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Does the agriculture value-added contribute to the economic growth in 30 African countries?

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Abstract. *Not a long ago, the agriculture sector was the main pillar of any economy in the world. It not only provides food production, but it participates to the expansion of the economic growth as well. In this paper, we shall try to investigate the relationship between agriculture sector and economic growth for 30 African countries over the period of 1980-2017 with individual and temporal fixed-effect panel model and panel cointegration. We found with Pedroni and Westerlund tests that we have not a cointegration relationship between variables; hence we cannot estimate the long-run panel model. Therefore, we only estimated the panel model with individual and temporal fixed-effect, then we established that the two variables of economic openness relied to agriculture sector are positive, but insignificant, while the variable of the agriculture value-added was positive and statically accepted at the level of 1%, and the coefficient of the labour force in the agriculture sector appears negative and insignificant. The panel Granger causality showed that there is bidirectional causality between agricultural raw materials exports and imports, and the causality of Dumitrescu and Hurlin established that there are several causalities.*

Keywords: agriculture; economic growth; African countries; individual and temporal fixed-effect panel model; panel cointegration; panel Granger causality, Dumitrescu and Hurlin causality.

JEL Classification: C33; O13; Q10.

1. Introduction

Since the last century, most African countries have witnessed a rapid and huge development (Wiggins, 2014). This expansion is relied to different factors, including agricultural growth, improvement in the rule of law and control of corruption, increases in foreign direct investment, government commitment to invest in the agriculture and food sectors, improvement in soft and hard infrastructure, higher prices for natural resources, and development assistance. Therefore, such countries have given a key role to agriculture growth in producing the broad-based growth needed to reduce poverty and hunger (ReSAKSS, 2014). Regarding to different studies, the development of the agricultural outputs is necessary for the whole economic system and account for the lion's share of employment and overall gross domestic product (GDP) in Africa. In addition, agriculture is capable of producing surplus food and labour, which boosts the productivity and profitability of the non-agricultural sector.

In several African countries, the agricultural sector takes a key part in the lives of the inhabitants, and can have a close relationship with the objectives of sustainable development defined by United Nation for Development program ranging from improving food security, ending poverty, creating employment, generating foreign exchange, supplying raw materials for industry, and providing a cushion during shocks, to supporting environmental sustainability, among others. Also, this sector contributes to rise the food production and exportation, which can effect or to be influenced by both domestic and international markets through forward (product market) and backward (factor market) linkages (Boansi, 2014). These spillover effects from the agriculture sector to the non-agriculture one will result in high overall productivity and growth. So, these developing countries are aiming at achieving the sustainable growth and sustainable development, therefore, the international trade (agriculture export for example) is generally perceived as a motivating factor to attaining this.

Indeed, the agriculture sector allows decreasing poverty; supplementing food availability and it generally improve the livelihood of the population. Timmer (2004) approves the hypothesis of agriculture-led growth (ALG), which denotes that the growth of the agricultural sector is essential for industrialization through a rise in rural incomes and delivery of industrial raw materials, provision of a domestic market for industry and above all, the release of resources to support the industry.

However, the abandonment of the agriculture in favour of the industrial sector will reduce the expansion of the economic growth and increase the inequality in income distribution. In spite of the fact that agriculture may be incapable to single-handedly transform an economy, it is a necessary and sufficient condition in kick-starting industrialization in the early stages of development (Byerlee, 2005). In fact, several investigations found that the agricultural sector in Africa is at its survival threshold and fails to trigger a positive spillover to the non-agriculture sector. For example, the industry sector supplies important agricultural inputs, new technology, electricity, more irrigation, and better infrastructure that links it to lucrative regional food markets (World Economic Forum, 2016).

In this study, we shall make a panel model to analyse the main determinant of the agriculture sector and the economic growth in 30 African countries over the period 1980-2017. This paper is divided into 5 main sections. The first section defines the introduction and it gives a brief description about the importance and the role of agriculture to reach the sustainable development goals. The second section is the literature review, we will see the theoretical framework about the agriculture and the empirical investigations about the main determinant of the economic growth related to the agriculture sector. The next section describes the data and the methodology employed in this study. The fourth section is the main empirical result and the last section represents the general conclusion.

2. Literature review

The potential of the agricultural segment is huge and we confirmed that it plays an important role in securing the food demand for the urban population and export goods for the international market. The economic systems of underdeveloped countries are mostly characterized by dual economies that comprise subsistence traditional agriculture and a modern urban sector (Lewis, 1954; Jorgenson, 1961; Schultz, 1964). Johnston and Mellor (1961) identified five main channels through which agriculture growth activates economic growth as follow:

- Supply of surplus labour to firms in the industrial sector.
- Supply of food for domestic consumption.
- Provision of markets for industrial output.
- Supply of domestic savings for industrial investment.
- Supply of foreign exchange from agricultural export earnings to finance the import of intermediate and capital goods.

Federico (2005) demonstrated three significant characters that agriculture has in the process of economic growth, the product role, the factor role, and the market role.

Many scholars (Verter and Bečvářová, 2014; Verter, 2015; Sari Hassoun and Mouzarine, 2019) claimed that the agricultural export is a catalyst for growth, especially in developing countries where it is the main source of foreign earnings and national incomes. In addition, they showed that the foreign trade in food provides a full quantity of goods and services to the countries involved. It also delivers various supplies that upsurge selections to the population. To some extent, the international trade preserves stability demand and supply that permits efficient exchanges and stimulate economic growth and development.

Bakari and Ahmadi (2018) persuaded that South Africa still among developing country due to its weakness of investment and exports in the agricultural sector. They showed that this segment represents only 3% of South Africa GDP. And they demonstrated that this country is based on agriculture import rather than export, so they are consuming more than producing.

Santos-Paulino (2002) employed fixed and random effects panel model for 62 developing countries during the period 1974-1995 and he assumed two theoretical models. The first model relied on agricultural production function, including both agricultural and non-agricultural exports as inputs. The second model was based on dual economy model (agricultural and non-agricultural where each sector was subdivided into the export and non-export sectors). The outcomes support the theory of export-led growth. It also highlighted the role of agricultural exports in economic growth and therefore suggested a balance in export promotion policies.

Dawson (2005) inspected the influence of agricultural exports on the economic growth in developing nations. The findings showed some alterations in economic growth amongst low, lower-middle, and upper-income nations. Therefore, the investment in the agricultural export had a direct impact on the economic growth. Debatably, proactive actions ought to be encouraged for improving the agricultural exports.

Hausmann et al. (2007) analysed the long-term elasticity of response of Uganda’s mainly agricultural primary commodity exports over the floating exchange rate regime in Uganda. They suggested that Uganda’s exports are positively and significantly correlated with relative prices and the levels of exchange rate, but negatively correlated with the terms of trade, capacity utilization, and exchange rate variability. They said that Uganda’s export-led growth strategy must be recognized, but the policy makers ought to take full consideration to the differences in supply conditions and responses of particular subsectors.

Shombe (2008) approved that the agricultural export-led economic performance in Tanzania.

Sanjuan-Lopez and Dawson (2010) studied with panel cointegration methodology and panel Granger causality the link amongst GDP, agricultural and non-agricultural exports over 42 nations. They established that there is a long-run connection, with agricultural exports having an elasticity of 0.07 and the non-agricultural export elasticity of GDP was 0.13. The Granger causality displayed unidirectional causality running from agricultural export to economic growth.

Henneberry and Curry (2010) employed three simultaneous equations to investigate the link amongst agricultural exports and import and GDP in Pakistan. They concluded for a positive connection between GDP and export from agriculture.

Bbaale and Mutenyo (2011) found evidence with a panel data that the agricultural exports-led income per capita in Sub-Saharan African Countries. Kang (2015) confirmed the agricultural export-led growth in the major rice exporting countries like Pakistan, Vietnam and Thailand.

Oluwatoyese et al. (2016) employed the VECM method to analyse the connection amongst agricultural export, oil export and economic growth in Nigeria over the period of 1981-2014. They established in the long term that the agriculture export and oil export cause economic growth.

Mehrara and Baghbanpour (2016) used the static gravity model to investigate the involvement of industry and agriculture exports to economic growth in 34 developing countries during the period of 1970-2014. The outcomes showed that the agricultural exports have no effect on economic growth. However, industry exports had a positive effect on economic growth.

Uremadu and Onyele (2016) analysed the contribution of total agricultural exports, exports of cocoa and exports of rubber on economic growth in Nigeria over the period of 1980-2014. They concluded that only total agricultural exports had a positive effect on economic growth.

Toyin (2016) employed the VAR model and the Granger causality to examine the link amongst agricultural exports and economic growth in South Africa during the period of 1975-2012. As results, they established that there is no existence of causality between the two variables.

Edeme et al. (2016) examined the relationship between the agricultural sector and economic growth for ECOWAS (15 African countries) over the period of 1980-2013. They employed the variables of the labour force participation rate, capital stock, agricultural exports, non-agricultural exports, inflation, GDP. As results, they displayed with panel fixed effect model that almost all exogenous variables had a positive but an insignificant contribution on the economic growth, except the non-agricultural exports which had a negative influence on economic growth. However, they established with the pooled regression that the labour force participation rate, agricultural exports have a significant and positive influence on economic growth, demonstrating that the agriculture sector can have a key role in increasing the economic development, especially in Liberia.

Verter and Bečvářová (2016) employed the OLS regression, Granger causality, impulse response function and the variance decomposition to study the contribution of agricultural exports on economic growth in Nigeria during the period of 1980-2012. The Granger causality result showed that there is bidirectional causality between the agricultural export quantity index and real GDP growth (evidence of the hypothesis that agricultural exports led economic growth). Also, they concluded that the agricultural export quantity index and the real effective exchange rate index have a significant and positive impact on GDP growth, but the agricultural degree of openness had a negative and significant impact on GDP growth.

Bakari and Mabrouki (2017) investigated the contribution of agricultural exports on economic growth in South Eastern Europe Countries during the period of 2006-2016. They employed the correlation analysis and the static gravity model, and they found that agricultural exports have a positive and strong correlation with GDP. Mahmood and Munir (2017) used VECM Granger causality to analyse the connection between agricultural exports and economic growth in Pakistan over the period of 1970-2014. Their findings showed that agricultural export has a positive, but insignificant effect on economic growth. However, the economic growth had a positive and statically accepted impact on the agricultural exports. This may be explained by the inability of agricultural exports to compete in international markets because of the high competitiveness and low quality of exported agricultural products. Bakari (2017a) employed VECM model to examine the influence of vegetables exports on economic growth in Tunisia over the period of 1970-2015. He concluded that vegetables exports have a positive effect on economic growth in the long run and in the short run. In the same context of the impact of agricultural product exports in Tunisia, Bakari (2017b) investigated the impact of olive oil exports on economic growth; he found that olive oil exports have a positive incidence on Tunisian economic growth in the long term and in the short run. Still in the same context, Bakari (2018) examined the effect of citrus exports on economic growth over the period of 1970-2016, and he established that citrus exports have a positive but insignificant effect on economic growth in the long term.

Ahmed and Sallam (2018) employed the ECM model and generalized autoregressive conditional heteroskedasticity (GARCH) models to study the relationship between agricultural exports and economic growth during the period of 1970-2013. Their outcomes displayed a positive connection amongst agricultural exports and economic growth in both long and short terms.

Bakari and Mabrouki (2018) employed the fixed effect to analyse the link amongst agricultural trade (agricultural exports, and agricultural imports), gross fixed capital formation, and economic growth (GDP) in 4 North Africa countries during the period 1982-2016. They established that all exogenous variables have a positive influence on economic growth, except the agricultural import which had a significant sign, so an increase by 1% in the agricultural exports may upsurge the level of GDP by 0.21%. These outcomes showed that such countries need to encourage the development and the investments in the agricultural sector to cover the value of imports (especially manufactural imports).

Therefore, from these investigations, we can summarise that the export in the agriculture in most Africa countries has a positive and a major influence on the development of Africa economic growth. Also, we saw that the agriculture import has a positive effect, but most authors do not focus on this variable in their investigations.

However, there are some studies that do not support the hypothesis of agricultural export-led growth and some researchers denote that the agricultural export does not have a robust relationship for fostering economic growth. Marshall et al. (1988) showed in their findings that they do not support the hypothesis of agricultural exports-led growth in the developing countries. Faridi (2012) analysed the relationship between GDP, labour force participation, capital stock, agricultural exports, non-agricultural exports and inflation in Pakistan during the period of 1972-2008 with using VECM method. He showed that almost all exogenous variables have a positive and significant contribution on economic growth, but the agricultural exports had a negative and significant effect. In addition, they determined that there is bidirectional causality between non-agricultural exports and real GDP, but there is no causality between agricultural exports and GDP.

Furthermore, several authors analysed the connection amongst the agriculture and economic growth (Oyejide, 2004; Oji-Okoro, 2011; Olajide et al., 2012; Ishola et al., 2013; Ebere and Osundina, 2014) found that the agricultural output, government expenditure, foreign direct investment and GDP are positively and significantly related. However, they said that the agricultural sector in Nigeria still suffers from inadequate finance, and poor infrastructure. In addition, we can find the same deprived situation in almost all Africa countries. Also, there are other papers that were based on the direct connection between the agricultural sector and economic growth.

Chebbi and Lachaal (2007) investigated the relationship between agriculture sector and economic growth in Tunisia during the period of 1961-2005 with using cointegration methodology and VAR model. The variables were GDP index of agricultural sector in constant price, GDP index of manufacturing industry in constant price, GDP index of non-manufacturing industry in constant price, GDP index of transportation, tourism and telecommunication sector in constant price and GDP index of commerce and service sector in constant price. They established that there is a cointegration connection and they rejected the weak exogeneity test, meaning that agricultural growth can cause the growth of the non-agricultural sector, while the non-agriculture sectors can cause the growth of the agricultural. In the short-term, the agricultural sector had a small and a positive contribution on the growth of the other non-agricultural sectors in Tunisia's economy.

Awokuse (2009) employed the procedure of ARDL to study the connection among agricultural sector and economic growth for 15 developing and transition economies over the period of 1971-2006. The variables were real GDP growth, gross capital formation per worker, population as a proxy for labour, agricultural value added per worker, real exports, and inflation rate. They demonstrated that the agricultural sector impacts positively and significantly the economic growth in 10 countries examined.

Faycal and Ali (2016) analysed the influence of the government support of the agricultural sector on economic growth in Algeria during the period of 1970-2014 with using ARDL methodology. The variables were GDP growth rate, added-value of the agricultural sector growth rate, added-value of the industrial sector growth rate, added-value of the agricultural sector (% of GDP), added-value of the industrial sector (% of GDP), food and nutrition imports (% total of imports), final expenditure in the agricultural sector and irrigation, dummy variable of support of the agricultural production and producers. They concluded that the support of the agricultural production and producers has a positive contribution on the agricultural growth, but in the long-run it has a negative effect. These findings determine that the policy of supporting in the agricultural sector allows a surplus in the production factors and it permits to keep the agricultural sector in Algeria. In addition, they showed that the total agricultural support regardless of its relationship with production and producers has a positive effect on agricultural production growth and economic growth in the long term.

Matthew and Ben (2016) employed the VAR model to investigate the influence of the agricultural sector and economic growth in Nigeria during the period of 1986-2014. The variables were per capita income, agricultural output and public agricultural expenditure. As result, they established that almost all variables were insignificant, meaning that there is no real effect of agriculture sector on economic growth, but with the impulse response and the variance decomposition, the authors said that the government should up its expenditure on the agricultural sector and to diversify the Nigeria's economy.

Ligon and Sadoulet (2018) used an unbalanced panel due to country-quantile and the interval between periods for the variables of expenditures and income to analyse the relative benefits of agricultural growth on the distribution of expenditures for 62 countries during the period of 1978-2011. They divided their study into two panels; the 1st panel was based on the expenditures, the share of total expenditure (%) and average annual growth rate in expenditures per capita. The 2nd panel was relied on income variable, per capita GDP, the average share of agriculture, average annual growth rates in value-added. They established that the growth in GDP from agriculture has a larger effect on the expenditures of the poorer than does growth in GDP from other sectors. Also, they established that the income growth from agriculture was disproportionately beneficial for the poorest households.

Getahun et al. (2018) aimed at studying the connection amongst investment in agriculture, food sectors, economic growth and food and nutrition insecurity for 44 African countries during the period of 1961-2014. They employed the methodology of panel cointegration and Granger causality to examine the variables of total factor productivity, share of employment in agriculture, the total gross output of crops and livestock, land, capital, machinery power, synthetic nitrogen/phosphorus/potassium fertilizers, policy variable, food production, undernourishment, global hunger index, institutional support and commitment index, budgetary commitment (share of government spending on agriculture), six governance indicators, GDP per capita growth, openness, the share of food and beverage imports, index of the share of the sum of imports and exports to GDP, R&D expenditures in the agriculture sector (number of wheel and crawler tractors), natural resources abundance as a share of GDP, the expenditure share of GDP in health, and education infrastructure development, the real agricultural output growth rate. They found that the agricultural growth, government commitment to the sector, progress in food and nutrition security and improvement in governance quality impact positively and significantly the economic growth with FMOLS model. The Granger causality result displayed that the agricultural growth, government commitment, and quality of governance Granger cause overall economic growth.

3. Data and methodology

Data

In this paper, we investigated the relationship between per capita gross domestic product, per capita agricultural raw materials exports, per capita agricultural raw materials imports, per capita agricultural value-added and labour force in agriculture sector for 30 African countries (Algeria, Benin, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Republic of the Congo, Rep., Egypt, Gabon, Ghana, Cote d'Ivoire, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Togo, Tunisia, Uganda, Zambia, and Zimbabwe) during the period of 1980-2017. The following table describes different variables employed in this study.

Table 1. *Variables definition*

Variables	Unites	Source of data
GDP: per capita gross domestic product	current US$	World Bank national accounts data, and OECD National Accounts data files.
AGRME: per capita agricultural raw materials exports	current US$	World Bank staff estimates through the WITS platform from the Comtrade database maintained by the United Nations Statistics Division.
AGRMI: per capita agricultural raw materials imports	current US$	World Bank staff estimates through the WITS platform from the Comtrade database maintained by the United Nations Statistics Division.
AGVA: Agriculture, forestry, and fishing, value added	current US$	World Bank national accounts data, and OECD National Accounts data files.
LF: employment in agriculture	Number of employment	International Labour Organization

Methodology

The supply side viewpoint is considered in the theoretical framework in order to inspect the role of the agricultural sector (value-added, exports and imports) to economic growth. We begin with the neo-classical growth model, originally developed by Solow (1956). The objective of this paper is to investigate how agriculture influences the economic growth. Therefore, we extend Solow's aggregate production by incorporating both agriculture variables and labour force as additional inputs with inflation as a control variable

We shall apply an estimate based on a production function that describes the situation of countries characterized by an open economy includes the exogenous variables (AGVA, AGRME, AGRMI, and LF). The basic model is written and modelled as follows:

$$GDP = Function\ (AGVA, AGRME, AGRMI, LF) \quad (1)$$

$$GDP_{it} = C + AGVA_{it}^{\beta 1} + AGRME_{it}^{\beta 2} + AGRMI_{it}^{\beta 3} + LF_{it}^{\beta 4} \quad (2)$$

We employ the natural logarithm specification, because the coefficient on the natural-log scare is directly interpretable as approximate proportional differences and as elasticity. This transformation has provided us with the following benefits, problems related to dynamic qualifications of the data set are avoided log-linear specification and it gives a more consistent and efficient empirical results (Gujarati et al., 2009; Sari Hassoun et al., 2019; Sari Hassoun and Ayad, 2020).

$$Ln\ (GDP_{it}) = Ln\ (C) + \beta_1\ Ln\ (AGVA_{it}) + \beta_2\ Ln\ (AGRME_{it}) +$$

$$+ \beta_3\ Ln\ (AGRMI_{it}) + \beta_4\ Ln\ (LF_{it)} + \mathcal{E}_{it} \quad (3)$$

$$Ln\ (GDP_{it}) = \beta_0 + \beta_1\ Ln\ (AGVA_{it}) + \beta_2\ Ln\ (AGRME_{it}) + \beta_3\ Ln\ (AGRMI_{it}) +$$

$$+ \beta_4\ Ln\ (LF_{it)} + \mathcal{E}_{it} \quad (4)$$

The augmented production function, including all variables is expressed in equation (2). The intercept or constant term (C or a_0) shows the level of technology employed in the country which is assumed to be constant. The returns to scale are associated with agriculture value-added (AGVA), agricultural exports (AGRME), agricultural import (AGRMI), and labour force (LF) which are shown by β_1, β_2 and β_3, and β_4 respectively.

In equation (3), we can show that all the variables are transformed into logarithms to create linear to the nonlinear form of Cobb-Douglas production. Finally, we retain the technology constant in the equation (4).

This study is carried out two panel models, a static panel data analysis under fixed or random effect model, which permits us to estimate coefficients in short-run and to model individual heterogeneity. In the fixed effect model, the estimation can be accomplished by MCO on a model corresponding to the divisions to the individual means. But, with the random effect model, the MCO estimator is not efficient, whereas the MCG estimator is good. To select between these two models, we will include the Hausman (1978) test, which is a test for the lack of correlation of specific effects and regresses.

On the other hand, we should use a panel cointegration model to display the long run estimation.

The 1st panel model can be written as follows:

$$\mathrm{LNGDP_{i,t}} = \mathrm{a_0} + \mathrm{a_{0i}} + \mathrm{a_1 LNAGRME_{i,t}} + \mathrm{a_2 LNAGRMI_{i,t}} + \mathrm{a_3 LNAGVA_{i,t}} + $$
$$+\mathrm{a_4 LNLF_{i,t}} + \varepsilon_{\mathrm{i,t}} \quad (5)$$

a_0 : Is the intercept term and it is identical for all cross-sections (individuals).

$a_{0\mathrm{i}}$: Defines the term of fixed effect for the countries (i).

However, if the relationship between the endogenous variable and the exogenous variables is not fixed, but random, the individual effect cannot be a fixed parameter ($a_{0\mathrm{i}}$), but a random one, thus in this case, we shall reformulate the equation with:

$$\varepsilon_{i,t} = a_{0\mathrm{i}} + \Delta_{\ t} + v_{i,t} \quad (6)$$

$a_{0\mathrm{i}}$: In this case, the term is random effect for the countries (i);

$\Delta_{\ t}$: Represents the temporal effect;

$v_{i,t}$: Designs the error term, which is orthogonal to cross-section and temporal effects

The 2nd panel model is formulated as follows:

$$\mathrm{LNGDP_{i,t}} = \mathrm{a_1 LNAGRME_{i,t}} + \mathrm{a_2 LNAGRMI_{i,t}} + \mathrm{a_3 LNAGVA_{i,t}} + $$
$$+\mathrm{a_4 LNLF_{i,t}} + \varepsilon_{\mathrm{i,t}} \quad (7)$$

$LNGDP_{i,t}$: Represents the variable of sustainable economic development or the economic growth or the income of the country (i) over the period of (t). Generally, it is the sum of gross value added by all resident producers in the economy plus any product taxes minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current US dollars.

$LNAGRME_{i,t}$: Defines the variable of agriculture export of the country (i) over the period of (t). Agricultural raw materials comprise crude materials, except fuels.

$LNAGRMI_{i,t}$: Is the variable of agriculture import of the country (i) over the period of (t). Agricultural raw materials comprise crude materials, except fuels.

$LNAGVA_{i,t}$: Signifies the variable of agriculture value-added of the country (i) over the period of (t). It includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC).

$LF_{i,t}$: Symbolises the number of workers or the labour force of the country (i) over the period of (t).

$\varepsilon_{i,t}$: Denotes the error term or the specified error of the country (i) over the period of (t).

This research is one of the rare studies that emphasize the connection between economic growth, and agriculture variables within a panel framework of 30 African countries. The objective is to inspect the link between (GDP), (AGRME), (AGRMI), (AGVA) and (LF). We started by testing the short-term panel model, whether it is influenced by a fixed or random effect with the Hausman (1978) test and then estimating the appropriate model.

Afterward, we shall try to estimate the long-run panel model with paying attention to the heterogeneity term, and following the panel cointegration methodology. We shall start with the panel unit root test to see whether the variables have the same order of integration, then we will test the existence of panel cointegration between variables, if there is a confirmation of the long run relationship, we can perform the panel model with Fully-Modified Ordinary Least Square (FMOLS), and Dynamic Ordinary Least Square (DOLS). Finally, we will test the panel Granger and Dumitrescu-Hurlin causality.

Panel unit root tests

The panel-based methods proposed by Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003), Augmented Dickey-Fuller-Fisher and Phillips-Perron-Fisher of Maddala and Wu (1999), and Breitung (2001) are employed in this research. For each variable, we tested for unit roots in the panel by using three types of models (one with constant and trend term, one with only constant term and one without constant and trend term).

Panel cointegration test

In this paper, we shall run the Westerlund (2007) panel cointegration tests; due to the panel cross-sectional dependence and when we have a time dimension greater than the cross-section dimension ($T > N$). And, we will confirm our results with the procedure of Pedroni (1999, 2004), because he uses 11 different tests that take into consideration the heterogeneity and its tests examine the dynamic relationship in the long-term.

4. Empirical result

The first panel model estimation

We used an estimation of pooled data to work with the standard error robustness of the estimator of within group, incomplete panel, and heterogeneous panel.

The Hausman test indicates 92.24*** and its probability is zero, denoting that we cannot accept the null hypothesis, rather we accept the alternative hypothesis at the level of 1%, thus this panel model can be estimated with a fixed-effect model.

Therefore, we estimate three panel models with fixed-effect described in the Table 2, and we found that the panel model with individual and temporal fixed-effect is the optimal model, due to the coefficient of Akaike, Schwarz and Hannan-Quinn criterion and the coefficient of Loglikehood.

Table 2. *The first panel model*

Models / Variables	Pooled model	Panel model with individual fixed-effect	Panel model with temporal fixed-effect	Panel model with individual and temporal fixed-effect
Intercept	2.55***	-1.926***	2.983***	4.122***
LNAGRME	-0.038***	0.014*	0.038***	0.010
LNAGRMI	0.419***	0.067***	0.426***	0.017
LNAGVA	0.776***	1.014***	0.693***	0.657***
LNLF	-0.025***	0.220***	-0.026***	-0.048*
AIC	1.390	-0.284	1.400	-0.846
SC	1.419	-0.086	1.580	-0.498
HQ	1.401	-0.208	1.469	-0.713
Loglikehood	-557.998	149.084	-536.376	402.923
R^2	0.780	0.961	0.792	0.979
F statistic	716.744***	591.208***	98.975***	609.218***
F probability	0	0	0	0
Hausman test	92.240***		Probability	0

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.

Source: Done on EViews 10.

The regression coefficient is (0.979), meaning that the four exogenous coefficients explain 97.9% of the model. The fisher coefficient is 609.218, indicating that we can't reject the alternative hypothesis at the level of 1%, so we can say that the model is statistically accepted.

The intercept term appears positive and significant at the level of 1%, demonstrating that there are some omitted variables or the variables that are not introduced in this model affect positively and significantly the African economic growth. In various investigations, the term of intercept signifies the technology advancement, thus we can say in this case that the machinery expansion and the novel knowledge in the agriculture sector will boost the elasticity of the economic growth by more than 4.

The two variables of economic openness relied to agriculture sector are positive, but insignificant, indicating that in the short term, the agriculture export and import are not efficient and they cannot supplement the level of the economic growth. Therefore, such countries are required to improve their foreign balance in the agriculture sector in order to achieve the two sustainable development goals, by having the food security as making food, crop and agriculture output available for population and reducing the level of poverty.

The sign of the agriculture value-added is positive and statically accepted at the level of 1%, showing that a rise by 1 unit in this variable improve the level of (LNGDP) elasticity by 0.657, signifying that the agriculture sector is supporting the African economic growth by providing extra food and labour, which lifts the level of the productivity and profitability of the non-agricultural sector. Not only does the agriculture increase the rate of the economic growth, but it diversifies the whole economic system of such African countries as well.

The sign of the labour force in the agriculture sector appears negative and insignificant, displaying that a rise by 1 unit in (LNLF) decreases the rate of (LNGDP) elasticity by 0.048, meaning that the number of workers in this domain has not the necessary skills and knowledge to enhance the level of the economic growth.

The result of the individual and temporal fixed-effect is presented in the Tables 3 and 4. The findings of the individual fixed-effect shows that 14 countries (Algeria, Benin, Cameron, Cape Verde, Republic of the Congo, Egypt, Gabon, Mauritius, Morocco, Senegal, South Africa, Tunisia, Zambia and Zimbabwe) have a positive effect, denoting that such countries are encouraging the achievement of the first and second target of the sustainable development, and they are directing their economic condition, but the 16 countries (Burkina Faso, Burundi, Central Africa, Ghana, Côte D'Ivoire, Kenya, Madagascar, Malawi, Mali, Mauritania, Niger, Nigeria, Rwanda, Sudan, Togo and Uganda) have a negative effect, meaning that they are still not working enough for the adoption of sustainable development. However, the outcomes of the temporal fixed-effect display that from 1991 to 2004, there was a negative influence, meaning that such countries did not focus on the development of the agriculture sector to improve their economic situation. But, since 2005, these African countries have worked to expanse their agriculture condition and then it started to have a real impact on their economic growth.

Table 3. *The individual fixed-effect estimation*

Countries	Cross-section fixed effects
Algeria	0.794
Benin	0.991
Burkina Faso	-0.651
Burundi	-0.997
Cameron	0.145
Cape Verde	0.462
Central Africa	-0.999
Republic of the Congo	0.747
Egypt	0.377
Gabon	1.256
Ghana	-0.413
Côte d'Ivoire	-0.168
Kenya	-0.329
Madagascar	-0.531
Malawi	-0.721
Mali	-0.644
Mauritania	-0.323
Mauritius	1.168
Morocco	0.452

Countries	Cross-section fixed effects
Niger	-0.844
Nigeria	-0.007
Rwanda	-0.704
Senegal	0.0849
South Africa	1.692
Sudan	-0.531
Togo	-0.756
Tunisia	0.671
Uganda	-0.574
Zambia	0.198
Zimbabwe	0.155

Source: Done on EViews 10.

Table 4. *The temporal fixed-effect estimation*

Countries	Period fixed effects
1991	-0.247
1992	-0.236
1993	-0.273
1994	-0.296
1995	-0.242
1996	-0.254
1997	-0.222
1998	-0.242
1999	-0.205
2000	-0.170
2001	-0.184
2002	-0.150
2003	-0.107
2004	-0.037
2005	0.017
2006	0.080
2007	0.150
2008	0.194
2009	0.180
2010	0.235
2011	0.289
2012	0.282
2013	0.310
2014	0.318
2015	0.271
2016	0.257
2017	0.281

Source: Done on EViews 10.

The result of the cross section dependence test developed by Breusch-Pagan (1980), Pesaran (2004) based on scaled LM and the other one based on the average of the pairwise correlation (CD), and Baltagi, Feng and Kao (2012) are displayed in the Table 5. The outcomes show that all tests rejected the null hypothesis, and accepted the alternative hypothesis for all variables, meaning that there is a spillover or a neighbouring effect between such countries, as they have the same socioeconomic situation.

Table 5. *Cross-Section Dependence Test*

Test	LNGDP	LNAGRME	LNAGRMI	LNAGVA	LNLF
Breusch-Pagan	8682.110***	2173.396***	2867.410***	5437.037***	8216.432***
Prob	0	0	0	0	0
Pesaran scaled LM	279.603***	58.937***	82.466***	169.584***	263.815***
Prob	0	0	0	0	0
Pesaran CD	92.016***	20.650***	35.045***	69.281***	52.554***
Prob	0	0	0	0	0
Baltagi, Feng and Kao	279.026***	58.360***	81.889***	169.008***	263.238***
Prob	0	0	0	0	0

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.
Source: Done on EViews 10.

The second panel model estimation

Panel unit root results

The findings of the panel unit root tests in the Tables 6, 7 and 8 shows that the variables are reported to be integrated on first difference I (1), so we can reject the null hypothesis at the level of 1% for all tests, rather we accept the alternative hypothesis. In the econometrics theory there are usually ambiguities between different outcomes, but in this case we can say that all variable are integrated at the same order. Consequently, we can perform the Pedroni and Westerlund cointegration test.

Table 6. *Panel unit root test with trend and intercept term*

Null hypothesis: the existence of unit root						
Variables		Methods				
		LLC (t-stat)	Breit (t-stat)	IPS (w-stat)	MW-ADF. F (χ^2)	MW-PP. F (χ^2)
Level	LNGDP	-1.98** (0.023)	-1.22 (0.889)	-2.56*** (0.005)	95.50*** (0.002)	60.66 (0.451)
	LNAGRME	9.29 (1)	2.39 (0.991)	-2.48*** (0.006)	84.48** (0.020)	80.16** (0.042)
	LNAGRMI	-3.49*** (0)	-3.65*** (0)	-5.22*** (0)	134.60*** (0)	118.32*** (0)
	LNAGVA	-2.26** (0.011)	-0.51 (0.301)	-2.65*** (0.003)	85.467** (0.017)	89.00*** (0.008)
	LNLF	-1.34* (0.089)	0.98 (0.837)	1.56 (0.941)	57.57 (0.564)	48.32 (0.860)
1st dif	LNGDP	-17.89*** (0)	-10.70*** (0)	-16.24*** (0)	326.59*** (0)	335.61*** (0)
	LNAGRME	-5.61*** (0)	-1.27 (0.101)	-21.28*** (0)	435.31*** (0)	996.94*** (0)
	LNAGRMI	-20.80*** (0)	-12.84*** (0)	-22.95*** (0)	484.25*** (0)	1346.18*** (0)
	LNAGVA	-17.16*** (0)	-7.23*** (0)	-15.99*** (0)	358.12*** (0)	535.73*** (0)
	LNLF	-7.75*** (0)	-0.72 (0.235)	-8.89*** (0)	232.50*** (0)	620.98*** (0)

Source: Done on EViews 10.

Table 7. *Panel unit root test with intercept term only*

Null hypothesis: the existence of unit root						
Variables		Methods				
		LLC (t-stat)	Breit (t-stat)	IPS (w-stat)	MW-ADF. F (χ^2)	MW-PP. F (χ^2)
Level	LNGDP	0.67 (0.748)	…	4.58 (1)	16.95 (1)	16.22 (1)
	LNAGRME	-1.88** (0.029)	…	-5.30*** (0)	127.29*** (0)	102.63*** (0)
	LNAGRMI	-2.76*** (0.002)	…	-3.02*** (0.001)	92.73*** (0.004)	94.35*** (0.003)
	LNAGVA	0.36 (0.640)	…	0.610 (0.729)	54.47 (0.677)	46.79 (0.893)
	LNLF	-0.14 (0.44)	…	3.24 (0.999)	51.20 (0.783)	90.21*** (0.007)
1st dif	LNGDP	-17.87*** (0)	…	-17.24*** (0)	376.90*** (0)	421.29*** (0)
	LNAGRME	-5.46*** (0)	…	-23.24*** (0)	514.56*** (0)	569.25*** (0)
	LNAGRMI	-24.69*** (0)	…	-25.74*** (0)	552.20*** (0)	593.65*** (0)
	LNAGVA	-22.52*** (0)	…	-20.41*** (0)	452.04*** (0)	517.31*** (0)
	LNLF	-10.30*** (0)	…	-11.82*** (0)	274.57*** (0)	285.23*** (0)

Source: Done on EViews 10.

Table 8. *Panel unit root test without trend and intercept term*

Null hypothesis: the existence of unit root						
Variables		Methods				
		LLC (t-stat)	Breit (t-stat)	IPS (w-stat)	MW-ADF. F (χ^2)	MW-PP. F (χ^2)
Level	LNGDP	6.09 (1)	…	…	8.46 (1)	6.81 (1)
	LNAGRME	3.41 (0.999)	…	…	55.88 (0.626)	57.48 (0.568)
	LNAGRMI	-0.05 (0.476)	…	…	67.92 (0.225)	68.37 (0.214)
	LNAGVA	2.57 (0.995)	…	…	17.65 (1)	15.33 (1)
	LNLF	16.87 (1)	…	…	22.12 (1)	15.26 (1)
1st dif	LNGDP	-21.86*** (0)	…	…	521.44*** (0)	558.98*** (0)
	LNAGRME	-0.84*** (0)	…	…	709.52*** (0)	796.97*** (0)
	LNAGRMI	-28.66*** (0)	…	…	722.51*** (0)	861.48*** (0)
	LNAGVA	-24.61*** (0)	…	…	596.21*** (0)	703.74*** (0)
	LNLF	-4.10*** (0)	…	…	224.01*** (0)	256.96*** (0)

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.

Source: Done on EViews 10.

Panel cointegration results

We employ the Stata command of Persyn and Westerlund (2008) to display the four error-correction-based panel cointegration tests and 11 panel cointegration of Pedroni. Our outcomes established that we cannot reject the null hypothesis, which indicate that there is no cointegration relationship between these variables. Therefore, we cannot perform a long run model as (FMOLS), or (DOLS).

Table 9. *Cointegration test with Westerlund*

Bootstrapping critical value under H_0: model with trend and intercept term				
Statistic	Value	Z-value	p-value	Robust P-value
Gt	-2.999**	0.815	0.208	0.040
Ga	-2.296	9.547	1	0.980
Pt	-7.534	6.863	1	0.470
Pa	-1.764	7.714	1	0.920
Bootstrapping critical value under H_0: model with intercept term only				
Statistic	Value	Z-value	p-value	Robust P-value
Gt	-2.150	1.693	0.955	0.170
Ga	-2.710	7.325	1	0.950
Pt	-8.253	3.244	0.999	0.370
Pa	-1.754	5.455	1	0.900
Bootstrapping critical value under H_0: model without trend and intercept term				
Statistic	Value	Z-value	p-value	Robust P-value
Gt	-1.872**	0.572	0.716	0.030
Ga	-2.206	5.910	1	0.870
Pt	-7.465	1.097	0.864	0.180
Pa	-1.522	3.440	1	0.580

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.

Source: Done on Stata 15.

Table 10. *Pedroni cointegration test*

		Tests	Statistic	Prob	Tests	Statistic	Prob
Panel model with trend and intercept	Pedroni (1999)	Panel v-stat	1.09	0.137	Group p-stat	3.98	1
		Panel rho-stat	2.97	0.998	Group pp- stat	-4.36***	0
		Panel PP-stat	-1.50*	0.065	Group ADF- stat	-4.00***	0
		Panel v-stat	-1.86**	0.031			
	Pedroni (2004)	Panel v-stat	0.80	0.211			
		Panel rho-stat	2.10	0.982			
		Panel PP-stat	-3.22**	0			
		Panel v-stat	-3.43***	0			
Panel model with only intercept	Pedroni (1999)	Panel v-stat	-1.28	0.899	Group p-stat	2.06	0.980
		Panel rho-stat	1.41	0.922	Group pp- stat	-3.63***	0
		Panel PP-stat	-1.48*	0.068	Group ADF- stat	-2.78***	0.002
		Panel v-stat	-1.21	0.111			
	Pedroni (2004)	Panel v-stat	-0.43	0.668			
		Panel rho-stat	0.38	0.648			
		Panel PP-stat	-3.44***	0			
		Panel v-stat	-2.97***	0.001			

		Tests	Statistic	Prob	Tests	Statistic	Prob
Panel model without trend and intercept	Pedroni (1999)	Panel v-stat	-2.23	0.987	Group p-stat	3.21	0.999
		Panel rho-stat	2.49	0.993	Group pp- stat	-0.55	0.289
		Panel PP-stat	0.77	0.782	Group ADF- stat	-0.39	0.345
		Panel v-stat	0.91	0.819			
	Pedroni (2004)	Panel v-stat	-2.06	0.980			
		Panel rho-stat	1.34	0.910			
		Panel PP-stat	-1.18	0.118			
		Panel v-stat	-0.97	0.163			

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.
Source: Done on EViews 10.

Panel Granger and Dumitrescu-Hurlin results

The previous result will not have a serious impact on the outcomes of two tests of panel causality. We began with defining the optimal lag model with vector autoregressive model, according to the final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ), it appears that the best model is with 3 lagged variables, so we ought to use it to test whether there is a panel causality between these variables. From Granger (1969) panel test, we established that there is bidirectional causality between AGRMI and AGRME, meaning that there is two-way effect among the importation and the exportation and any effect occur in one variable will have a serious impact on the other. Also, we found that there are five unidirectional causalities running from GDP to AGRMI, from AGRMI to LF, from GDP to AGVA, from AGVA and from GDP to LF, confirming some outcomes provided from the literature review. On the other hand, the results from the panel causality of Dumitrescu and Hurlin (2012), we established that there are eight homogenous bidirectional causalities, between AGRMI and AGRME, among GDP and AGRME, amongst LF and AGRME, between AGVA and AGRMI, among LF and AGRMI, amongst GDP and AGVA, between LF and AGVA and among LF and GDP. Besides, there are two unidirectional causalities, running from AGVA to AGRME and from GDP to AGRMI.

Table 11. *VAR lag order selection criteria*

Lag	FPE	AIC	SC	HQ
0	18.563	17.110	17.152	17.126
1	$8.93*10^{-8}$	-2.0421	-1.7930	-1.9444
2	$6.32*10^{-8}$	-2.3869	-1.9302*	-2.2078
3	$5.61*10^{-8}$	-2.5071*	-1.8429	-2.2467*
4	$5.85*10^{-8}$	-2.4644	-1.5926	-2.1226
5	$6.08*10^{-8}$	-2.4264	-1.3470	-2.0032
6	$6.05*10^{-8}$	-2.4323	-1.1454	-1.9278
7	$6.00*10^{-8}$	-2.4405	-0.9460	-1.8545
8	$6.37*10^{-8}$	-2.3819	-0.6798	-1.7145
9	$6.11*10^{-8}$	-2.4245	-0.5148	-1.6758
10	$6.14*10^{-8}$	-2.4196	-0.3024	-1.5895

* denotes the optimal lag model.
Source: Done on EViews 10.

Table 12. *Panel Granger Test*

Null hypothesis	Fisher statistic	Fisher statistic
AGRMI does not Granger cause AGRME	5.093***	0.001
AGRME does not Granger cause AGRMI	3.008**	0.029
AGVA does not Granger cause AGRME	0.764	0.514
AGRME does not Granger cause AGVA	0.252	0.859
GDP does not Granger cause AGRME	1.274	0.281
AGRME does not Granger cause GDP	1.281	0.279
LF does not Granger cause AGRME	0.295	0.828
AGRME does not Granger cause LF	0.073	0.974
AGVA does not Granger cause AGRMI	0.802	0.492
AGRMI does not Granger cause AGVA	1.167	0.321
GDP does not Granger cause AGRMI	5.113***	0.001
AGRMI does not Granger cause GDP	0.483	0.693
LF does not Granger cause AGRMI	0.644	0.586
AGRMI does not Granger cause LF	2.531*	0.056
GDP does not Granger cause AGVA	6.010***	0.0005
AGVA does not Granger cause GDP	1.066	0.362
LF does not Granger cause AGVA	1.799	0.145
AGVA does not Granger cause LF	3.743**	0.010
LF does not Granger cause GDP	2.076	0.102
GDP does not Granger cause LF	4.508***	0.003

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.

Source: Done on EViews 10.

Table 13. *Panel Dumitrescu-Hurlin Test*

Null hypothesis	W-stat	Zbar-stat	Prob.
AGRMI does not homogeneously cause AGRME	4.756**	2.274**	0.022
AGRME does not homogeneously cause AGRMI	5.487***	3.499***	0.0005
AGVA does not homogeneously cause AGRME	5.444***	3.427***	0.0006
AGRME does not homogeneously cause AGVA	4.335	1.569	0.116
GDP does not homogeneously cause AGRME	5.594***	3.678***	0.0002
AGRME does not homogeneously cause GDP	4.477*	1.805*	0.070
LF does not homogeneously cause AGRME	4.804**	2.354**	0.018
AGRME does not homogeneously cause LF	6.719***	5.565***	0
AGVA does not homogeneously cause AGRMI	4.384*	1.651*	0.098
AGRMI does not homogeneously cause AGVA	4.784**	2.322**	0.020
GDP does not homogeneously cause AGRMI	5.650***	3.773***	0.0002
AGRMI does not homogeneously cause GDP	3.948	0.921	0.356
LF does not homogeneously cause AGRMI	7.353***	6.629***	0
AGRMI does not homogeneously cause LF	4.945***	2.591***	0.009
GDP does not homogeneously cause AGVA	9.475***	10.187***	0
AGVA does not homogeneously cause GDP	6.737***	5.596***	0
LF does not homogeneously cause AGVA	8.087***	7.859***	0
AGVA does not homogeneously cause LF	4.949***	2.598***	0.009
LF does not homogeneously cause GDP	9.046***	9.467***	0
GDP does not homogeneously cause LF	5.397***	3.349***	0.0008

*, **, ***, denotes that we cannot accept the null hypothesis; rather we accept the alternative hypothesis at the level of 10%, 5%, and 1%.

Source: Done on EViews 10.

5. Conclusion

Nowadays, some developing countries see that the agricultural expansion is a prerequisite to industrialization and economic growth; other nations strongly disagree and claim for a dissimilar pathway. In spite of considerable discussion and qualitative inspection of the contribution of agriculture to economic growth and development, few empirical investigations on this issue exist. This study investigates the importance of the agriculture sector as an "engine of growth" by examining data for 30 African countries during the period 1980-2017 with using the methodology of panel model with individual and temporal fixed-effect and panel cointegration.

We confirmed with Pedroni and Westerlund tests that we have not a cointegration relationship between these variables; therefore we cannot estimate the long-run panel model. Thus, we estimated only the panel model with individual and temporal fixed-effect, and we found that the two variables of economic openness relied to agriculture sector are positive, but insignificant, demonstrating that an increase by 1 unit in export and import enhance the level of (LNGDP) by 0.010 and 0.017, respectively, while the variable of the agriculture value-added was positive and statically accepted at the level of 1%, showing that a rise by 1 unit in this variable improve the level of (LNGDP) elasticity by 0.657. The coefficient of the labour force in the agriculture sector appears negative and insignificant, displaying that a rise by 1 unit in (LNLF) decreases the rate of (LNGDP) elasticity by 0.048.

The outcomes of the individual fixed-effect shows that 14 out of 30 countries have a positive effect, so they inspire the adoption of the sustainable development goals, but 16 out 30 countries have a negative effect, so they are not encouraging the integration of (SDG). However, the outcomes of the temporal fixed-effect display that from 1991 to 2004, there was a negative influence, meaning that such countries did not focus on the development of the agriculture sector to improve their economic situation. But, since 2005, these African countries have worked to expanse their agriculture condition and then it started to have a real impact on their economic growth.

The result from the cross section dependence test display that we rejected the null hypothesis, and we accepted the alternative hypothesis for all variables, meaning that there is a spillover or a neighbouring effect between such countries, as they have the same socioeconomic situation.

The findings from the panel causality provides several confirmations of the positive relationship the agriculture sector and the economic growth factor, confirming that these African countries need to improve their agricultural situation to enhance the level of the economic growth and reach the socioeconomic satisfaction.

Conflict of interest

There is no competing interest regarding this manuscript.

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