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Research Article

Agricultural Imports, Agriculture Productivity and Economic Growth in sub-Saharan Africa: A Bootstrap Granger Noncausality Analysis in Heterogeneous Panels

Esther N. Mwangi[1,2,*], Fuzhong Chen[3], Daniel M. Njoroge[4]

[1]*School of International Trade and Economics, University of International Business and Economics, #1031, Block B, International Plaza, Huixing Dongjie, Chaoyang District, Beijing 100029, China*
[2]*Karatina University, Karatina, Kenya*
[3]*University of International Business and Economics, Beijing, China*
[4]*Dedan Kimathi University of Technology, Neyri, Kenya*

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ABSTRACT

This study investigates the causal links among agricultural imports, agriculture productivity, and economic growth in 40 sub-Saharan African countries over the period 1990–2015. Granger noncausality tests are applied to infer direction of causality, whereas the generalized two-stage least squares instrumental variable technique estimates the effects while controlling for endogeneity. The bootstrapping procedure is used to deal with cross-sectional dependence. The results reveal bidirectional causality between agricultural imports and agriculture productivity in the full sample, and in middle- and low-income non-oil-exporting countries. The relationship between agricultural imported inputs and agriculture productivity is positive and significant. In addition, unidirectional causality from agricultural imports to economic growth is seen in the full sample and middle-income non-oil exporters. Growth elasticity of agricultural imports is about 0.98 in the full sample and about 1.3 in the middle-income group. Therefore, agricultural trade policies in the region should be reexamined to promote international trade for economic development.

1. INTRODUCTION

Debate on agricultural trade can be traced back from the negotiations on agricultural trade under the General Agreement on Tariffs and Trade, which came into force in 1948. Later, significant progress toward agricultural trade reforms were covered and continues to be negotiated upon by the World Trade Organization Agreement on Agriculture, which came into force in 1995 as a result of the 1986–1994 Uruguay Round of world trade negotiations supported by the General Agreement on Tariffs and Trade (WTO, 2016). Since 1994, agricultural trade has been liberalized, which has led to increased globalization and integration. World Trade Organization members commit themselves to general agricultural trade rules pertaining to market access, domestic support, and export competition within well-defined timelines. The ultimate goal of these negotiations is to improve the livelihoods of farmers around the world through implementing sound agricultural trade regulations and domestic policies that promote competition and reduce distortions in agricultural trade (WTO, 2016). The research on agricultural trade and economic growth is therefore gaining attention in the recent past both in developed and developing countries.

Most countries in sub-Saharan Africa (SSA) are agriculture-based, and agriculture accounts for about 32% of their Gross Domestic Product (GDP) on average (World Bank, 2008). In addition, more than 65% of the total population in the region is used in the agriculture sector, although Africa in general has recently been experiencing rapid agricultural exits particularly in oil-producing countries (Headey et al., 2010). Nevertheless, Africa's agriculture has the potential to reduce rural and urban poverty, which explains why boosting agriculture productivity remains a critical priority (Mozumdar, 2012). In SSA, agriculture production remains relatively low compared with other regions in the world. Agriculture total factor productivity in SSA has been generally low and highly volatile, with an annual growth rate ranging between −0.05 and +0.05 for both low- and middle-income countries for the period 1962–2015 (USDA 2019). Stagnation in agriculture productivity in the region has resulted to low agricultural output and consequently low global share of Africa's agricultural exports.

*Corresponding author. Email: esthermwangi2013@gmail.com; emwangi@karu.ac.ke
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Nevertheless, consumption demand has continued to grow because of the increase in population and income growth (Parker, 2011; Badiane et al., 2018). According to the Food and Agriculture Organization (2017), the value of food consumption exceeds the value of food production in SSA for the period 2000–2017.

The demand deficits are met by imports, which are becoming more challenging to finance because of the increasing international food commodity prices and poor performance of exports in the recent past. For example, over the period 2000–2010, Africa accounted for only about 2.8% of the world's exports (UNCTAD, 2013). Between 1998 and 2013, the value of Africa's agricultural imports grew fivefold whereas the value of agricultural exports tripled leading to increased trade deficit (Badiane et al., 2018). According to Blein et al. (2013), over the period 2007–2011, 37 African countries were net importers of food, whereas 22 countries were net importers of agricultural raw materials. Furthermore, for the period 1960–2007, Africa in general was a net importer of food and other agricultural products despite her agriculture potential (FAO, 2011). In SSA, the value of agricultural products exports exceeded the value of imports for the period 1961–2005, indicating a favorable balance of agricultural trade. However, for the period 2005–2017, the region was a net importer of agricultural products.

The agricultural market in SSA is not homogeneous in the sense that each country presents some degree of heterogeneity in terms of imports demand and exports. A few countries are able to meet their import bills, whereas many still find difficulties (Manitra et al., 2012). Low yields and agriculture productivity coupled with increasing rates of population and economic growth among SSA and developing countries have been cited in the economic literature as the main factors behind the increasing demand for agricultural imports (Ikema, 1969; Gormely, 1991; Hilderink, et al., 2012; FAO, 2011; Parker, 2011; Manitra et al., 2012; Badiane et al., 2018).

The link between trade openness and growth has been widely studied, and the central debate is whether trade openness leads to economic growth or it is economic growth that drives trade openness. Most previous studies have analyzed the causality between exports and economic growth, whereas a few focus on the causality between agricultural exports and economic growth. The relationship between imports and economic growth has not gained much attention despite the economic intuition that import supports growth. Theoretically, it has been argued that imports play a critical role in promoting economic growth through technological transfer and spillover effects, which in turn increase efficiency and productivity. Imports expose domestic firms to foreign competition triggering their response to technology advancement (Haddad et al. 1996; Lawrence and Weinstein, 1999). Consequently, consumption gains resulting from a wide variety of commodities made available at competitive prices lead to welfare improvement. Furthermore, several studies (Lawrence and Weinstein, 1999; Awokuse, 2007; Awokuse, 2008) have tested and supported the import-led growth hypothesis that implies that imports supports economic growth. In SSA, Fosu (2001) reports that import instability affects economic growth negatively; thus, stability of imports flow is crucial for growth in the region.

This research seeks to investigate whether any causality exists between agricultural imports and GDP per capita growth, and between agricultural imports and agriculture productivity of different country groups in SSA in a framework design that accounts for cross-section dependence and slope heterogeneity in SSA. We focused on the agriculture sector because of its significance in the region as earlier stated. The research is further prompted by the increasing imports of food and agricultural products in SSA. The analysis is based on World Bank's nonoverlapping classification of countries, that is, oil exporters, middle-income non-oil exporters and low-income non-oil exporters, and applies bootstrapped Granger noncausality tests in heterogeneous panels. In order to gain more insight on the effect of variables of interest, the analysis is extended by application of Instrumental Variable (IV) estimation with Generalized Two-stage Least Squares (G2SLS) for panel-data models to control for endogeneity.

The results reveal a strong bidirectional causality between agriculture productivity and agricultural imports in the full sample, and in middle- and low-income non-oil-exporting countries. However, in oil-exporting countries no causality is observed between agriculture productivity and agricultural imports. The relationship between agriculture productivity and agricultural imports is positive and significant. There is no evidence of unidirectional causality running from GDP per capita growth to agricultural imports in the whole sample and in the subsamples. However, evidence of unidirectional causality running from agricultural imports to GDP per capita growth is recorded in the full sample and in middle-income non-oil-exporting countries. The growth elasticity of agricultural imports is approximately 0.98 in the full sample and about 1.3 in middle-income non-oil-exporting countries. The results imply that agricultural import-led growth hypothesis is supported in SSA. The findings of this study contribute to existing international trade literature by attempting to correct the misconception that imports reduce economic growth via import leakages and crowding out domestic production by showing that agricultural imports are positively and significantly related to agriculture productivity and GDP per capita growth in SSA. Imports are either consumed or invested, hence import of agricultural consumer goods and capital goods play an important role in influencing technology absorption and innovation in the domestic market in order to keep pace with international competition. Technology transfer increases production efficiency, output, and consequently growth of the economy.

The rest of this paper is composed of the following sections. Section 2 highlights some empirical evidence on the relationship between trade openness, productivity, and economic growth. Description of the data used in the analysis is provided in Section 3, whereas Section 4 explains the process of empirical analysis. Section 5 presents the empirical results, discussion of the results, and robustness check. Finally, the conclusions of the study are provided in Section 6.

2. LITERATURE REVIEW: TRADE OPENNESS, PRODUCTIVITY, AND ECONOMIC GROWTH NEXUS

In international trade literature, several studies have attempted to identify the relationship and the direction of causality between trade openness (measured by ratio of imports plus exports to GDP or ratio of imports to GDP or ratio of export to GDP) and economic growth.

Some of these studies have applied the conventional regression analysis, which only captures the effect of trade openness on economic growth. Most of these studies find that trade openness significantly affect economic growth positively (Sala-i-Martin, 1997; Frankel and Romer, 1999; Dollar and Kraay, 2002; Yanikkaya, 2003; Nicita et al., 2014; Were, 2015; Zahonogo, 2016; Abreha, 2019). Other studies use Granger causality or error correction models to identify the direction of causality between trade openness and economic growth variables. These studies provide mixed results. For example, Ahmad and Kwan (1991) apply Granger causality in 47 African countries and find no causality between exports and growth. Bbaale and Mutenyo (2011) analyze exports and economic growth in 35 SSA countries and find that agricultural exports and capital goods imports significantly affect per capita income growth. Fatma and Ayse (2013) apply the Granger noncausality test in G7 countries to investigate causality between trade openness and growth over the period 1970–2011. They find positive bidirectional causality between the variables. Thomas and Margarete (2012) analyze the relationship between GDP per capita and trade openness for 158 countries over the period 1970–2009 using error correction models. Their study finds positive significant bidirectional causality.

On imports and productivity, Lee (1995) finds that imported capital goods inputs increased efficiency and long-run growth in developing countries. Sangho et al. (2007) use Korean data for the period 1980–2003 to investigate the link between imports and productivity growth. They find positive and significant effect. Uslu (2016) studies the causal link between imports and growth in Turkey for the period 1998–2014 and finds positive causality running from imports to GDP growth. Guntukula (2018) reports a bidirectional causality between imports and economic growth in India. Abreha (2019) investigated the causal relationship between imports and firm productivity in Ethiopia and records productivity gains from imports. Aluko and Adeyeye (2020) use Granger causality to test causality between imports and economic growth in Africa. They report unidirectional causality running from imports to economic growth in some countries, whereas in other countries they find unidirectional causality running from economic growth to imports. In most of the countries under study, they conclude that there is no causality between imports and economic growth both in the short and long run.

Few studies have investigated the effect of agricultural trade on economic growth. Sanjuán-López and Dawson (2010) use Granger causality tests and report a long-run positive relationship between agricultural exports and economic growth in developing countries. In Africa, Ouma et al. (2016) study the relationship between agricultural trade and economic growth in East Africa community using vector autoregressive and vector error correction models. They find bidirectional causality between agricultural exports and economic growth in Kenya, unidirectional causality in Rwanda, and no causality in the case of Tanzania, Uganda, and Burundi. Nahanga and Bečvářová (2016) use Granger causality and impulse response function in their analysis and report that agricultural exports support economic growth in Nigeria. Bakari and Mohamed (2018) investigate the effect of agricultural trade on economic growth of North Africa. They report that agricultural exports have positive effect on GDP, but agricultural imports have no effect on economic growth. Most of these studies investigate the contribution of agricultural exports on economic growth thereby overlooking the effect of agricultural imports.

3. DATA

This study uses panel data for 40 SSA countries for the period 1990–2015. Countries and time span are selected based on data availability. The list of countries in the sample is presented in Appendix Table A1. Data are obtained mainly from the Food and Agriculture Organization Corporate Statistical Database, World Bank, and International Monetary Fund. Agricultural imports are measured by the total value of aggregated agricultural products measured in US$. Economic growth is measured using GDP per capita growth, whereas agricultural productivity is measured by the value of agricultural production per hectare of agricultural land following Frisvold and Ingram (1995). Table 1 presents a summary of the variables description and data sources, whereas Appendix Table A2 presents the descriptive statistics of these variables.

Table 1 | Variable description and data sources

Variables	Code	Definition	Data source
Agricultural imports	agricM	Total value of agricultural imports in US$	FAOSTAT
Agriculture output	agricQ	Total value in international $constant (2004–2006)	FAOSTAT
Agricultural land	agricL	Rain fed, irrigated cropland and permanent pasture in hectares	FAOSTAT
Agriculture productivity	agricvperha	Total agricultural production value per hectare of agricultural land	Computed using FAOSTAT data
Economic growth	GDPpc growth	Annual percentage growth rate of GDP per capita based on constant 2010 US$	World Bank
Investment	grosskform	Gross capital formation as % of GDP	World Bank and OECD
Human capital	schenroll	Secondary School enrollment as % of gross enrollment	UNESCO
Population growth	popgrowth	Annual population growth rate in %	World Bank
Inflation	inflation	Annual consumer price index	International Monetary Fund
Imported inputs	importedI	Total value of imported agricultural inputs in US$	Calculated from Eora26 IO tables
Agricultural labor	agricLbr	Number of economically active adults in agriculture	FAOSTAT
Agricultural capital	agricK	The total stock of farm machinery	FAOSTAT
Fertilizer	Fert	Metric tons of N, P_2O_5, K_2O fertilizer consumption	International Fertilizer Association and FAO
Food imports	foodM	Food imports (% of merchandise imports)	World Bank

FAO, Food and Agricultural Organisation; FAOSTAT, Food and Agriculture Organization Corporate Statistical Database; GDP, gross domestic product; OECD, Organisation for Economic Co-operation and Development; UNESCO, United Nations Educational, Scientific and Cultural Organization.

For the purpose of robustness check, other variables included in the growth model are population growth rate, inflation, and investment, which are measured by all the fixed assets of the economy plus the net changes in the level of inventories. Secondary school enrollment captures the level of human capital. Data on imported agricultural inputs was computed from Eurostat manual of supply, use and input–output tables, specifically Eora26. Eora26 is a model in which all countries have been aggregated to a 26-common sector classification and the supply–use tables from the full Eora MRIO are converted to symmetric industry-by-industry input–output tables using the industry technology assumption (Lenzen et al., 2012, 2013). In order to gain more insights, the sample is divided into three nonoverlapping subsamples based on the World Bank country classification—that is, oil exporters, middle-income non-oil exporters, and low-income non-oil exporters. These groups of countries are assumed to exhibit different degrees of heterogeneity in agricultural trade.

4. METHODOLOGY

4.1. Preliminary Analysis: Cross-sectional Dependency, Unit Root, and Panel Cointegration

Hashem Pesaran (2006) emphasizes the importance of accounting for cross-sectional dependence in panel data to avoid biased results. Testing cross-sectional correlation of errors in panel data is crucial because the shock emanating from one country is likely to be transmitted to other countries as a result of the high degree of cross-border trade and/or financial integration accelerated by globalization (Kar et al., 2011; Menyah et al., 2014; Chang et al., 2014). In addition, countries in the sample differ on the degree of imports dependency and levels of growth hence assumption of slope homogeneity in the analysis may not hold. Therefore, the analysis starts by testing data for cross-sectional dependence and slope homogeneity. Cross-sectional dependence is tested using Hashem Pesaran (2004) cross-sectional dependency test (CD) and Breusch–Pagan Lagrange multiplier (LM) test of independence. Hashem Pesaran (2004) shows that the test is robust for panels, where time (T) tends to infinity first, and then the number of observations of the cross-sectional (N) tends to infinity and vice versa. The CD test statistic is computed as follows:

$$\mathrm{CD} = \sqrt{\frac{2T}{N\left(N-1\right)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right)\xrightarrow{d} N(0,1), \tag{1}$$

where, $\hat{\rho}_{ij}$ is the estimate of the pairwise correlation of the residuals. The null hypothesis of cross-section independence is tested against alternative hypothesis of cross-section dependence. In testing slope homogeneity, the Hashem Pesaran and Yamagata (2008) test for slope homogeneity in large panels is used. This test is a standardized version of Swamy (1970) test of slope homogeneity and can be applied in both balanced and unbalanced panels. Furthermore, Bersvendsen and Ditzen (2020) show that the test is appropriate in the presence of cross-sectional dependence. The null hypothesis that slope coefficients are homogenous is tested against the alternative hypothesis of slope heterogeneity.

Granger noncausality test applied in this study assumes that the variables are stationary. In line with this, Cross-sectional augmented Im, Pesaran, and Shin (CIPS) test proposed by Hashem Pesaran (2007) is used to test for nonstationary in the variables. CIPS test is a second-generation panel unit root test that assumes cross-sectional dependency and is valid for series having different lags and unbalanced panels. The null hypothesis—that is, all panels contain unit root—is tested against the alternative hypothesis—that is, some panels are stationary.

The widely used panel cointegration tests in the economic literature proposed by Pedroni (1999, 2004) and the Westerlund (2007) Error Correction Based (Westerlund ECB, hereafter) were applied to test cointegration. Both tests allow for a large degree of heterogeneity and accounts for cross-sectional dependence within and across the cross-sectional units. Pedroni (1999, 2004) computes seven test statistics in a heterogeneous panel with one or more nonstationary regressors. All statistics diverge to negative infinity, save for panel-v as the p-value converges to zero. In both tests, the null hypothesis of no cointegration is tested against the alternative hypothesis that all panels are cointegrated.

4.2. Panel Granger Causality Test

According to Granger (1969), considering two series of variables x and y that are stationary, x is said to cause y if y can be better predicted using all information available in the set of x and y other than when the information set does not include x. In order to test and determine direction of causality, this study adopts Dumitrescu and Hurlin's (2012) procedure for testing Granger noncausality in heterogeneous panel data and uses Stata user-written command developed by Lopez and Weber (2017). This is the most recent test developed in the economic literature. It requires a balanced panel and allows for the selection of the number of lags to be included. The procedure for the test involves the estimation of the following regression for each individual in the panel:

$$y_{i,t} = \alpha_i + \sum_{p=1}^{P}\beta_{ip}y_{i,t-p} + \sum_{p=1}^{P}\lambda_{ip}x_{i,t-p} + \varepsilon_{i,t} \quad \text{For } i = 1, \ \ldots, N \text{ and } t = 1.\, T, \tag{2}$$

where $x_{i,t}$ and $y_{i,t}$ are the two stationary variables for individual i in time t. P is the lag selected, which is assumed to be the same for all individuals. The null hypothesis of no Granger causality is defined as:

$$H_0 : \lambda_{i1} = ... = \lambda_{iP} = 0, \forall i = 1,....., N \tag{3}$$

The alternative hypothesis that there can be causality in some panels but not necessarily all is defined as:

$$\begin{aligned} H_1 : \lambda_{i1} = ... = \lambda_{iP} = 0, \forall i = 1,....., N_1 \\ \lambda_{i1} \neq 0, \text{or....or}, \lambda_{iP} \neq 0, \forall_i = N_1 + 1,...., N \end{aligned} \tag{4}$$

F-test of the P linear hypothesis $\lambda_{i1} = ... = \lambda_{iP} = 0$ is conducted to obtain Wald statistic W_i for each individual panel. The average Wald test statistic $\overline{W}$ is then computed using the adjusted Wald statistic for each individual i, as follows:

$$\overline{W} = \frac{1}{N}\sum_{i=1}^{N} W_i \tag{5}$$

The decision to reject or not to reject the null hypothesis is based on the values of the test statistics: Z bar ($\overline{Z}$) and Z bar tilde ($\tilde{Z}$). The null hypothesis is rejected when the favored statistic is larger than the corresponding critical values. Dumitrescu and Hurlin (2012) recommend that when T is large relative to N, $\overline{Z}$ should be considered; however, when N is large but T is relatively small, then $\tilde{Z}$ should be favored. However, Monte Carlo simulations have shown that the test gives credible results even when both N and T are small. Rejecting the null hypothesis implies the presence of Granger causality. The standardized Z statistic, that is, $\overline{Z}$, is computed as:

$$\overline{Z} = \sqrt{\frac{N}{2P}} * (\overline{W} - P) \xrightarrow{d} N(0, 1) \text{ for } T \rightarrow \infty, N \rightarrow \infty \tag{6}$$

In the case of a panel dataset where, $T > 5 + 3P$, the standardized Z statistic, that is, $\tilde{Z}$ is computed as follows:

$$\tilde{Z} = \sqrt{\frac{N}{2P} * \frac{T-3P-5}{T-2P-3}} * \left[\frac{T-3P-3}{T-3P-1} * \overline{W} - P\right] \xrightarrow{d} N(0, 1) \text{ for } N \rightarrow \infty \tag{7}$$

Furthermore, the study estimates regressions for each individual country to obtain more insights on the coefficients of the regressions in which the tests are based. In the case of cross-section dependence, Dumitrescu and Hurlin (2012) propose a procedure to compute the bootstrapped critical values of $\overline{Z}$ and $\tilde{Z}$,[1] and emphasize that bootstrapping need to be considered should the data show evidence of cross-sectional dependence. The bootstrapping procedure is used at 95% significance level. The p-values are calculated by repeating the bootstrapping procedure 1000 times.

In testing for Granger noncausality, the null hypothesis is therefore rejected if $\overline{Z}$ or $\tilde{Z}$ (depending on the favored statistic) is greater than the 95% critical values obtained from the bootstrap procedure. For example, the null hypothesis that agriculture productivity does not Granger cause agricultural imports is rejected if $\overline{Z}/\tilde{Z}$ is greater than the 95% critical value; hence, we conclude that agriculture productivity indeed do Granger cause agricultural imports. The same description is extended in analysis of causal relationship between agricultural imports and economic growth.

5. RESULTS AND DISCUSSION

As previously stated, the Granger noncausality test procedure developed by Dumitrescu and Hurlin (2012) requires balanced panel data and assumes the variables are stationary. In addition, cross-section dependence is a problem that requires consideration particularly in panel data with long time series (Baltagi, 2008). Preliminary test results for cross-sectional dependence and slope homogeneity presented in Table 2 show that the p-values in both tests is zero; hence, the null hypothesis of cross-sectional independence and slope homogeneity are rejected. These results justified the application of the bootstrapping procedure.

Table 2 | Cross-sectional dependency and homogeneity tests results[a]

Test	Statistic	p-value
Cross-sectional dependency H0: cross-section independence		
Hashem Pesaran (2004) CD	29.403	0.000
Breusch–Pagan LM	7328.705	0.000
Slope homogeneity H0: slope homogeneity		
Delta	24.488	0.000
Delta adj.	26.621	0.000

[a]The data used for these tests cover the full sample period 1990 to 2015.

[1]See Dumitrescu and Hurlin (2012) for details on the step-by-step bootstrapping procedure.

The results for unit root test proposed by Hashem Pesaran (2007) that assumes cross-section dependence are presented in Table 3. The results show that, for all variables, some panels are stationary at level, and at first difference both without trend and with trend. Hence, the data were appropriate for testing causality.

Table 4 presents the results for both Pedroni (1999, 2004) and Westerlund ECB panel cointegration tests. Three models are used to run the tests where, in each case one variable is treated as the dependent variable and others as independent variables. For example, in the first model, agricultural imports are treated as the dependent variable whereas GDP per capita growth and agriculture productivity (agricvperha) are treated as independent variables. The results of the Pedroni test provide strong evidence for rejecting the null hypothesis of no cointegration in the three models. Westerlund ECB test results show strong evidence for not rejecting the null hypothesis of no cointegration as the p-values are greater than 0.05 in the first and third models. However, in the second model where GDP per capita growth is treated as a function of agricultural imports and agriculture productivity, the p-values are all 0; thus, the null hypothesis of no cointegration is rejected. These results indicate that the variables have long run relationship and hence, the study proceeds on estimating the causal relationships.

In testing causality on panel data, the Dumitrescu and Hurlin (2012) procedure allows for the selection of the number of lags to be included. Lag 1 is selected automatically based on minimum Akaike, Bayesian, or the Hannan–Quinn information criterion. This eliminates the bias associated with selection of too few lags or too many lags (Menyah et al., 2014). Table 5 presents the results of panel causality analysis between agriculture productivity and agricultural imports, and between economic growth (measured by GDP per capita growth) and agricultural imports.

Table 5 shows strong evidence of bidirectional causality between agriculture productivity and agricultural imports in the whole sample. The $\bar{Z}$ statistic is significant at the 0.05 level. Evidence for bidirectional causality is also observed both middle- and low-income non-oil exporters subsamples. This implies that agriculture productivity significantly determines agricultural imports, and the feedback effect is present. These results are consistent with the findings reported by Sangho et al. (2007). However, there is no evidence of causality between agriculture productivity and agricultural imports in oil-exporting countries.

Table 3 | CIPS panel unit root tests results[a]

Variables	Lags	Without trend		With trend	
		Z-bar statistic	*p*-value	*Z*-bar statistic	*p*-value
agricM	0	−11.055	0.000	−9.737	0.000
	1	−5.565	0.000	−3.905	0.000
agricvperha	0	−6.223	0.000	−5.045	0.000
	1	−2.164	0.015	−2.224	0.013
GDPpcgrowth	0	−18.528	0.000	−16.306	0.003
	1	−10.151	0.000	−7.790	0.000

[a]The data used for these tests cover the full sample period from 1990 to 2015. H0: All panels contain unit root. H1: Some panels are stationary.

Table 4 | Panel cointegration test results[a]

Pedroni panel cointegration test			Westerlund ECB panel cointegration test			
Statistic	Panel	Group	Statistic	Value	*Z*-value	Robust *p*-value
Model 1 (dependent variable –agricM)						
v	−2.768***		Gt	−0.776	8.644	1.000
Rho	0.4313	0.3946	Ga	−2.374	6.807	1.000
t	−1.948***	−3.196***	Pt	−5.682	4.990	0.790
adf	−0.4065	−0.2176	Pa	−1.885	4.502	0.860
Model 2 (dependent variable –GDPpc growth)						
v	3.463***		Gt	−2.897	−5.919	0.000
Rho	−12.45***	−10.55***	Ga	−9.560	−0.439	0.000
t	−20.73***	−26.26***	Pt	−15.899	−4.905	0.000
adf	−14.03***	−13.72***	Pa	−8.904	−3.438	0.000
Model 3 (dependent variable –agricvperha)						
v	0.9496		Gt	−2.353	1.322	0.340
Rho	−3.246***	−1.853**	Ga	−6.697	5.983	0.570
t	−6.114***	−6.857***	Pt	−7.362	7.877	0.980
adf	−3.274***	−2.684***	Pa	−3.583	6.460	0.930

[a]The data used for these tests cover the full sample period from 1990 to 2015. The null hypothesis in both tests is no cointegration. For Pedroni test, $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$. For Westerlund ECB test, Lag 1 and lead 1 are selected based on AIC, the test is done with constant and no trend, Bartlett kernel window length is selected based on $4(T/100)^{2/9} \approx 3$. p-values are calculated by repeating the bootstrap 100 times.

Table 5 | Results summary of panel Granger noncausality test[a]

	$\overline{W}$	$\bar{Z}/\tilde{Z}$-statistic	95% critical value
H0: Agriculture productivity does not Granger-cause agricultural imports			
Full sample	3.8433	10.326**	6.376
Oil exporters	3.794	5.589	6.287
Middle-income non-oil exporters	3.845	6.969*	6.379
Low-income non-oil exporters	3.862	9.050**	5.271
H0: Agricultural imports does not Granger-cause agriculture productivity			
Full sample	3.631	9.526***	6.734
Oil exporters	1.071	0.141	5.789
Middle-income non-oil exporters	4.584	8.778**	6.257
Low-income non-oil exporters	4.083	9.950**	6.065
H0: GDP per capita growth does not Granger-cause agricultural imports			
Full sample	1.017	−0.312	2.321
Oil exporters	0.731	−0.538	2.884
Middle-income non-oil exporters	2.022	2.504	3.455
Low-income non-oil exporters	0.537	−1.463	2.669
H0: Agricultural imports does not Granger-cause GDP per capita growth			
Full sample	1.773	3.532*	3.418
Oil exporters	0.712	−0.576	3.926
Middle-income non-oil exporters	3.697	6.605**	3.850
Low-income non-oil exporters	1.165	0.521	3.333

[a]The data used cover the full sample period 1990–2015. *$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$. Bootstrap procedure is repeated 1000 times. In the whole, sample the test statistic favored is $\tilde{Z}$ because $N > T$, whereas in the subsamples the test statistic favored is $\bar{Z}$ because $T > N$.

Causality analysis between economic growth and agricultural imports shows no evidence of causality running from GDP per capita growth to agricultural imports in all the subsamples. The result implies that economic growth does not significantly cause agricultural imports in SSA. These results contrast the claims in existing economic literature that increased imports of agricultural products in the region are partly a result of increased economic growth (Parker, 2011; Hilderink, et al., 2012; Badiane et al., 2018). There is strong evidence of unidirectional causality running from agricultural imports to GDP per capita growth in the full sample and in the middle-income non-oil exporter group. The $\bar{Z}$ statistics are significant at the 0.1 and 0.05, levels respectively. These results support the agricultural import-led growth hypothesis which suggests that imports growth have a positive and significant effect on economic growth. These results are in line with the findings of Uslu (2016) and Aluko and Adeyeye (2020), which state that imports cause GDP growth in some countries. Nonetheless, agricultural imports do not Granger-cause GDP per capita growth in oil exporter and low-income non-oil exporter subsamples.

5.1. Endogeneity and Robustness Check

For robustness check, the causality analysis is repeated by country level for all countries under study. The results indicate unidirectional causality from agriculture productivity to agricultural imports in the case of Angola, Kenya, Malawi, Nigeria, Rwanda, and Somali. A unidirectional causality running from agricultural imports to agriculture productivity is evident in the case of Burundi, Mozambique, Senegal, Central Africa, Mauritius, and Gambia. In addition, a strong evidence of bidirectional causality between agriculture productivity and agricultural imports is evident in the case of Zambia. Causality analysis between GDP per capita growth and agricultural imports reveals a weak bidirectional causality between GDP per capita growth and agricultural imports in the case of only two countries—Cote d'Ivoire and Ghana—out of the 40 countries in the sample. Unidirectional causality running from agricultural imports to GDP per capita growth is found in the case of five countries: Cote d'Ivoire, Ghana, Kenya, Sao Tome, and Cape Verde, which are all classified as middle-income non-oil exporter countries. There is no evidence of unidirectional causality running from GDP per capita growth to agricultural imports in all countries under study. The weak bidirectional causality between GDP per capita and agricultural imports presented in the case of Cote d'Ivoire and Ghana could be a result of the feedback effect.[2] These findings support the main results of the subsamples presented in Table 5.

5.2. Effect of Agricultural Imports on Economic Growth

Having established that a feedback effect exists between agriculture productivity and agricultural import, and that agricultural imports cause economic growth in some countries (direction of causality), we next examine the effect of agricultural imports on economic growth while controlling for endogeneity. In this section, the IV technique is used to address endogeneity. The following growth model is estimated:

$$\log y_{git} = \alpha + \beta \log \text{agric}M_{it} + \lambda' X_{it} + c_i + \varepsilon_{it}, \quad (8)$$

[2]The results for country-level causality analysis are presented in Appendix Table A3 and A4.

where y_{git} is the GDP per capita growth rate of country i in time t, agric$M$ is the value of agricultural imports, X is a vector of control variables, c represents the individual effect, and ε_{it} is the idiosyncratic errors. Control variables added in the model include investment rate measured by the logarithm of the gross capital formation (ln grosskform), logarithm of the population growth rate (ln popgrowth), human capital measured by the rate of secondary school enrolment (ln schrenroll), and inflation. The 2SLS instrumental variable (2SLS-IV) technique of the fixed effects and random effects in panel data is applied. Hausman test is applied to make a choice on the model consistent with the data. Fixed-effect robust errors clustered at country level are used to control heteroskedasticity. Agricultural land is used as an instrument for agricultural imports following Frankel and Romer 1999. Sargan–Hansen test for overidentification, developed by Sargan (1958) and Hansen (1982), is applied to test for overidentification whereas Anderson canon corr. LM statistic tests are used to test for underidentification. The empirical results of the 2SLS-IV estimation for the regression of agricultural imports on economic growth are shown in Table 6.

As presented in Table 6, the Sargan–Hansen test statistic is equal to zero, which implies that the model is exactly identified. The Anderson canon corr. LM statistic is significant at the 1% level, implying that the null hypothesis (that the model is underidentified) is rejected. Furthermore, the F-statistic for Anderson–Rubin (AR) Wald joint test for relevance and exogeneity developed by Anderson and Rubin (1949, 1950) is significant at the 5% level in the full sample and the middle-income group. This implies that the instrument used is valid—that is, it is significantly correlated with agricultural imports and is uncorrelated with the error term, hence it does not affect the dependent variable through other channels other than the regressor of interest. The AR joint test is robust to weak instruments. In addition, weakly identified instrument could lead to biased results. Hence, the Cragg–Donald (1993) Wald F-test is applied to test for weak identification. The results satisfy the rule of thumb (F-statistic is greater than 10) in all subsamples; hence the instrument used is not weak.

Column 1 in Table 6 shows the 2SLS-IV estimation results of random effects using the full panel. The coefficient of the logarithm of agricultural imports is −0.0395 and not significant. However, on applying 2SLS-IV fixed effects with robust standard errors (the model consistent with the data), the coefficient turns positive (0.977) and significant at the 0.05 level (column 2 in Table 6). This implies that agricultural imports positively and significantly influence economic growth. The growth elasticity of agricultural imports is approximately 0.98. This relationship is replicated in the middle-income non-oil-exporting countries, where the coefficient of the logarithm of agricultural imports is positive and significant at the 0.05 level (column 4 in Table 6). The growth elasticity of agricultural imports in this subsample is about 1.3. The relationship between agricultural imports and GDP per capita growth in the oil exporters and low-income non-oil exporters subsamples is negative and not significant (columns 3 and 5 in Table 6). Hence, agricultural imports do not significantly affect economic growth in these subsamples. In conclusion, these empirical results are consistent with the results of the Granger causality presented in Table 5.

5.3. Effect of Imported Agricultural Inputs on Agriculture Output

As a result of increasing globalization, agricultural inputs are either imported or produced domestically. We examine the effect of imported agricultural inputs on agriculture productivity as a potential channel through which agricultural imports promote economic growth. Table 7 presents the empirical results of the effect of imported agricultural inputs on agriculture output. The results reveal that for all the random-effects models applied (random effects was the model consistent with the data based on Hausman test results), the coefficient of logarithm of imported inputs is positive and significant at the 0.01 level in the full sample, and oil exporter and middle income non-oil exporter subsamples. In the low-income non-oil exporter group, the coefficient is positive but not statistically significant. The output elasticity of imported agricultural inputs is approximately 0.1. The coefficients of the control variables, which include logarithm of agricultural land, logarithm of agricultural labor, logarithm of agricultural capital, and logarithm of fertilizer, are positive as expected and are statistically significant.

Table 6 | Regression results for agricultural imports on economic growth[a]

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
lnGDPpc growth	**Full panel**	**Full panel**	**Oil exporters**	**Middle income**	**Low income**
lnagricM	−0.0395 (0.0676)	0.977** (0.573)	−0.123 (0.0876)	1.300** (0.601)	−0.000717 (0.149)
lngrosskform	0.457*** (0.121)	0.149* (0.231)	−0.160 (0.266)	0.0887* (0.477)	0.444* (0.227)
lnschenroll	−0.146 (0.108)	−1.495* (0.710)	−0.297 (0.198)	−1.651** (0.800)	−0.249 (0.173)
lnpopgrowth	−0.273*** (0.0930)	−0.215 (0.170)	−0.220 (0.316)	−0.184 (0.232)	−0.415** (0.203)
inflation	0.000312 (0.000219)	0.0003*** (0.0001)	0.000327 (0.000215)	0.0112* (0.006)	−0.00517 (0.00801)
Constant	0.646 (0.701)	−6.556 (4.383)	4.278*** (1.367)	−9.758** (4.56)	0.635 (1.300)
Hausman test (χ^2)		18.41**	0.27	18.48***	1.64
Over identification test (Sargan–Hansen statistic)	0.000	0.000	0.000	0.000	0.000
Under identification test (Anderson canon. corr. LM statistic)		31.589***		33.196***	
Weak identification test (Cragg–Donald Wald F-statistic)		33.041***	38.42***	38.808***	20.92***
Anderson–Rubin (AR) Wald test		6.52**	1.03	17.53***	0.91
Observations	819	819	168	231	420
Number of country	39	39	8	11	20

[a]Standard errors are in parentheses. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 7 | Regression results for imported agricultural inputs on agriculture output[a]

Variables	(1)	(2)	(3)	(4)	(5)
lnagricQ	**Full panel**	**Full panel**	**Oil exporters**	**Middle income**	**Low income**
ImportedI	0.105*** (0.0128)	0.102*** (0.0131)	0.111*** (0.0192)	0.103*** (0.0233)	0.0316 (0.0258)
lnagricL	0.746*** (0.0372)	0.745*** (0.0379)	0.904*** (0.0724)	0.382*** (0.0789)	0.818*** (0.0551)
lnagricLbr	0.228*** (0.0485)	0.243*** (0.0500)	0.384*** (0.111)	0.208** (0.0836)	0.435*** (0.0974)
lnagricK	0.0644*** (0.0147)	0.0677*** (0.0150)	0.0165 (0.0172)	0.161*** (0.0322)	0.0468* (0.0258)
lnfert	0.0234*** (0.00764)	0.0220*** (0.00786)	0.0122 (0.0129)	0.0783*** (0.0166)	0.00737 (0.0112)
foodM		−0.00215* (0.00115)	−0.000631 (0.00174)	0.00524 (0.00357)	−0.00294** (0.00149)
Constant	4.121*** (0.270)	4.082*** (0.288)	2.070*** (0.600)	5.686*** (0.590)	3.494*** (0.501)
Observations	819	819	168	231	420
Number of country	39	39	8	11	20

[a]Standard errors are in parentheses. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Furthermore, food imports were added to the model. The significance and magnitude of the coefficients of imported agricultural inputs and the control variables remained almost the same in the full sample (column 2 in Table 7). Nevertheless, food imports have a negative and significant impact on agriculture output in the full sample. The negative relationship between food imports and agricultural output is also reported in the oil exporter and low-income non-oil exporter groups. However, in the middle-income non-oil exporter group, food imports are positively correlated with agriculture output.

These results imply that a 1% increase in imported agricultural inputs increase agriculture output by approximately 0.1% in SSA. The results suggest that promoting imports of agricultural inputs and intermediate goods is an important channel through which agriculture productivity growth as well as economic growth in the region could be realized. These findings are consistent with empirical findings in the economic literature (Lawrence and Weinstein, 1999; Gokcekus, 1997; Sangho et al., 2007; Abreha, 2019), which report that imports enhance productivity whereas protectionism hinders technological advancement and productivity growth.

The positive relationship between agricultural imports and economic growth in SSA could therefore be explained by the fact that most agriculture-based SSA countries import intermediate goods in the production process, which boosts agriculture productivity and consequently economic growth. This is deduced from the results presented in Table 7. Most of the modern inputs such as hybrid seeds, pesticides, fertilizers, and machinery are sourced from the world market. Sheahan and Barrett (2014), report that farmers in SSA have increasingly been using external inputs to boost crop yields. Agricultural foreign direct investment in SSA, which has been on the rise recently, facilitates technology transfer and spillover effects, which further promote agricultural production in the region. Furthermore, dumping of food commodities enhances availability of cheap imported foods, leading to diet diversification, which could improve agricultural labor productivity as reported by Frisvold and Ingram (1995), particularly in middle-income countries, which report positive relationship between food imports and agricultural output.

As the results in Table 5 show, GDP per capita growth does not Granger-cause agricultural imports. Moreover, there is no evidence of unidirectional causality running from GDP per capita growth to agricultural imports in any of the countries under study. This implies that economic growth does not significantly affect agricultural imports in SSA. This could be explained by the fact that economic development in these economies is characterized by a decline in agricultural sector relative to the manufacturing sector (Anderson, 2010). Headey et al. (2010) report rapid agricultural exits in Africa in the recent past. Manufactured goods become more income elastic as the economy grows, and most of the resources are channeled to the manufacturing sector. Therefore, agricultural imports in SSA could be driven by other factors such as stagnation in agricultural productivity, population growth leading to increased demand that exceeds the agriculture productivity growth, low investment in agricultural research, and development among others. Badiane (1992) notes that the increasing food imports among African countries have little to do with economic transformation, but rather, is a result of stagnation in agricultural growth in the region.

6. CONCLUSION

This research applies Granger noncausality tests in heterogeneous panels to analyze causal relationships among agricultural imports, agriculture productivity, and GDP per capita growth using panel data for 40 SSA countries over the period 1990–2015. The panel Granger causality analysis applied accounts for cross-sectional dependence and provides finite results even when both N and T are small. The analysis is extended by using the IV technique with G2SLS for panel-data models to estimate the effect of variables of interest while controlling for endogeneity. In order to gain more insight, the sample is divided into three nonoverlapping sub-samples—oil exporters, middle-income non-oil exporters, and low-income non-oil exporters—based on World Bank classification.

The empirical results indicate strong evidence of feedback effect between agriculture productivity and agricultural imports in the full sample, middle income non-oil exporters, and low-income non-oil-exporting countries in SSA. In six countries, we find unidirectional causality running from agriculture productivity to agricultural imports, whereas unidirectional causality from agricultural imports to agriculture productivity is evident in six countries. Strong evidence of bidirectional causality between agriculture productivity and agricultural imports is evident in one country. There is no evidence of causality running from GDP per capita growth to agricultural imports in all subsamples. The results therefore do not agree with the existing claims in the economic literature that economic growth in SSA is among the factors contributing to increased agricultural imports in the region. However, there is strong evidence of unidirectional causality running from agricultural imports to GDP per capita growth in the full sample and in middle-income non-oil-exporting countries in SSA. This causality is evident in five countries. Thus, the agricultural import-led growth hypothesis is supported.

Two main findings are drawn from this study. First, a feedback effect exists between agriculture productivity and agricultural imports in SSA except in the case of oil-exporting countries. Second, economic growth does not significantly cause increased imports of agricultural products in SSA, but agricultural imports support economic growth in the region. The estimated growth elasticity of agricultural imports is about 0.98 in the full sample and about 1.3 in middle-income non-oil-exporting countries. Agricultural output elasticity of imported inputs in the region is about 0.1. These findings negate the misconception that imports hinder economic growth through import leakages and crowding out of domestic production by showing that agricultural imports have a positive and significant impact on agriculture productivity and consequently economic growth in SSA. Agricultural import of raw materials, and intermediate and capital goods promote competition, innovation, and absorption of advanced technology in the domestic market, which enhances production efficiency. The resulting productivity gains enhanced growth in the economy. Governments and policy makers in SSA countries should therefore carefully consider their agricultural trade policies in order to promote agricultural trade openness for economic growth and development. Policies that favor imports of agricultural inputs and intermediate commodities should be promoted more than the imports of end products and/or food. This will boost agricultural domestic production to meet local demand as well as provide for exports.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

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APPENDIX

Table A1 List of countries

Oil exporters	Middle-income non-oil exporters	Low-income non-oil exporters	
Angola	Cote d'Ivoire	Burkina Faso	Zimbabwe
Chad	South Africa	Burundi	Central Africa
Cameroon	Ghana	Guinea	Madagascar
Congo	Kenya	Malawi	Somalia
Nigeria	Zambia	Mali	Comoros
Sudan	Mauritania	Mozambique	Liberia
Gabon	Mauritius	Niger	Senegal
Seychelles	Namibia	Rwanda	Sierra Leone
	Lesotho	Gambia	
	Botswana	Benin	
	Sao Tome	Togo	
	Cape Verde	Uganda	

Table A2 Descriptive statistics of the variables

Variables		Mean	Std. dev.	Min	Max	Observations
agricvperha	Overall	701.995	452.529	89.085	3290.598	$N = 1040$
	Between		438.779	164.485	2727.148	$n = 40$
	Within		129.952	52.777	1919.444	$T = 26$
GDPpcgrowth	Overall	1.367	5.266	−47.503	37.536	$N = 1040$
	Between		1.5682	−1.274	5.103	$n = 40$
	Within		5.033	−49.809	35.230	$T = 26$
agricM	Overall	497,724.5	905,867.3	6448	8,331,117	$N = 1040$
	Between		672,395.2	21,545.23	3,114,184	$n = 40$
	Within		615,921.2	−2,055,419	5,714,657	$T = 26$
grosskform	Overall	21.876	9.769	−2.424	61.469	$N = 1040$
	Between		7.389	11.383	46.912	$n = 40$
	Within		6.495	3.2596	57.661	$T = 26$
popgrowth	Overall	2.455	1.107	−6.766	8.118	$N = 1040$
	Between		0.685	0.705	3.632	$n = 40$
	Within		0.876	−6.027	8.857	$T = 26$
inflation	Overall	21.274	168.239	−11.686	4145.106	$N = 1040$
	Between		67.953	1.540	424.966	$n = 40$
	Within		154.009	−396.411	3741.414	$T = 26$
schenroll	Overall	35.542	22.601	5.221	115.957	$N = 1040$
	Between		20.246	9.606	88.280	$n = 40$
	Within		10.537	−3.526	73.753	$T = 26$
agricl	Overall	4470.823	7297.637	1.690	52,982.57	$N = 1040$
	Between		7278.981	3.510	42,282.22	$n = 40$
	Within		1243.709	−8461.043	15,171.17	$T = 26$

Std. dev., standard deviation.

Table A3 | Causality between agriculture productivity and agricultural imports[a]

Country	H0: Agriculture productivity does not Granger-cause agricultural imports			H0: Agricultural imports does not Granger-cause agriculture productivity		
	$\overline{W}$	$\tilde{Z}$-statistic	95% critical value	$\overline{W}$	$\tilde{Z}$-statistic	95% critical value
Angola	8.362	4.483*	4.090	0.001	−0.654	4.556
Benin	1.166	0.039	2.906	0.152	−0.564	3.200
Botswana	0.002	−0.653	3.351	0.179	−0.548	3.249
Burkina Faso	0.626	−0.282	3.357	0.404	−0.415	3.209
Burundi	1.928	0.493	2.279	14.725	8.109**	1.899
Chad	0.523	−0.343	2.137	0.253	−0.504	2.221
Cameroon	3.239	1.273	4.487	1.645	0.324	5.163
Congo	5.441	2.583	6.184	0.000	−0.655	4.039
Cote d'Ivoire	0.650	−0.268	3.604	3.705	1.551	3.984
Guinea	0.965	−0.081	3.715	0.121	−0.583	3.768
Ghana	0.610	−0.292	4.422	8.749	4.552	4.771
Kenya	11.253	6.042**	3.949	0.001	−0.699	4.302
Malawi	8.720	4.535*	3.423	1.345	0.146	3.270
Mali	1.904	0.478	2.341	3.596	1.436	2.616
Mozambique	4.894	2.258	2.748	11.800	6.368**	2.802
Niger	2.458	0.808	4.510	0.842	−0.164	4.206
Nigeria	8.304	4.287*	3.968	1.275	0.104	4.795
Rwanda	11.112	5.959**	3.735	0.992	−0.064	3.809
Senegal	0.628	−0.281	3.244	19.761	11.106**	2.555
Sierra Leone	6.158	3.010	3.320	4.989	2.315	3.744
South Africa	2.462	0.810	4.495	5.870	2.839	5.301
Sudan	0.610	−0.292	2.761	0.588	−0.305	3.407
Togo	3.057	1.165	2.778	0.450	−0.387	2.901
Uganda	4.405	1.967	2.995	0.060	−0.619	3.633
Zambia	16.697	9.282**	3.523	12.006	6.490**	3.910
Zimbabwe	1.772	0.400	2.585	0.644	−0.217	2.727
Central Africa	2.817	1.022	3.065	7.831	4.006*	3.313
Madagascar	8.960	4.678	5.269	1.654	0.330	4.444
Somalia	11.741	6.333**	2.780	0.192	−0.540	3.203
Mauritania	5.308	2.504	3.336	4.725	2.157	3.274
Mauritius	0.206	−0.533	3.407	15.335	8.472**	4.019
Namibia	0.334	−0.456	2.530	0.141	−0.571	2.620
Sao Tome	3.469	1.410	3.781	0.896	−.0121	3.873
Seychelles	2.084	0.585	3.766	4.371	1.947	3.649
Cape Verde	2.739	0.975	3.784	0.000	−0.361	4.517
Comoros	0.150	−0.566	2.114	2.941	1.096	4.412
Gabon	1.522	0.251	3.813	0.432	−0.397	3.492
Gambia	3.074	1.175	2.798	7.802	3.989*	2.921
Lesotho	2.409	0.779	2.041	3.387	1.361	1.834
Liberia	0.700	−0.238	2.243	1.379	0.166	3.073

[a]The data used cover the full sample period from 1990 to 2016. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table A4 | Causality between agricultural imports and economic growth[a]

Country	H0: GDP per capita growth does not Granger-cause agricultural imports			H0: Agricultural imports does not Granger-cause GDP per capita growth		
	$\overline{W}$	$\tilde{Z}$-statistic	95% critical value	$\overline{W}$	$\tilde{Z}$-statistic	95% critical value
Angola	0.491	−0.363	2.140	0.191	−0.541	2.526
Benin	0.499	−0.358	1.956	0.220	−0.530	1.967
Botswana	0.391	−0.422	1.881	0.015	−0.646	1.842
Burkina Faso	0.040	−0.631	2.012	0.046	−0.627	1.806
Burundi	0.159	−0.560	2.796	0.041	−0.630	2.200
Chad	0.312	−0.469	1.981	0.049	−0.626	1.908
Cameroon	1.596	0.295	3.088	0.166	−0.556	3.351
Congo	0.054	−0.623	2.742	3.448	1.398	2.377
Cote d'Ivoire	6.911	3.458*	2.478	5.759	2.773**	2.729
Guinea	0.562	−0.321	1.661	2.297	0.712	1.888
Ghana	9.012	4.708*	3.007	18.599	10.414***	2.765
Kenya	1.990	0.530	2.404	4.837	2.250*	2.224
Malawi	0.312	−0.469	1.978	0.938	−0.096	1.920
Mali	0.765	−0.200	1.872	0.997	−0.061	1.874
Mozambique	0.316	−0.467	2.314	0.000	−0.655	1.690
Niger	0.799	−0.179	1.828	4.044	1.752	2.435
Nigeria	0.797	−0.181	2.790	0.567	−0.318	2.335
Rwanda	0.045	−0.628	2.296	0.042	−0.630	1.946
Senegal	0.001	−0.654	2.053	0.312	−0.469	2.363
Sierra Leone	0.063	−0.617	2.164	0.079	−0.608	1.997
South Africa	1.603	0.299	2.662	0.562	−0.320	2.983
Sudan	1.655	0.330	2.029	0.585	−0.307	1.694
Togo	0.578	−0.311	2.466	0.285	−0.485	2.028
Uganda	0.810	−0.173	1.847	1.323	0.133	2.477
Zambia	1.277	0.105	2.863	2.063	0.573	2.168
Zimbabwe	0.000	−0.655	2.378	1.950	0.506	2.369
Central Africa	3.354	1.341	1.645	0.849	−0.149	1.704
Madagascar	1.056	−0.026	1.925	0.212	−0.529	1.934
Somalia	0.162	−0.558	1.664	0.363	−0.438	1.804
Mauritania	0.232	−0.517	1.687	0.151	−0.565	2.331
Mauritius	0.010	−0.649	1.589	0.136	−0.574	1.982
Namibia	0.528	−0.341	2.328	0.975	−0.074	2.078
Sao Tome	1.426	0.194	2.128	4.927	2.367**	2.277
Seychelles	0.231	−0.517	1.874	0.002	−0.653	2.119
Cape Verde	0.015	−0.646	2.363	6.013	3.062**	2.924
Comoros	0.509	−0.352	2.299	1.142	0.025	1.705
Gabon	0.712	0.778	2.080	0.689	−0.245	2.115
Gambia	0.406	−0.413	1.821	3.471	1.411	2.040
Lesotho	0.872	−0.136	2.009	0.320	−0.464	2.071
Liberia	0.140	−0.571	1.779	2.246	0.682	2.287

[a]The data used cover the full sample period from 1990 to 2016. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.