-Obasi, & Asongu, 2019). In spite of the dependence of Nigerian peasant farmers on traditional tools and indigenous farming methods, the huge impact of agriculture on the Nigerian economy, even after the discovery of oil, cannot be ignored.

During the 1970s, the agricultural sector suffered major neglect due to the oil boom, yet peasant farmers produce 95% of her food needs as well as 70% of the nation's exports (Lawal, 1997). In 2004, agriculture accounted for 34.21% of the GDP and by 2016, this number had fallen to 21.18% (The World Bank, 2016), which has led to poverty challenges and insufficient basic food needs (Ogen, 2007). The oil boom has been identified as the root cause to neglect the agricultural sector, and, by extension, the fall in local production of staple foods and increased dependency on mono-cultural economy, as argued by Izuchukwu (2011), Oluwatoyese and Applanaidu (2014), Falola and Heaton (2008) and Odetola and Etumnu (2013).

In order to mitigate the mono-cultural driven economy, diverse agricultural development projects, programs, and policies were embarked upon, including the 1972 National Accelerated Food Production program, the Nigeria Agricultural and Co-operative Bank's (NAFPP), 1976 Operation Feed the Nation (OFN), the 1979 Green Revolution, and the 1986 Directorate of Food Roads and Rural Infrastructure (DFFRI) as reported by Uniamikogbo and Enoma (2001) A detailed summary of the agricultural programs embarked on Nigeria between 1937 and 1988 is reported by Ayoola (2001) and those between 1992 and 2016 can be seen in Table 1 in the Appendix. Further financial measures were launched by subsequent governments as well, such as the establishment of an agricultural credit scheme, which are yet to yield the much desired results within the agricultural sector and lead to economic growth in Nigeria.

Contemporary debate on the importance of agricultural sector in economic growth or development has shown that agriculture is not just a sector that provides resources to foster industrialization. The report of Alexandratos (1995) underlined that it is an important sector for increasing export earnings, alleviating unemployment, and improving food security. Murphy, Shleifer, and Vishny (1989) posit that a positive synergy abound between agricultural productivity and the level of industrialization. Similarly, a study by Enoma (2010), using time series data from 1986 to 2007 on Nigeria, found a positive relationship between agriculture and economic growth. The study suggests that an increase in agriculture has a positive impact on exportation as well. Furthermore, Oluwatoyese and Applanaidu (2014) revealed that fishery and food production have a positive significant relationship with economic growth in Nigeria using time series data ranging from 1981 to 2011.

In spite of much emphasis on the significance of agriculture on economic growth, the sector is still facing significant problems, such as political inconsistencies and discontinuities (Donwa & Odia, 2010; Izuchukwu, 2011), and the influence of this sector on economic growth and development has been inconsequential (Child, 2008). Recently, the Nigerian economy has enjoyed sustained economic growth for a decade, with annual real GDP increasing by 6.3% in 2014. The manufacturing and agricultural sectors contribute 9 and 21%, respectively, while services contribute the largest chunk of about 57%, all indicating that the non-oil sector is the major driver for the recently experienced economic growth.

With the current plunge in the global oil price, low foreign reserve has further seen a fall in the foreign exchange, and thus it is more imperative than ever for the Nigerian economy to be diversified and refrain from a mono-economy. With the availability of high human labor and huge land expanse, Nigeria can tap into the agricultural sector to achieve economic growth, even with the dwindling oil generated revenue.[1]

Table 2 below includes a review of the literature overview of the impact of agriculture on economic growth from different parts of the globe.

TABLE 1 Nigeria's articulation of agricultural policy from 1992 to 2016

Official title	Year	Purpose
National Fadama Development project	1992	Aimed at improving the flooded plains of the savannah (Fadama)
National special program for food security	2003	Aimed at achieving food security and alleviating poverty
Value chain development	2010	Aimed at improving income level and food security of rural farmers who engaged in production, processing, and marketing of rice and cassava
Nigeria agricultural transformation agenda support program	2015	Aimed at commodity value chain development that will enhance sustainable increase of small-scale farmers' and rural entrepreneurs' income
Agricultural promotion policy	2016	This is majorly a build up from the agricultural transformation agenda of previous government reflecting policy stability on the part of the new administration. The program aims to view agriculture as a business that will enhance national economic growth, food as a human right for all and not as a luxury, and value chain as a linking bridge between different phases of agricultural production.

Note: Source: Author's summary.

TABLE 2 Literature survey of agricultural studies

Study (author)	Period	Region	Methodology	Variables	Empirical findings
Izuchukwu (2011)	1986–2007	Nigeria	Ordinary least squares, ANOVA	RGDP, domestic saving, FDI, GE	The study found positive correlation among and causal interaction among series
Goldman and Smith (1995)	Nil	Nigeria and Indian	Descriptive statistics, survey analysis	Nil	The study submitted that the tested agricultural. Attributes are panacea for economic growth
Alene, Manyong, Tollens, and Abele (2007)	Nil	Nigeria	NPV	Nil	Priority setting reduces poverty in Nigeria
Oyakhilomen and Zibah (2014)	1970–2011	Nigeria	ARDL, Cointegration	Interest rate, exchange rate, inflation, economic growth	Agriculture improves economic growth, however does not fill the poverty vacuum
Onyishi, Arene, and Ifiorah (2015)	1987–2011	Nigeria	ADL, OLS	Inflation, interest rate, credit volume	Agricultural sector impact on economic growth given diverse regime
Sertoglu, Ugural, and Bekun (2017)	1981–2013	Nigeria	VECM, Cointegration	Agric. Output, Oil rent, RGDP	Agriculture is panacea for economic growth, it impact positively on growth of Nigeria
Tijani et al. (2015)	1970–2006	Nigeria	VECM, Cointegration	RGDP, current account and government expenditure	Agricultural expenditure impact positively significant on economic growth
Izuchukwu et al. (2014)	1980–2009	Nigeria	VAR, Granger causality and Cointegration	GDP, GE, exchange rate, trade volume	Agricultural Granger causes that is drive economic growth
Yusuf (2014)	1981–2012	Nigeria	VECM, Cointegration	RGDP, gross capital formation, agricultural output	The study submitted that agriculture have significant effect on national output
Chisasa and Makina (2015)	1970–2011	South Africa	Cointegration VECM, Granger causality	RGDP and Bank credit	Bank credit contributes positively and significantly to economic growth
Izuchukwu (2011)	1974–2008	Pakistan	VECM and cointegration analysis	RGDP, Agric. credit, land, labor	The study affirms the positive impact of credit to economic output
Anthony (2010)	1986–2007	Nigeria	Time series analysis, VECM and Granger causality	Agriculture credit, total export, RGDP	Agriculture drives economic growth
Tiffin and Irz (2006)	2006	85 panel of countries	Panel cointegration and causality	RGDP, AVA	In developing countries AVA drives economic growth while in developed unclear
Akram, Hussain, Sabir, and Hussain (2008)	1973–2005	Pakistan	VECM and cointegration analysis	RGDP and poverty index	This study reveals that agriculture reduces poverty in the study area
Sekumade (2009)	1970–2003	Nigeria	VECM, Granger causality and cointegration analysis	RGDP, crude oil, export	Export crop contributes to economic growth
Turan Katircioglu (2006)	1975–2002	North Cyprus	VECM, Granger causality and cointegration analysis	Agricultural output, RGDP	Agricultural output drives economic growth
Oluwatoyese and Razak (2016)	1981–2013	Nigeria	VECM, Granger causality and cointegration analysis	RGDP, REXR, unemployment, interest rate	The study finding shows that agriculture is significant and contribute to national output

(Continues)

TABLE 2 (Continued)

Study (author)	Period	Region	Methodology	Variables	Empirical findings
Eyo (2008)	1981–2006	Nigeria	Time series Analysis, VECM and Granger causality	Foreign XR, credit to agriculture, interest rate	The study recommends the need to fortify the private sector to contribute to agriculture sector as to revamp the sector to increase economic growth
Olajide, Akinlabi, and Tijani (2012)	1970–2010	Nigeria	OLS analysis	Agriculture, output, RGDP	Positive and significant relationship between the variables under review
Ahungwa, Haruna, and Abdusalam (2014)	1960–2012	Nigeria	Time series Analysis, VECM and Granger causality	RGDP, industry (service %GDP)	The study submitted that agriculture have significant effect on national output
Akpan, Udoka, and Okon (2014)	1970–2012	Nigeria	Time series analysis, Johansen cointegration, VECM and Granger causality	RGDP, agriculture, crop, productivity	Agriculture shows positive correlation with economic growth

Source: Author's compilation.

Abbreviations: ANOVA, analysis of variance; ARDL, autoregressive distributive lag models; AVA, agricultural value added; GE, General computation equilibrium; NPV, Net present value; OLS, ordinary least squares; RGDP, real gross domestic product; VAR, vector Autoregressive model; VECM, vector error correction model.

Therefore, using Johansen cointegration and Gregory–Hansen cointegration with regime shift, VECM, DOLS, FMOLS, Granger causality, and spectral BC causality tests for data from 1981 to 2016, this study investigates the contribution of each agricultural subsector to economic growth and further suggests the policy implication of investing in each of these sectors. The other part of this study is organized as follows: Section 2 renders the source of data and methodology applied. Section 3 explains the empirical findings while Section 4 offers the concluding remarks and policy recommendation(s).

2 | DATA SOURCE AND METHODOLOGICAL CONSTRUCTION

This study employed annual observation for the period 1981–2016. The data were retrieved from Nigeria Statistical Bulletin (NSB), and data availability formed the basis for the choice of the time lag. The descriptive statistics of the time series variables are reported in Table 3.

In order to examine the relationship between some selected agricultural sectors and economic growth in Nigeria, four independent variables were chosen based on previous empirical studies. The dependent variable is gross domestic product per capita, which helps to capture the level of economic growth, while forestry, crop production, fishery, and livestock are the explanatory variables. The statistical formulae employed in this paper are given below:

$$\text{RGDP} = f(\text{FOR}, \text{CP}, \text{FIS}, \text{L/STOCK}) \quad (1)$$

$$\text{RGDP/Ca}_t = \beta_0 + \beta_1 \text{FOR}_t + \beta_2 \text{CP}_t + \beta_3 \text{FIS}_t + \text{LSTK}_t + U_t \quad (2)$$

where the a priori expectation is $\beta_1, \beta_2, \beta_3$, and $\beta_4 > 0$, FOR is forestry production, CP is crop production, FIS is fishery production, LSTK is livestock production; all are expected to have a positive relationship with economic growth.

The econometrics route of this study follows four paths: First, stationarity test, this is necessary to avoid 1(2) variables and spurious regression. This study leverages on Zivot–Andrews unit root test, which takes structural break into account. Second, for long-run equilibrium relationship, multivariate Johansen cointegration test and Gregory–Hansen test for cointegration with regime shifts estimation are employed while the magnitude of cointegration is achieved by the DOLS estimator by Stock and Watson (1993). Third, VECM is employed to ascertain simultaneously the short- and long-run dynamics of the fitted model. Finally, the direction of causality between the variable under consideration is observed by both traditional time domain causality—Granger causality—and frequency domain causality—spectral BC—tests.

Considering the structural breaks evidence from the Zivot–Andrews unit root tests for the time series variables, Gregory–Hansen cointegration test with one regime shift is performed to capture the long-run equation among the time series variables. Given that the Johansen cointegration test explored the linear combination of variables (y_1 = dependent variable and y_2 = regressor) by obtaining the residuals for the standard model from

TABLE 3 Descriptive statistics

Code	RGDP	LSTOCK	FORE	FISH	CROP
Source	World Bank	Nigeria statistical bulletin	Nigeria statistical bulletin	Nigeria statistical bulletin	Nigeria statistical bulletin
Mean	10.220	6.392	4.569	4.863	8.496
Median	10.016	6.279	4.466	4.786	8.256
Maximum	11.142	7.077	5.145	5.882	9.608
Minimum	9.530	5.833	4.209	3.704	7.472
SD	0.535	0.365	0.272	0.611	0.715
Skewness	0.443	0.487	0.868	0.032	0.211
Kurtosis	1.774	1.920	2.403	2.051	1.542
Jarque–Bera	3.431	3.172	5.055	1.354	3.454
Probability	0.179	0.204	0.079	0.507	0.177

$$y_{1t} = \mu + \alpha y_{2t} + e_t \tag{3}$$

where y_{1t} is $I(1)$, for $i = 1, 2$ and e_t is $I(0)$, it is developed by Gregory and Hansen (1996). Thus, Gregory and Hansen (1996) adjust the constant (μ) and/or the slope (α) such that the modified residual-based cointegration test now allows for structural change. The adjustments proposed by Gregory and Hansen (1996) shows the shift of the constant (as in Equation 4), the shift of the constant with time trend (as in Equation 5), and the shift in the constant and slope (as in Equation 6). The modified equations are presented as follow:

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha y_{2t} + e_t \tag{4}$$

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta_t + \alpha y_{2t} + e_t \tag{5}$$

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1 y_{2t} + \alpha_2 y_{2t} \varphi_{t\tau} + e_t \tag{6}$$

such that the $i = 1, 2$ for μ is the respective periods before and after the regime shift, α is the slope coefficient, β_t is the time trend, and $\varphi_{t\tau}$ is the introduced dummy variable where $\varphi_{t\tau} = 1$ if $t \geq [n\tau]$or $\varphi_{t\tau} = 0$ if $t < [n\tau]$and $\tau\varepsilon$ (0, 1).

In the present study, the impact of the selected agricultural subsector on Nigerian economic growth is observed in the long-run by the DOLS estimator, which is developed by Stock and Watson (1993). As a robust test for the DOLS outcomes in this paper, we also apply FMOLS. In addition, we employed VECM to ascertain simultaneously the short- and long-run dynamics of the fitted model.

Next, to obtain information about the causal relationship between the selected agricultural subsectors and economic growth, Granger causality test is employed. In general, the Granger causality test is a test to identify (a) whether the selected agricultural subsector Granger causes economic growth, and (b) whether economic growth Granger causes the selected agricultural subsector in Nigeria. Similarly, the frequency domain causality test is also employed to provide additional robustness check to the previous estimates. Following the previous works of Geweke (1982) and Hosoya (1991), Breitung and Candelon (2006) proposed the frequency domain causality test. The test has merits over traditional time-domain approaches as its renders more degrees of variations relative to conventional time-domain test that offers variation over a specific period. Thus, the frequency domain technique is more robust to variation in terms of seasonality. In addition, the method is consistent in the terrain of nonlinearity, and causality cycles are with low or high frequencies.

3 | EMPIRICAL FINDINGS

As an initial test, the integration of order of the time series variables is observed using Zivot–Andrews unit root test. The outcome of the test, as revealed in Table 4, shows that all variables were non-stationary at levels and the null hypothesis at either of the critical levels for all tests could not be rejected. However, all variables became stationary after taking the first difference at 5% critical interval, indicating also stationarity after the first difference. The results allow us to proceed to investigate the long-run equilibrium relationship between RGDP and CROP, LSTOCK, FISH, and FORE variables using Johansen cointegration test, and Gregory-Hansen test for cointegration with regime shift.

Table 5 depicts the outcomes of Johansen and Gregory–Hansen cointegration tests. The Johansen cointegration test was necessary, given that all variables were integrated of first order $\sim I(1)$. This necessitated a test for possible long-run relationship among the variables being investigated. The table shows four cointegration vectors and the result depicts that the trace statistics reveal evidence of a unique cointegration equation, which suggests a cointegration relationship among the observed variables. As clearly seen in Table 5, the outcome of the Gregory–Hansen cointegration test is consistent with the outcome of Johansen cointegration test since the null hypothesis of no cointegration is rejected in all the cases—ADF, Z_t, and Z_a—thus shows that there is statistical evidence of cointegration even with one regime shift.

Table 6 reveals the VECM, DOLS, and FMOLS results. The error correction estimation test was necessary after the establishment of a first-order cointegrating relationship among the observed variables, to capture for disequilibrium in the short run as the variables move toward their long-run equilibrium path; it indicates the estimated lagged error correction term of economic growth. The error correction term is required to be statistically different from zero or significant

TABLE 4 Zivot–Andrews unit root test

	RGDP	CROP	LSTOCK	FISH	FORE
At level					
C	−4.003 (1991)**	−3.136 (2002)**	−2.544 (1991)**	−2.639 (1991)**	−3.979 (1989)**
C&T	−3.330 (1994)**	−5.008 (2002)**	−3,510 (1997)	−2.957 (1991)**	−4.882* (1989)**
At first difference					
C	−5.278**	−8.949**	−8.102**	−6.638**	−5.023**
C&T	−5.592**	−8.067**	−8.167**	−5.593**	−5.241**

Note: C and C&T indicate constant and constant and trend in the Zivot–Andrews unit root test, correspondingly.
*Denote statistical significance at 0.10 levels, respectively.
**Denote statistical significance at 0.05 levels, respectively.

TABLE 5 Cointegration tests

Johansen cointegration test				
	Trace stat.	Trace critical value	Max-Eigen stat.	Max-Eigen critical value
$r = 0$	110.821**	69.818	43.833**	33.876
$r \leq 1$	66.988**	47.856	30.815**	27.584
$r \leq 2$	36.173**	29.797	21.738**	21.131
$r \leq 3$	14.434*	15.494	14.402**	14.264
$r \leq 4$	0.031	3.841	0.0318	3.841

Gregory–Hansen test for cointegration with regime shift				
		ADF	Z_t	Z_a
Test statistic		−7.36** (1992)	−8.40** (2003)	−96.39** (2003)
Asymptotic critical values	1%	−7.31	−7.31	−100.69
	5%	−6.84	−6.84	−88.47
	10%	−6.58	−6.58	−82.3

Note: Trace test statistics was reported with their corresponding probabilities. As given by Osterwald-Lenum (1992) with lag length 1:1 and model 4 in cointegration equation were chosen. p value < .05.* 5% significance level. Numbers in parentheses () represent break points while * and ** denotes statistical significance.
*Denote statistical significance at 0.10 levels, respectively.
**Denote statistical significance at 0.05 levels, respectively.

and negative, indicating deviation from equilibrium (stability). This posits the long-run convergence of the model, implying that, if an external shock is introduced into the model, the model will converge over time. The speed of error correction or adjustment of the model is at an average of 54%, which means 54% of the error present within the model will be corrected in the long run. The coefficient of determination implies that 54% of the variation in gross domestic product is explained by the explanatory variables. The long-run equilibrium regression in Table 6 via DOLS also reveals that fishery, crop, and forestry subsectors show significant relationship at 5% level of significance, which has an implication on long-run economic growth in Nigeria. Forestry subsector has a positive significant impact on economic growth in the long-run. This suggests that the forestry sector is a good indicator for economic growth in Nigeria over the investigated period. As forest activities create job opportunities in Nigeria, especially in the southern part of the country where there is huge presence of forest trees. Similarly, fishery, crop, and livestock subsectors also exhibit positive relationship with significant impact on the long-run economic growth. This is insightful, as all subsectors are drivers of economic growth in Nigeria. It means that, in general, agriculture is the mainstay of the Nigerian economy. This is suggestive to the key players and policymakers to fortify the sector for continuous increase in economic output. This finding is consistent with the study of Oyakhilomen and Zibah (2013). As clearly seen in Table 6, the outcomes of FMOLS are in line with the outcomes of DOLS.

Table 7 reports the Granger causality analysis. The table depicts the pairwise Granger causality test for the causal relationship between Gross Domestic Product per capita (GDP/CA) and the observed variables—Fishery, Forestry Crop production, and Livestock, all in their logarithm form, to reduce the variance of the data. The study revealed that the forestry subsector of agriculture has Granger causality GDP per capita with f-stat of 3.930 and probability of 0.019, indicating a unidirectional relationship running from the forestry sector of agriculture to economic growth. The result is the same for all subsectors of agriculture

TABLE 6 VECM, DOLS, and FMOLS tests

VECM				
Variable	**Coefficient**	***SE***	***t* statistic**	**Prob.**
ECT(−1)	−0.541**	0.113	−4.791	0.000
DOLS				
Variable	**Coefficient**	***SE***	***t* statistic**	**Prob.**
C	2.989**	0.365	8.139	0.000
FORE	0.302**	0.136	2.209	0.034
CROP	0.351**	0.079	4.410	0.000
FISH	0.146**	0.042	3.460	0.001
LSTOCK	0.335	0.216	1.549	0.131
Diagnostic results from the DOLS estimator				
R^2	0.994		*SE regr.*	0.041
			L.R.Variance	0.003
FMOLS				
Variable	**Coefficient**	***SE***	***t* statistic**	**Prob.**
C	2.947**	0.405	7.273	0.000
FORE	0.269*	0.150	1.788	0.083
CROP	0.335**	0.075	4.477	0.000
FISH	0.138**	0.042	3.244	0.002
LSTOCK	0.393	0.242	1.622	0.115
Diagnostic results from the FMOLS estimator				
R^2	0.994		*SE* regr.	0.041
			L.R.Variance	0.002

Note: Optimum lag length by Schwarz information while the lag and lead is (1, 1), respectively. The long-run variance estimates were by Bartlett Kernel and Newey–West bandwidth of 4.0000.
*Denote statistical rejection levels at 10%, respectively.
**Denote statistical rejection levels at 5%, respectively.

TABLE 7 Granger causality test

Null hypothesis	*F* statistics	*p* value
FORE does not Granger cause RGDP	3.930**	.019
CROP does not Granger cause RGDP	4.246**	.024
FISH does not Granger cause RGDP	11.017**	.000
LSTOCK does not Granger cause RGDP	3.460*	.060

*Significant at 10%, respectively.
**Significant at 5%, respectively.

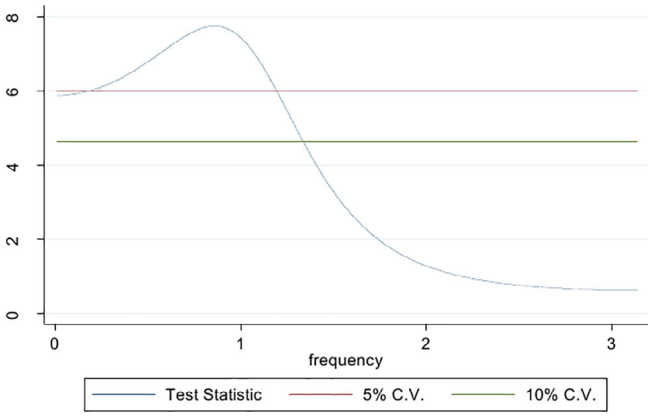

FIGURE 1 Spectral BC Causality from CROP to RGDP

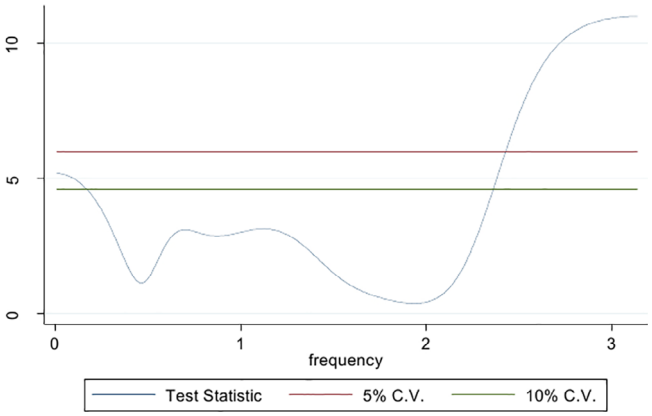

FIGURE 2 Spectral BC Causality from LSTOCK to RGDP

and economic growth; there is a unidirectional relationship flowing from each of these subsectors to economic growth, the implication of the causality reveals that all subsectors of agriculture in Nigeria, if properly harnessed and given due attention, will help boost the GDP (economic growth) of Nigeria. The findings of this paper are similar to the conclusion of Oluwatoyese and Applanaidu (2014), who found that crop production has a positive impact on economic growth within Nigeria. Furthermore, this finding is also on par with the study done by Izuchukwu (2011), who found that increase in government expenditure on agriculture has a positive impact on economic growth within Nigeria.

As a robust causality test for the traditional Granger causality test, the present study also employs the frequency domain approach of Breitung and Candelon (2006) to the annual Nigerian data, from 1981 to 2016, to examine the direction of Granger causality between the selected agricultural subsector and economic growth, which helps to detect the nonlinear effect and the cyclical nature that cause linkage. The results of spectral BC causality test are reported in Figures 1–4, which clearly underline the importance of the selected agricultural subsector, namely the FORE, CROP, FISH, and LSTOCK variables, over the Nigerian economic growth at different frequencies.

4 | CONCLUSION AND POLICY IMPLICATIONS

Using annual frequency data sourced from Nigeria Statistical Bulletin (NSB), the current study explored the contribution of selected agricultural subsector to her economic growth over the period 1981–2016. The study conducted a unit root test to ensure that the data set are stationary to avoid spurious results; it was ascertained that the data set are stationary after first differencing. Applying an error correction model, the result from the study posits that promoting significant

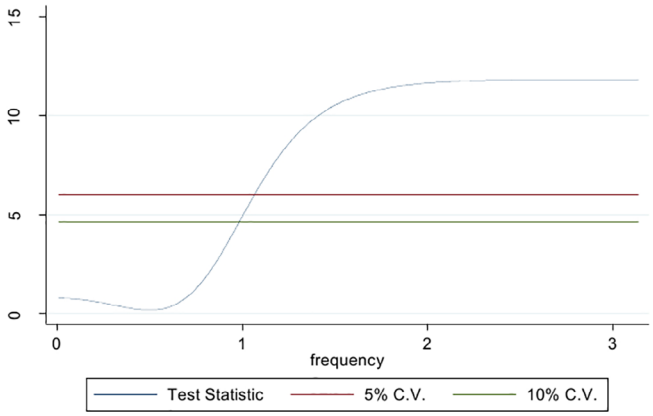

FIGURE 3 Spectral BC Causality from FORE to RGDP

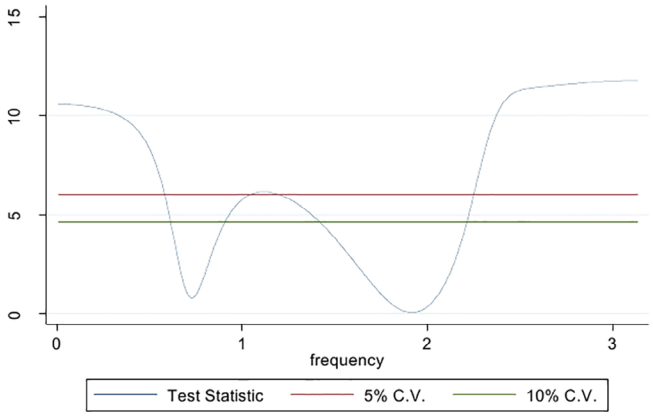

FIGURE 4 Spectral BC Causality from FISH to RGDP

agricultural sectors will enhance economic growth; the study revealed that a long-run cointegrating relationship exists among the variables in the model with 54% speed of convergence (error correction) to their equilibrium path on an annual basis by the contribution of model regressors. Subsectors, such as fisheries, forestry, livestock, and crop production, are found to exert important impact on gross domestic product (economic growth).

Furthermore, empirical evidence from the study submits that there exists an equilibrium bond between gross domestic product per capita and forestry, fishery, crop production, and livestock production over the underlined period. The results highlight the importance of developing the agricultural sector in Nigeria to achieve a long-run sustainable economic growth, and it also posits that there is a one-way causal relationship between all the subsectors of agriculture and economic growth. The impact of these agricultural sectors and economic growth as measured by GDP per capita, as obtained in the analysis, calls for the need to focus on agricultural sectors as a bridge toward achieving sustainable economic growth in Nigeria.

In the face of a continuous plunge in the crude oil price, it is important for a nation like Nigeria to explore diversification of its economy, particularly into the agricultural sector. Thus, government administrators and policymakers are encouraged to take pragmatic steps to form policies that foster the contribution of all the considered agricultural sub-sectors to agricultural practices, such as providing subsidies, timely disbursement of financial credit, and the encouragement of mechanization through robust extension services. This will in no doubt trigger long-run positive impact of the agricultural sector on economic growth. The aforementioned is key, as the sector a plays pivotal role in poverty alleviation and economic prosperity within developing countries in time of economic interconnectedness and globalization, and the agricultural subsectors are economically rewarding by a synergistic participation of the private sector, both at the small and large-scale levels.

ENDNOTE

[1] The need to highlight more on the contribution of the different agricultural sub-sector is crucial. However, for brevity, Nigeria Bureau of statistics provides more insights, see https://nigeria.opendataforafrica.org/NGNBSNGDPPTO2016/nigerian-gross-domestic-product-report-q4-2019?accesskey=sfpmatg&fbclid=IwAR0LUogrjUKP9c0ahxpE7WYTmxdc2xmOSrxq3eg1OyR7UyTMCHv8dSzhE0M.

REFERENCES

Ahungwa, G. T., Haruna, U., & Abdusalam, R. Y. (2014). Trend analysis of the contribution of agriculture to the gross domestic product of Nigeria (1960–2012). *Journal of Agriculture and Veterinary Science*, *7*(1), 50–55.

Akpan, S. B., Udoka, S. J., & Okon, U. E. (2014). Examination of empirical relationships between industrial activities and agricultural policy outputs in Nigeria (1970-2012). *International Journal of Food and Agricultural Economics (IJFAEC)*, *2*(1128–2016-92022), 13–22.

Akram, W., Hussain, Z., Sabir, H. M., & Hussain, I. (2008). Impact of agricultural credit on growth and poverty in Pakistan (time series analysis through error correction model). *European Journal of Scientific Research*, *23*(2), 243–251.

Alene, A. D., Manyong, V. M., Tollens, E. F., & Abele, S. (2007). Targeting agricultural research based on potential impacts on poverty reduction: Strategic program priorities by agro-ecological zone in Nigeria. *Food Policy*, *32*(3), 394–412.

Alexandratos, N. (Ed.). (1995). *World agriculture: Towards 2010: An FAO study*, Chichester: Food & Agriculture Org.

Alola, A. A., & Alola, U. V. (2018). Agricultural land usage and tourism impact on renewable energy consumption among coastline Mediterranean countries. *Energy & Environment*, *29*(8), 1438–1454.

Anthony, E. (2010). Agricultural credit and economic growth in Nigeria: An empirical analysis. *Business and Economics Journal*, *14*(1), 1–7.

Ayoola, G. B. (2001). *Essays on the agricultural economy: A book of readings on agricultural development policy and administration in Nigeria* (Vol. 1), Princeton: TMA Publishers [for] Farm and Infrastructure Foundation.

Breitung, J., & Candelon, B. (2006). Testing for short-and long-run causality: A frequency-domain approach. *Journal of Econometrics*, *132*(2), 363–378.

Child, M. N. (2008). The effect of a depressed economy on agricultural sector. *Journal of African Studies*, *3*(2), 152–167.

Chisasa, J., & Makina, D. (2015). Bank credit and agricultural output in South Africa: Cointegration, short run dynamics and causality. *Journal of Applied Business Research (JABR)*, *31*(2), 489–500.

Dercon, S. (2009). Rural poverty: Old challenges in new contexts. *The World Bank Research Observer*, *24*(1), 1–28.

Donwa, P., & Odia, J. (2010). An empirical analysis of the impact of the Nigerian capital market on her socio-economic development. *Journal of Social Sciences*, *24*(2), 135–142.

Eyo, E. O. (2008). Macroeconomic environment and agricultural sector growth in Nigeria. *World Journal of Agricultural Sciences*, *4*(6), 781–786.

Falola, T., & Heaton, M. M. (2008). *A history of Nigeria*, Austin: Cambridge University Press.

Geweke, J. (1982). Measurement of linear dependence and feedback between multiple time series. *Journal of the American Statistical Association*, *77*(378), 304–313.

Gregory, A. W., & Hansen, B. E. (1996). Practitioners corner: tests for cointegration in models with regime and trend shifts. *Oxford bulletin of Economics and Statistics*, *58*(3), 555–560.

Gokmenoglu, K. K., Bekun, F. V., & Taspinar, N. (2016). Impact of oil dependency on agricultural development in Nigeria. *Journal of Economic & Management Perspectives*, *10*(2), 151–163.

Goldman, A., & Smith, J. (1995). Agricultural transformations in India and northern Nigeria: Exploring the nature of green revolutions. *World Development*, *23*(2), 243–263.

Gollin, D. (2010). Agricultural productivity and economic growth. *Handbook of Agricultural Economics*, *4*, 3825–3866.

Gollin, D., Parente, S., & Rogerson, R. (2002). The role of agriculture in development. *American Economic Review*, *92*(2), 160–164.

Hosoya, Y. (1991). The decomposition and measurement of the interdependency between second-order stationary processes. *Probability Theory and Related Fields*, *88*(4), 429–444.

Izuchukwu, O. (2011). Analysis of the contribution of agricultural sector on the Nigerian economic development. *World Review of Business Research*, *1*(1), 191–200.

Jorgenson, D. W. (1961). The development of a dual economy. *The Economic Journal*, *71*(282), 309–334.

Lawal, A. A. (1997). The economy and the state from the pre-colonial times to the present. In *Nigerian peoples and cultures* (pp. 195–198). Ibadan: Davidson.

Lawal, W. A. (2011). An analysis of government spending on agricultural sector and its contribution to GDP in Nigeria. *International Journal of Business and Social Science*, *2*(20), 1–10.

Mabuza, M. L., Taeb, M., & Endo, M. (2008). Impact of food aid on smallholder agriculture development in Swaziland. *African Journal of Food, Agriculture, Nutrition and Development*, *8*(2), 151–169.

Mishra, P., & Dash, D. (2014). Rejuvenation of biofertilizer for sustainable agriculture and economic development. *Consilience*, *1*(11), 41–61.

Murphy, K. M., Shleifer, A., & Vishny, R. (1989). Income distribution, market size, and industrialization. *The Quarterly Journal of Economics*, *104* (3), 537–564.

Odetola, T., & Etumnu, C. (2013). Contribution of agriculture to economic growth in Nigeria. The 18th. Retrieved from https://pdfs.semanticscholar.org/1b7b/284b899d9cc59eba44c29fbc6db898946320.pdf

Ogen, O. (2007). The agricultural sector and Nigeria's development: Comparative perspectives from the Brazilian agro-industrial economy, 1960-1995. *Nebula*, *4*(1), 184–194.

Olajide, O. T., Akinlabi, B. H., & Tijani, A. A. (2012). Agriculture resource and economic growth in Nigeria. *European Scientific Journal*, *8*(22), 103–115.

Oluwatoyese, O. P., & Applanaidu, S. D. (2014). Effect of agricultural sector determinants on economic growth. *Australian Journal of Basic and Applied Sciences*, *8*(8), 68–72.

Oluwatoyese, O. P., & Razak, N. A. A. (2016). Macroeconomic factors and agricultural sector in Nigeria. *Procedia-Social and Behavioral Sciences*, *219*, 562–570.

Onyishi, L. O., Arene, C. J., & Ifiorah, C. M. (2015). Impact of interest rate reform on agricultural finance and growth in Nigeria. *Russian Journal of Agricultural and Socio-Economic Sciences*, *37*(1), 1–10.

Osterwald-Lenum, M. (1992). A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics. *Oxford Bulletin of Economics and Statistics*, *54*(3), 461–472.

Oyakhilomen, O., & Zibah, R. G. (2013). Fishery production and economic growth in Nigeria: Pathway for sustainable economic development. *Journal of Sustainable Development in Africa*, *15*(2), 99–109.

Oyakhilomen, O., & Zibah, R. G. (2014). Agricultural production and economic growth in Nigeria: Implication for rural poverty alleviation. *Quarterly Journal of International Agriculture*, *53*(892–2016-65234), 207–223.

Ranis, G., & Fei, J. C. (1961). A theory of economic development. *The American Economic Review*, *51*(4), 533–565.

Sekumade, A. B. (2009). The effects of petroleum dependency on agricultural trade in Nigeria: An error correlation modeling (ECM) approach. *Scientific Research and Essay*, *4*(11), 1385–1391.

Sertoglu, K., Ugural, S., & Bekun, F. V. (2017). The contribution of agricultural sector on economic growth of Nigeria. *International Journal of Economics and Financial Issues*, *7*(1), 547–552.

Ssozi, J., Asongu, S., & Amavilah, V. H. (2019). The effectiveness of development aid for agriculture in sub-Saharan Africa. *Journal of Economic Studies*, *46*(2), 284–305.

Stock, J. H., & Watson, M. W. (1993). A simple estimator of cointegrating vectors in higher order integrated systems. *Econometrica: Journal of the Econometric Society*, *61*(4), 783–820.

The World Bank. (2016) World development indicator. Retrieved December, 2019 from https://data.worldbank.org/

Thirtle, C., Lin, L., & Piesse, J. (2003). The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Development*, *31*(12), 1959–1975.

Tiffin, R., & Irz, X. (2006). Is agriculture the engine of growth? *Agricultural Economics*, *35*(1), 79–89.

Tijani, A. A., Oluwasola, O., & Baruwa, O. I. (2015). Public sector expenditure in agriculture and economic growth in Nigeria: An empirical investigation. *Agrekon*, *54*(2), 76–92.

Timmer, C. P. (1995). Getting agriculture moving: Do markets provide the right signals? *Food Policy*, *20*(5), 455–472.

Turan Katircioglu, S. (2006). Causality between agriculture and economic growth in a small nation under political isolation: A case from North Cyprus. *International Journal of Social Economics*, *33*(4), 331–343.

Uduji, J. I., Okolo-Obasi, E. N., & Asongu, S. A. (2019). The impact of e-wallet on informal farm entrepreneurship development in rural Nigeria. *The Electronic Journal of Information Systems in Developing Countries*, *85*(3), e12066.

Uniamikogbo, S. O., & Enoma, A. I. (2001). The impact of monetary policy on manufacturing sector in Nigeria. *The Nigeria Economic and Financial Review*, *3*(2), 37–45.

Yusuf, S. A. (2014). Role of agriculture in economic growth & development: Nigeria perspective.

AUTHOR BIOGRAPHIES

Dr. Mary Oluwatoyin Agboola is currently an Assistant professor at the College of Business Dar Al Uloom University, Riyadh Saudi Arabia. Her Research interest is focused on Food security, Poverty and Developmental issues, Macro Economics and Energy Economics.

Festus Victor Bekun currently serves as an Assistant professor at Istanbul Gelisim University Turkey and a senior research fellow at South Ural State University Russia. His research interest is in the areas of agricultural economics, energy economics, and tourism economics. His works have appeared in top-tier journals including Science of The Total Environment, Energy & Environment, more recently Current Issues in Tourism and Heliyon, among others.

The author is currently working on oil price spillover volatility on selected agricultural commodity prices and energy market dynamics. He can be contacted via this Email: fbekun@gelisim.edu.tr or bekunfestusvictor@yaho.com

Olawumi Abeni Osundina is a female instructor in the department of Economics at Babcock University, Nigeria. She has a Ph.D. in Economics obtained from Eastern Mediterranean University, North-Cyprus. She obtained both her Master's degree in Finance and Bachelor's degree in Economics from Babcock University, Nigeria. She is a multi-disciplinary researcher whose research interest includes, but not limited to, sustainable development; agricultural, energy and environmental economics; and women and gender studies. She is open to learning. She has passion for acquiring new knowledge and skills, and applying them to make impact in her environment, community and society at large. (osundinaol@babcock.edu.ng)

Dervis Kirikkaleli is the current senior lecturer at the European University of Lefke. He holds a BSc in Economics from Eastern Mediterranean University (CY). He is a University of Stirling (UK) alum, where he completed his MSc and PhD in Banking and Finance. His research area is macroeconomics, environmental economics and financial economics. He can be contacted via this Email: dkirikkaleli@eul.edu.tr

How to cite this article: Agboola MO, Bekun FV, Osundina OA, Kirikkaleli D. Revisiting the economic growth and agriculture nexus in Nigeria: Evidence from asymmetric cointegration and frequency domain causality approaches. *J Public Affairs*. 2022;22:e2271. https://doi.org/10.1002/pa.2271