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Intra-Africa agricultural trade, governance quality and agricultural total factor productivity: Evidence from a panel vector autoregressive model

Delphin Kamanda Espoir¹, Frank Bannor¹, and Regret Sunge²

Abstract

The African Continental Free Trade Area (AfCFTA) agreement was signed by at least 54 African countries and has the potential of lifting up to 30 million Africans out of extreme poverty, according to the World Bank (2020). The agricultural sector is regarded as a fertile ground for achieving the AfCFTA ambitions. However, agricultural productivity in Africa is low and falling. It is argued that intra-Africa trade and good governance can help increase agricultural productivity. Nonetheless, both are low, casting doubt on their ability to enhance agricultural productivity. This study attempts for the first time to examine the causal relationship between the intra-Africa agricultural trade, governance quality, and the agricultural total factor productivity (ATFP) for 47 countries over the period 1995–2018. We extend the analysis to regional economic communities (RECs) to understand the diversity in this relationship within the continent. Using the panel VAR model in the generalized method of moment (GMM) estimation approach, our results suggest a long-run equilibrium relationship between the three variables. Specifically, the results indicate that at the African level, intra-Africa agricultural trade has a statistically positive effect on governance quality and ATFP. In contrast, good governance has positive and negative impacts on ATFP and trade, respectively. We also find that ATFP positively influences intra-Africa agricultural trade and governance. At the RECs level, our estimations show significant heterogeneity in the three variables' impacts. Based on our findings, we recommend a rapid implementation of the AfCFTA agreement. However, we suggest that the implementation should be idiosyncratic to each region's structural economies. Furthermore, we encourage the promotion of good governance, particularly in agriculture policy implementation.

Keywords: Agricultural trade, agricultural total factor productivity, governance, PVAR

JEL codes: C23, G38, O47, Q17

1. Introduction

Trade, agriculture, and good governance are essential pillars of Africa's development. Current trade and economic growth and development initiatives in Africa are inclined towards the recent and historic African Continental Free Trade Area (AfCFTA). The agricultural sector is regarded as a fertile ground for the achievement of AfCFTA ambitions (Food and Agricultural Organization [FAO] & African Union Commission [AUC], 2021). Indeed, the International Food Policy Research Institute (IFPRI) considers advancing intra-African agricultural trade crucial in unlocking food insecurity and poverty in the region. This can be achieved by increasing incomes through job creation and agricultural value chains (Bouët & Odjo, 2019; Sandrey et al., 2018). A critical intermediate target of enhancing agricultural trade is to boost agricultural productivity (United-Nations, 2016). Nonetheless, the effectiveness of agricultural trade and growth in agricultural productivity is a function of good and inclusive governance (AUC & NEPAD, 2019; Fosu, 2018; Mbaku, 2020).

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Intra-Africa agricultural trade is linked to agricultural total factor productivity (ATFP) in many ways. It can allow the enlargement of existing markets, creation of new ones, thereby promoting new growth opportunities (Mukasa et al., 2017). Further, it insulates countries against global agricultural shocks (Sunge & Ngepah, 2020b) and internalises economies of scale within the continent (Rampa, 2012). Also, intra-regional agricultural trade, in the form of regional trade integration, removes technical inefficiency in agriculture, as regional trade costs are lower than otherwise (Sunge & Ngepah, 2019). In addition to intra-regional trade, good governance can also promote ATFP in many respects. Bates & Block (2013) submit that more competitive presidential elections have changed political incentives to benefit farmers. Also, the rule of law protects property rights in agriculture which safeguards agricultural investment (Lio & Liu, 2008), a key enabler of agricultural productivity growth.

Recognising the need to enhance intra-Africa trade, increase agricultural productivity, improve good governance, governments in Africa have put in place necessary policy frameworks. Notable is the historic AfCFTA, enforced on 01 January 2021 following the idea's inception through the Abuja Treaty of 1991. The AfCFTA is expected to deepen regional integration and help to remove trade barriers and frictions. FAO & AUC (2021) argues that AfCFTA will increase intra-Africa trade and unlock the potential contribution of agriculture to Africa's sustainable development. This is further enhanced by the Comprehensive Africa Agriculture Development Programme (CAADP) and the Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods (AAGTSPIL). These two outcomes of the Maputo (2003) and Malabo (2014) declarations are geared to increase investment in agriculture and increase agricultural productivity. Also, good governance forms aspiration 3 of the AUC Agenda 2063 (AUC, 2015). Despite all these policy efforts, the trends in intra-African trade, agricultural productivity, and governance are low.

Statistics from African Export-Import Bank (2018) reveal that in spite of the continent's overall trade growing at a rapid pace, intra-Africa trade is not only low but stagnant. For instance, in 2016, intra-African exports accounted for only 18% of the continent's overall exports compared to 59 and 69 percent for intra-Asian and intra-European exports, respectively (Sow, 2018). In 2018 and 2019, the ratio fell to 15%. The same goes for intra-African agricultural trade. According to Bouët & Odjo (2019), the ratio of intra-African agricultural trade has been trending below 20% in the past few decades. Elsewhere, in Asia and Europe, the shares are above 60% (FAO & AUC, 2021). The trends in ATFP are also a cause of concern. Data from the United States Department of Agriculture (USDA) (2021) show that while global ATFP increased from 1.184% between 1980 and 2000 to 1.65% for the period 2001-2016, sub-Saharan Africa (SSA) ATFP fell from 0.94% to 0.29%. According to the Global Harvest Initiative (GHI) (2018), global ATFP growth of 1.75% is required to feed about 10 billion people by 2050. With respect to governance, the African Peer Review Mechanism (APRM) & African Governance Architecture (AGA) (2019) reports that despite a general improvement in the state of governance in Africa, democracy and political governance remain poor. We argue that the three policy areas are vital in defining Africa's development going forward.

Regardless of the importance of the relationship among intra-Africa agricultural trade, governance quality, and ATFP, research connecting them is surprisingly scant. Our review of evidence on the trade-productivity nexus shows that some studies (Mahadevan, 2003; Pandey, 2009; Teweldemedhin & Van Schalkwyk (2010) examine the impact of total trade on agricultural productivity. Others (Dhehibi et al., 2018; Hassine et al., 2010; Hassine & Kandil, 2009; Hwang & Wang, 2004) offer evidence on the effect of agricultural trade. In these studies, the importance of intra-regional trade seems to have been neglected. At least Sunge & Ngepah (2020a, 2020b) provide evidence that intra-Africa agricultural trade positively affects ATFP. Nonetheless, with the enforcement of the AfCFTA,

the next important question that is still to be answered is that within Africa, in which region will agricultural trade provide higher-agricultural productivity effects.

While we find several studies (Bates & Block, 2013; Bayyurt et al., 2015; Lio & Liu, 2008; Sunge & Ngepah, 2020a, 2020b) on the governance-ATFP relationship, none provide evidence on the Regional Economic Communities (RECs) within Africa. Finally, on the governance-trade association, we also note that most studies (including Adewuyi & Olubiyi, 2020; Bonaglia et al., 2001; Khan, 2020; Kumari & Bharti, 2021; Pontet & Udvari, 2016) are based on aggregate trade data. This masks sectorial heterogeneities that are likely to exist. Studies on the impact of governance on agricultural trade are even more scarce (see Mendonça et al., 2014; Biswas & Kennedy, 2015), and we could not find one for Africa.

In the wake of the above, we make two contributions. To start with, we provide the first examination of the causal relationship between the intra-Africa agricultural trade, governance quality, and the agricultural total factor productivity (ATFP) in Africa. Further to that, we extend the analysis to regional economic communities (RECs). Our line of argument is that while efforts to harmonise economic and trade policy across the continent, the convergence can be limited by key factors. African regions are likely to remain heterogeneous in respect of environmental degradation (Espoir et al., 2021b) and governance (Aloui, 2019) which should not be ignored in analysing agricultural TFP determinants. This helps to uncover and understand the diversity that exists within the continent. By so doing, we are able to answer the question; in which region will agricultural trade provide higher-agricultural productivity effects? Lastly, we employ PVAR, a more robust econometric approach for analysis. It allows us to analyse interactions of several variables simultaneously, sometimes through Granger causality, variance decomposition, and impulse response analysis (Hayakawa, 2016). Second, it permits each variable in the model to be explained by its lags and the other variables' lagged values. Third, it can deal with unobserved individual heterogeneity. Fourth, using suitable instruments, the PVAR framework enables correcting the endogeneity of the dynamic panel model. Thus, the findings from such an econometric approach (PVAR) are expected to be reliable enough and robust in the sense that it minimises bias and the results yield valuable policy implications.

The layout of the rest of the sections is as follows: Section 2 presents a brief overview of the AfCFTA agreement. Section 3 provides the empirical literature on the relationship between the intra-regional agricultural trade and ATFP, governance and ATFP, and agricultural trade and governance. Section 4 discusses the data and empirical estimation. Section 5 presents and discuss the results, while Section 6 concludes and provides policy recommendations.

2. Overview of the African Continental Free Trade Area (AfCFTA)

Africa is the world's second biggest continent, behind Asia, with a surface area of 30.3 million square kilometers Kröner et al. (2020). Africa's nominal GDP was \$2.46 trillion in 2019 (UNstats, 2020), with a projected population of 1.31 billion, and a median age of 18 years (UNCTADstats, 2020). With a GDP per capita of \$1,882, Africa is the poorest continent in the world, and its population is the youngest of all the continents. In spite of the low concentration of wealth, Africa's prospects for economic development are bright. Africa is an important economic market in the global perspective because of its young population.

Increased trade through regionalism has been seen by independent experts and scholars as the universal solution to the continent's twin challenges of sluggish economic growth and poverty reduction

(African Development Bank, 2015). In this regard, the Lagos Plan of Action (1980) was prepared in by the then-organisation of African Unity, with the help of United Nations Economic Commission for Africa (UNECA), with the goal of establishing the African Economic Community (AEC). In preparation for the establishment of the AEC, the Abuja Treaty was signed in 1991, and the continent was split into five regional areas: north, south, east, west, and central Africa (Draper et al. 2007). The development of several regional economic communities (RECs)³ was intended to serve as nerve centers for the formation of the AEC by 2028. In 1991, African leaders committed to negotiate free trade agreements (FTAs) in each REC, followed by a customs union. This was envisaged to eventually result in a continent-wide customs union, with tariffs and quotas between members removed and a uniform external tariff created.

Given the foregoing, it was expected that trade among African countries should have far outperformed their current levels. However, that has not been the case. The African continent has been trading in significant volumes with the outside world (primarily the developed world), while intra-African trade has remained at a very low level compared to the continent's trade with the outside world (see Alemayehu, 2002).

Africa's overall goods trade grew rapidly, from \$558.9 billion in 2005 to more than \$1 trillion in 2012 (Afreximbank, 2018). However, by 2017, the continent's overall merchandise trade was valued at \$920 billion. Prior to 2011, the continent's merchandise exports typically outstripped its merchandise imports; but, from 2013 forward, merchandise imports have outstripped exports. African trade increased in lockstep with global trade, indicating a sustained tightening of global trade ties. However, in spite of the continent's overall trade growing at a rapid pace, intra-Africa trade has remained stagnant (Afreximbank, 2018). Intra-African exports accounted for only 18% of the continent's overall exports in 2016, compared to 59 and 69 percent for intra-Asian and intra-European exports, respectively (Sow, 2018). In 2019, intra-Africa trade amounted to 15% of overall trade in Africa, the same as in 2018. Intra-Africa trade has remained low over the previous 10 years, with the greatest percentages of 19% and 20% of overall trade been recorded in 2015 and 2016 (Trade law centre, 2019). The majority of intra-Africa trade takes place between countries that are members of the same regional economic community (REC), specifically between countries that are members of the REC's Free Trade Agreement (FTA) or Customs Union (CU).

The importance of intra-African trade cannot be understated. This has been demonstrated by the experience of countries such as Kenya, where increased intra-African trade intensity has protected the country against external shocks (Afreximbank, 2018). Some reasons for the very low level of intra-African trade have been shown to be the more difficult, expensive, and time-consuming nature of trade compared to trade in other parts of the world (Hartzenberg, 2011).

To boost the continent's growth rate and low level of intra-African trade, African leaders decided to implement initiatives such as the Tripartite Free Trade Area (TFTA) and most recently, the African Continental Free Trade Area (AfCFTA). In particular, the AfCFTA which is a historic step, more than 25 years after the Abuja Treaty, is intended to help African countries penetrate into new African markets. According to estimates from McKinsey Global Institute (2016), Africa's manufacturing output may nearly quadruple from \$500 billion in 2016 to \$930 billion in 2025. Three-quarters of this

³ The RECs regions for Africa are: East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA), the Southern African Development Community (SADC), and the Economic Community of West African States (ECOWAS).

may come from fulfilling domestic demand, mostly in the food, beverage, and other similar processed products. The AfCFTA has the potential to raise 30 million people out of acute poverty (1.5 percent of the continent's population) and 68 million people out of moderate poverty (World Bank, 2020). Data from the World Bank shows that 415 million people in Africa lived in severe poverty in 2015. Poverty rates vary greatly across the continent, ranging from 41.1 percent in Sub-Saharan Africa to less than 3 percent in North Africa (World Bank, 2020). Moreover, the World Bank (2020) estimates that with full implementation of the AfCFTA, the number of people living in poverty in West Africa would drop by 12 million, while the numbers in Central and East Africa would drop by 9.3 million and 4.8 million, respectively. AfCFTA has the potential to raise 67.9 million people out of poverty by 2035. This number represents 3.6 percent of the continent's population, at the poverty threshold of \$5.50 per day. A full implementation of the AfCFTA is expected to boost job possibilities and earnings for low-wage employees, as well as assist to reduce the wage gap between men and women.

A 2020 report by the Regional Strategic Analysis and Knowledge Support System (ReSAKSS) indicates that agricultural employment under AfCFTA is expected to increase in 60% of countries, and earnings for unskilled labor would grow faster when agricultural employment is increased. This would be a significant milestone because, despite its great agricultural potential, Africa continues to be a net importer of agricultural products. This is evident in the fact that over the last few years, agricultural value-added development has been sluggish in all African sub-regions. In 2018, the continent's agriculture growth rate was 2.9 percent, down from 4.5 percent in 2017 (ReSAKSS, 2020). Between 2017 and 2018, the biggest drop-in agriculture growth rate was in Southern Africa, which declined from 8.3 percent to 1.7 percent.

Furthermore, a report from FAO (2021) shows that, between 2015 and 2017, Africa's agricultural imports were over \$80 billion in nominal terms, more than doubling from \$39 billion in 2005–07. Intra-REC imports accounted for about 17% of total imports, a little rise from a decade ago (15 percent in 2005–2007). Agricultural imports increased in all RECs during the same time period. Basic commodities including grains, vegetable oils, sugar, meat, and dairy products have seen a significant growth in agricultural and food imports. The majority of imports come from outside the African region (e.g., wheat, sunflower oil and dairy products from Europe; rice and palm oil from Asia; maize, poultry and beef from Latin America). Within the same period, imports of sugar and sugar confectionery amounted to \$6.6 billion; imports of dairy products were \$4.6 billion; while imports of meat products amounted to \$4.5 billion (FAO, 2021). At the same time, about half of Africa's exports of vegetable oils are headed for African markets. However, this makes up only 13 percent of the region's imports (\$0.4 billion for palm oil, \$0.2 billion for soybean oil and \$0.1 billion for sunflower oil). Therefore, agricultural development through improving productivity is critical not just for poverty reduction but also ensuring food security. Maintaining agricultural output growth, and deepening intra-Africa trade is a prerequisite for reducing unemployment and alleviating rural poverty within Africa.

3. Empirical Literature

In this section, we review the existing evidence on three fronts. First, the relationship between intra-regional agricultural trade and ATFP. Second, we review the literature on governance quality and ATFP, and third, governance quality and agricultural trade.

3.1. Intra-regional agricultural trade and ATFP

Despite the global increase in regionalism, there is a dearth of studies examining the impact of intra-regional trade on variables of interest, particularly in Africa, let alone in agriculture. A few studies looked at the impact of intra-Africa trade on macroeconomic variables and competitiveness (Emeka,

2020), youth unemployment (Anyanwu, 2014), and human development (UNDP, 2011). With respect to agriculture, evidence is even thinner. Some studies have looked at the impact of aggregate trade on agricultural TFP (Mahadevan, 2003; Pandey, 2009; Teweldemedhin & Van Schalkwyk, 2010). Other studies (Dhehibi et al., 2018; Hassine et al., 2010; Hassine & Kandil, 2009; Hwang & Wang, 2004) offered evidence on the effect of agricultural trade. Nonetheless, these studies overlooked the impact of intra-Africa agricultural trade on productivity. Perhaps such evidence was not important then. However, following the effective implementation of the AfCFTA, analysing the effects of intra-Africa trade, particularly in agriculture, becomes more important. Close evidence is given by Sunge & Ngepah (2020a, 2020b).

In their analysis, Sunge & Ngepah (2020a, 2020b) use crop-based data (maize and rice) from 13 African countries from 2005-2016. Technical efficiency and agricultural TFP growth were computed from a quasi-trans log stochastic frontier production function and the Malmquist Data-Envelopment Analysis (DEA) approach. In the former study, it was established that the major RTAs⁴ in Africa helped to reduce technical inefficiency. Only SADC was found to have an insignificant impact. The result reflects the regional integration efforts that are increasingly focusing on agriculture. The regional blocks have set up specific programmes and policies to boost agriculture productivity in their member states. Using the dynamic fixed effects estimator, Sunge & Ngepah (2020b) compare the productivity impacts of intra and extra Africa agricultural trade. Their finding revealed that intra-Africa agricultural trade has positive and significant productivity effects, higher than extra Africa gains. The results from these studies show optimism towards the recently enforced AfCFTA. However, the next important question that is still to be answered is that within Africa, in which region will agricultural trade provide higher-agricultural productivity effects.

Our contribution in this study is to provide such an answer by disaggregating the agricultural productivity effects according to agricultural trade from four RECs regions in Africa (EAC, ECOWAS, COMESA, SADC). Our line of argument is that while efforts to harmonise economic and trade policy across the continent, convergence can be limited by vital factors. African regions are likely to remain heterogeneous in respect of climate regimes and environmental degradation (Espoir et al., 2021b) and governance (Aloui, 2019) which should not be ignored in analysing agricultural TFP determinants. Hence, we extend the analysis to regional economic communities.

3.2. Governance and ATFP

Lio & Liu (2008) study the relationship between governance and agricultural performance using panel data from three periods (1998, 2000, and 2002) from 127 countries. The study used two estimations for the analysis: an inter-country agricultural production function and the other on a structural equation model. Lio and Liu used a composite measure of governance, constructed as a rescaled mean value of the six governance indicators from World Bank Governance indicators,⁵. The estimations revealed that given the same production technology, agricultural production and productivity increases with better governance. We note that a partial productivity measure (agricultural output per worker) was used for the examination. The challenge with such a measure is that it ignores the contribution of other inputs. This can be quickly resolved by using a TFP measure.

⁴ East Economic Community (EAC), Economic Community of West African States (ECOWAS), Common Market for East and Southern Africa (COMESA), and the Southern African Development Community (SADC)

⁵ Voice and accountability, political stability, regulatory quality, the rule of law, control of corruption, and government effectiveness

Arguing from a political reform and policy perspective, Bates & Block (2013) show that governance enhances agricultural TFP growth in Africa. To measure the impact of political reforms also used two proxies of governance. First, it used the Executive Index of Electoral Competition (EIEC) suggested by Ferree & Singh (2002) and further developed by the World Bank. The index shows the degree of competition that characterises governments. Second, the Relative Rate of Assistance (RRA) derived from Anderson (2010) was used to reflect the government policy's inclination to or away from the agricultural and nonagricultural sectors. A difference in difference fixed effect estimation revealed that electoral competition increases agricultural output and TFP growth. The intuition is that governments elected through political competition are more likely to suggest favourable policies to farmers.

Sunge & Ngepah (2020a, 2020b) provide crop level (maize and rice) evidence supporting the conventional wisdom that good governance spurs agricultural TFP growth. Both studies used panel data from 13 countries for 2005–2016. In Sunge & Ngepah (2020a), maximum likelihood estimation of a true fixed-effects model indicates that better regulatory quality significantly reduces agricultural technical inefficiency. In the latter study, dynamic fixed effects estimation disclosed that the effect of government agricultural support on agricultural TFP growth is augmented by better governance. This was also confirmed by Lio & Lui (2008), who use the mean value of the six indicators as a proxy for governance.

Bayyurt et al. (2015) investigate the impact of governance on agricultural efficiency in 24 countries (23 European and Turkey) for 2003–2006. Efficiency scores and TFP change indices were obtained using the data envelopment analysis and Malmquist index techniques. At the same time, four indicators (voice and accountability control of corruption, government effectiveness, and regulatory quality together) proxied governance. Results from panel probit regression indicate that voice and accountability had a significant positive impact on agricultural efficiency. All the other governance indicators have insignificant though positive efficiency effects.

3.3. Agricultural Trade and Governance.

Several studies have assessed the relationship between governance and trade. The majority of them examined the effect of governance on trade outcomes (see Adewuyi & Olubiyi, 2020; Basedow & Kauffmann, 2016; Berden et al., 2014; Khan, 2020; Kumari & Bharti, 2021; Suntharalingam & Hassan, 2016). A few (see Bonaglia et al., 2001; Klautzer, 2013; Pontet & Udvari, 2016) looked at the reverse relationship. Also, these studies examine the relationship at the aggregate trade level without paying attention to sectoral trade. Examining the relationship at the sectoral level is important for unearthing sectorial heterogeneity. It becomes even more critical for the agriculture sector. In most developing countries, agriculture is a politically sensitive sector with heavy government influence in domestic agriculture support processes (Sunge and Ngepah, 2020b).

We find evidence on the effect of institutions on agricultural trade from Mendonça et al. (2014) and Biswas & Kennedy (2015). Mendonça et al. (2014) estimated the gravity model as in Anderson & van Wincoop (2003, 2004) using data from 59 countries drawn across the globe from 2005 to 2010. The results revealed that institutional heterogeneity between countries has a negative and significant impact on agricultural trade. They elaborated that higher transaction costs between countries with different institutional systems are detrimental to agricultural trade. Biswas & Kennedy (2015) assessed the impact of e-governance on agricultural exports for 2003–2005. The study employed four econometric regressions- pooled and cross-sectional, OLS, and Instrumental Variable- on an augmented gravity model. The results established that better e-governance favorably affects agricultural exports after controlling for endogeneity.

4. Data and empirical estimation

4.1. Data and variable measurement

In this study, the empirical procedure starts by generating ATFP, agricultural trade, and governance index data. For ATFP, we employ two conventional methods. We first use the parametric estimation of the production function using the Cobb-Douglas production framework. We then calculate ATFP for each country as a Solow residual. We secondly employ data obtained through the non-parametric estimation of a Malmquist-Luenberger productivity index (MLPI) using the Data Envelopment Analysis (DEA) for robustness check of our findings. Further, we obtain an index of agricultural trade as the sum of agricultural exports and imports on the agricultural value-added. Finally, we apply the Principal Component Analysis (PCA) to construct a governance index for African countries.

4.1.1. Agriculture total factor productivity data

4.1.1.1. Growth Accounting method

Using the growth accounting approach, we follow the methodology implemented by Fuglie (2011) to generate ATFP data. We estimate a Cobb-Douglas production function for the entire sample of African countries. Let Y represents the agricultural output and X be a vector of inputs, with subscript t and i indicating time and country identifier, respectively. The Cobb-Douglas production function in logarithm form is as follows:

$$\ln Y_{i,t} = \ln A_{i,t} + \sum_{i=1}^n \vartheta_i \ln X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $A_{i,t}$'s are intercept terms that represent technology over time and across countries, and ϑ_i are production elasticities for n factor inputs. X is a vector of inputs, and ε is the stochastic error term.

The indices of $ATFP_{i,t}$ are provided by the changes over time in $A_{i,t}$. By taking the derivative of Eq. (1) with respect to time, we obtained the variables in terms of percentage changes as:

$$\frac{\partial \ln Y_{i,t}}{\partial t} = \frac{\partial \ln ATFP_{i,t}}{\partial t} + \sum_{i=1}^n \vartheta_i \frac{\partial \ln X_{i,t}}{\partial t} + \frac{\partial \varepsilon_t}{\partial t} \quad (2)$$

Due to the independence assumption on the random error term with mean zero and constant variance, the last expression of Eq. (1) is dropped, and we solved for $ATFP_{i,t}$ as:

$$ATFP_{i,t} = \dot{Y}_{i,t} - \sum_i \vartheta_i \dot{X}_{i,t} \quad (3)$$

where the dot above each variable represents its growth rate.

Fuglie (2011) shows that in the absence of input prices data and under certain economic assumptions, the elasticities ϑ_i 's could be considered and interpreted as cost-shares (the proportion of output that each input receives in payment for its services). As seen in Eq. (3), the growth in ATFP is obtained as the difference between the growth in aggregate agricultural output and growth in aggregate inputs. We use a two-step procedure to get the ATFP time-series data for the sample of African countries. First, we utilise Fixed Effects Instrumental Variable (FEIV) regression on Eq. (3) to get the inputs shares. In this regression, we employ the aggregate agricultural output as the dependent variable. For the independent variables, we use the agriculture labour force, fertilizer, land, farm machinery, and

livestock. Apart from accounting for factor heterogeneity across African countries, the FEIV regression allow us to control possible endogeneity. To correct the endogeneity, we use indexes of the global fertilizer prices, four lags of the independent variables, and the year dummies as instruments in the first stage regression.

4.1.1.2. The Malmquist-Luenberger productivity method

The Malmquist TFP index introduced by Malmquist (1953) and upgraded by Caves, Christensen, and Diewart (1982), requires no price information, acknowledges technical inefficiency, and allows the decomposition of TFP growth into technical efficiency, technical change, and scale efficiency (Coelli *et al.*, 2001). It is a technology-based, discrete-time index that uses output and input distance functions to construct the productivity growth index. The index measures how close a particular output level is to the output that could be obtained from the same level of inputs if production is technically efficient (Bjurek, 1996). Correspondingly, the input distance function measures the input vector minimal proportional contraction given an output vector. The Malmquist output distance functions using period t and s for a given technology are given by:

$$M_o^t(q_s, x_s, q_t, x_t) = \frac{d_o^t(q_t, x_t)}{d_o^t(q_s, x_s)} \text{ and } M_o^s(q_s, x_s, q_t, x_t) = \frac{d_o^s(q_s, x_s)}{d_o^s(q_t, x_t)} \quad (4)$$

M_o^t and M_o^s are output distance functions in period t and s respectively, q_s and q_t represent period s and t outputs, and x is a vector of inputs. s represents the base period. Given that technologies can define the productivity index in periods t and s , the Malmquist ATFP index could be presented as the geometric mean of the period t and s to avoid arbitrary selection between periods t and s . Thus, the output-oriented Malmquist ATFP index is presented as:

$$m_o = [m_o^t(q_s, x_s, q_t, x_t) m_o^s(q_s, x_s, q_t, x_t)]^{\frac{1}{2}}. \quad (5)$$

Similarly, the input distance functions using period t and s technology are given by:

$$m_i^t(q_s, x_s, q_t, x_t) = \frac{d_i^t(q_t, x_t)}{d_i^t(q_s, x_s)} \text{ and } m_i^s(q_s, x_s, q_t, x_t) = \frac{d_i^s(q_t, x_t)}{d_i^s(q_s, x_s)} \quad (6)$$

From Eq. (6), the input-oriented Malmquist TFP Index is given as:

$$m_i = [m_i^t(q_s, x_s, q_t, x_t) m_i^s(q_s, x_s, q_t, x_t)]^{\frac{1}{2}} \quad (7)$$

However, the Malmquist TFP index introduced by Malmquist (1953) has some shortcomings that cannot be ignored. One of those shortcomings is the complete omission of the undesirable output in determining the productivity index. Another measure called the Malmquist-Luenberger productivity index (MLPI) was introduced by Chung *et al.* (1997), which credits the reduction of undesirable outputs such as pollution. Suppose two adjacent periods, denoted as t and s , respectively. If we choose the direction to be $g = (O, y, -b)$, the output-oriented Malmquist-Luenberger productivity index with undesirable outputs could be defined as:

$$MLPI = \left[\frac{1 + D_r^s(x^s, y^s, b^s; g)}{1 + D_r^s(x^t, y^t, b^t; g)} X \frac{1 + D_r^t(x^s, y^s, b^s; g)}{1 + D_r^t(x^s, y^s, b^s; g)} \right]^{1/2} \quad (8)$$

As for the Malmquist index, we apply a geometric mean of a fraction-based MLPI in the base year s (first fraction) and t (second fraction), to avoid an arbitrary choice between base years (Wang and Du, 2021). Also, note that the MLPI indicates productivity improvements if the value is greater than one and productivity reduction if the value is less than one.

4.1.2. Agriculture trade and governance index

We construct an index of agricultural trade using agricultural exports and imports of various African countries. To get the agricultural trade index, we apply the following formula:

$$\text{TRADE: } \frac{(X+M)}{AVAD} \quad (9)$$

where X and M represent the agricultural exports and imports, respectively, and $AVAD$ denotes the agricultural value-added.

We also construct the governance index (GOVI) using the Principal Component Analysis (PCA). We employ the PCA to derive the principal index of six institutional quality indicators ((Political stability and absence of Violence (PV), Government effectiveness (GE), Control of Corruption (CC), Voice and Accountability (VA), Regulatory Quality (RQ), and the Rule of Law (RL)). In constructing the composite index of governance indicators, we first start by collecting the residuals from the regression of a particular composite index of the institutional quality (Espoir and Sunge, 2021). Then, the residuals obtained from each regression are aggregated through PCA. According to the literature, the PCA is a procedure that takes high dimension sets of indicators and transforms them into novel indices that capture information on a different dimension and are mutually uncorrelated (Akanbi, 2014). Then, to obtain an aggregated GOVI, the first eigenvectors (factor loadings) from the PCA could be employed as the required weights. Thus, the linear combination of the index was calculated as follows:

$$GOV_{i,t} = \phi_1 PV_{i,t} + \phi_2 GE_{i,t} + \phi_3 CC_{i,t} + \phi_4 VA_{i,t} + \phi_5 RQ_{i,t} + \phi_6 RL_{i,t} \quad (10)$$

where $\phi_1, \phi_2, \phi_3, \phi_4, \phi_5$ and ϕ_6 are the eigenvectors (factor loadings) obtained from the PCA and PV, GE, CC, VA, RQ and RL are subscriptions of the six indicators of governance.

4.2. Empirical model

This study employs a Panel Vector Autoregressive (PVAR) model in a Generalised Method of Moment (GMM) estimation framework to investigate the long-run effects between African countries' agricultural trade, governance quality, and agricultural total factor productivity (ATFP). The PVAR estimation framework is an extension of the standard VAR model introduced by Sims (1980). In this study, we opted for this framework because of its ability to analyse interactions of several variables simultaneously, sometimes through Granger causality and impulse response analysis (Hayakawa, 2016). Second, the PVAR framework allows each variable in the model to be explained by its lags and by the other variables' lagged values. Third, it gives a possibility to deal with unobserved individual heterogeneity. Fourth, using suitable instruments, the PVAR framework enables for correcting the endogeneity of the dynamic panel model. A comprehensive presentation of the PVAR framework is provided by Hayakawa (2016). The functional form is presented as:

$$\mathbf{y}_{i,t} = \mathbf{B}_1 \mathbf{y}_{i,t-1} + \mathbf{B}_2 \mathbf{y}_{i,t-2} + \dots + \mathbf{B}_k \mathbf{y}_{i,t-k} + \boldsymbol{\delta}_i + \boldsymbol{\varepsilon}_{i,t}, \quad (i = 1, \dots, N; t = 1, \dots, T) \quad (11)$$

where $\mathbf{y}_{i,t-q}$, ($q=0, \dots, k$), $\boldsymbol{\delta}_i$ and $\boldsymbol{\varepsilon}_{i,t}$ are $K \times 1$ vectors denoting the unobserved individual fixed effects and the stochastic error term, respectively. \mathbf{B}_r ($r=0, \dots, k$) are $K \times K$ coefficient matrices attached to the lagged variables $\mathbf{y}_{i,t-k}$ and k denotes the lag order (VAR order).

We consider the models in forward orthogonal deviations (FODs) as suggested by Arellano & Bover (1995) by applying the first difference transformation to remove the individual fixed effects ($\boldsymbol{\delta}_i$) in Eq. (11). This transformation provides the following representation:

$$\mathbf{y}_{i,t}^* = \mathbf{B}_1 \mathbf{y}_{i,t-1}^* + \mathbf{B}_2 \mathbf{y}_{i,t-2}^* + \dots + \mathbf{B}_k \mathbf{y}_{i,t-k}^* + \boldsymbol{\varepsilon}_{i,t}^*, \quad (i = 1, \dots, N; t = 1, \dots, T_1) \quad (12)$$

where $\mathbf{y}_{i,t-q}^* = c_t [\mathbf{y}_{i,t-q} - (\mathbf{y}_{i,t-q+1} + \mathbf{y}_{i,t-q+2} + \dots + \mathbf{y}_{i,T-q}) / (T-t)]$, ($q=0,1,2,\dots,k$)
 $\boldsymbol{\varepsilon}_{i,t}^* = c_t [\boldsymbol{\varepsilon}_{i,t} - (\boldsymbol{\varepsilon}_{i,t+1} + \boldsymbol{\varepsilon}_{i,t+2} + \dots + \boldsymbol{\varepsilon}_{i,T}) / (T-t)]$, with $c_t^2 = (T-t)(T-t+1)$.

According to Hayakawa (2016), the advantage of the transformation in Eq. (12) is that if the original error term $\boldsymbol{\varepsilon}_{i,t}$ is serially uncorrelated and homoscedastic, the transformed stochastic error term $\boldsymbol{\varepsilon}_{i,t}^*$ will inherit the same property. Hence, we specify an AR (1) PVAR model and it includes three variables: the log of agricultural total factor productivity (LnTFP), agricultural trade (LnTRADE), and governance indicator (LnGOVI). The three variables in a PVAR model are represented as:

$$\begin{aligned} \Delta \ln(TFP_{i,t}) = & \sum_{j=1}^q \beta_{11} \Delta \ln(TFP_{i,t-j}) + \sum_{j=1}^q \beta_{12} \Delta \ln(TRADE_{i,t-j}) \\ & + \sum_{j=1}^q \beta_{13} \Delta \ln(GOVI_{i,t-j}) + \varepsilon_1 \end{aligned} \quad (13)$$

$$\begin{aligned} \Delta \ln(TRADE_{i,t}) = & \sum_{j=1}^q \beta_{21} \Delta \ln(TRADE_{i,t-j}) + \sum_{j=1}^q \beta_{22} \Delta \ln(TFP_{i,t-j}) \\ & + \sum_{j=1}^q \beta_{23} \Delta \ln(GOVI_{i,t-j}) + \varepsilon_2 \end{aligned} \quad (14)$$

$$\begin{aligned} \Delta \ln(GOVI_{i,t}) = & \sum_{j=1}^q \beta_{31} \Delta \ln(GOVI_{i,t-j}) + \sum_{j=1}^q \beta_{32} \Delta \ln(TFP_{i,t-j}) \\ & + \sum_{j=1}^q \beta_{33} \Delta \ln(TRADE_{i,t-j}) + \varepsilon_3 \end{aligned} \quad (15)$$

We employ the GMM estimator to obtain consistent estimates of the parameter in Eq. (13) to (15). To study the presence/absence of the short-run causality among the three variables, we apply the Panel VAR Granger causality Wald tests (Abrigo & Love, 2016). Furthermore, we follow the framework provided by Abrigo & Love (2016) to estimate the forecast error variance decomposition (henceforth, FEVD) and impulse response function (henceforth, IRF).

5. Empirical results and discussion

5.1. ATFP and PCA results analysis

Given the uniqueness of this study, we start by presenting the estimated results of ATFP. Table 1 in Appendix presents the description and data source of the variables we use in our regressions. Table 2 presents the estimated coefficients of the agricultural production function for the entire sample. The first column of the estimates presents the results for the FEIV regression, while the second column of estimates displays the REIV regression results. As can be seen from this table, the results show a consistency in the sign of the variables' coefficients. However, we compute the ATFP indices for each country based on the FEIV estimates.

The use of FEIV estimates for calculating ATFP is justified by the result of the Hausman statistic, which rejects the REIV results (see Table 2). The Cropland estimated coefficient is 0.252 and livestock 0.501. These coefficients imply that a 1 percent increase in one of these inputs (holding other inputs constant) would increase aggregate output by about 0.3 and 0.5 percent, respectively. The elasticity on tractor machinery is considerably smaller—only 0.075. In other words, a 1 percent increase in tractor machinery would increase output only by 0.1 percent. Finally, the elasticities on fertilizers and labour are estimated around 0.233 and 0.346, respectively. These elasticities imply that a 1 percent increase in these inputs would raise aggregate outputs by 0.2 and 0.3 percent for fertilizers and agricultural labour, respectively.

Table 2: FEIV and REIV results of agricultural production function

Variables	FEIV results			REIV results		
	coefficient	std. dev	t-statistic	coefficient	std. dev	t-statistic
<i>Tractor machinery</i>	0.075***	0.015	4.81	0.048***	0.015	3.07
<i>Fertilizers</i>	0.233***	0.021	10.82	0.222***	0.021	10.55
<i>Crop Land</i>	0.252***	0.041	10.61	0.332***	0.027	11.92
<i>Livestocks</i>	0.501***	0.029	17.23	0.418***	0.028	14.63
<i>Labour</i>	0.346***	0.025	13.57	0.418***	0.023	17.47
Observations	1,787			532		
R-squared	0.731			1,787		
Housman test	77.54 [0.0000]					
VC matrix estimation ^a						

Note: standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1; p-values in square brackets.

^aWe used indexes of real global fertilizer, four lags of the independent variables, and the year dummies as instruments in the first stage IV regression.

As indicated earlier, we use the FEIV estimates to obtain country-level ATFP indices. Table 3 in the Appendix presents the full sample's aggregate and cross-country average indices of ATFP for the growth accounting and MLPI method over the 1996-2018. Looking at the results in Table 3, they indicate an average ATFP index of 99.82. To obtain the sample average growth rate, our calculated index is compared to the base of 100 in 1995. According to the growth accounting method, it is clear that in Africa, ATFP regressed by 0.18% over the entire period of 1995-2018. Our result is similar to that of Fuglie (2011) who reports that the agricultural TFP grew very slowly in SSA as a whole (only 0.2 percent per annum between 1961 and 1984).

While the growth accounting method presents negative productivity growth for the entire sample of African countries over the study period, the MLPI-DEA approach predicts positive growth rate (see Table 3). Specifically, we find an average index of 1.0019 (which correspond to 100, 19%), suggesting that, on average, ATFP grew by 0.19% over the entire period of 1996-2018. Figure 1 shows the trend of the average MLPI-DEA index in comparison to that of growth accounting method. As Figure 1 shows, there is moderate variance and correlation between the two. Furthermore, Table 4 presents the results of the Governance index (GOVI) variable. For this variable, we only consider the component that obtained an eigenvalue greater than one and those eigenvectors associated with variables whose factor loading exceeded 0.30 in absolute value. The analysis of these results revealed that one single factor (eigenvalue = 4.845) from the PCA entirely explains 80.7% of the total variance. Consequently, we retain only the first component for GOVI, as it retained approximately 80% of the variance of the initial data.

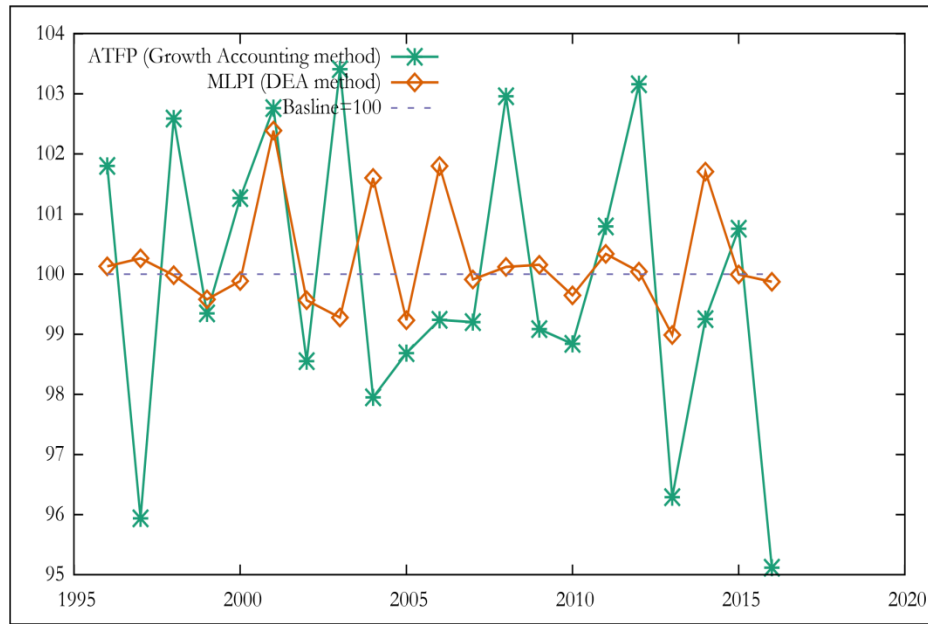


Figure 1: Trend of the average agriculture total factor productivity indices (growth accounting and MLPI-DEA method), 1995-2018. Source: Authors' own computations

Table 4: Principal component analysis results.

PCA results (Panel A)	Eigenvalue	Difference	Proportion	Cumulative
Components				
Component 1 / (Dimension 1)	4.845	4.433	0.807	0.807
Component 2 / (Dimension 2)	0.411	0.077	0.068	0.876
Component 3 / (Dimension 3)	0.334	0.089	0.055	0.931
Panel (B): PCA eigenvectors results				
Variable	Component 1	Component 2	Component 3	Unexplained
PV	0.371	0.871	-0.132	0.013
GE	0.424	-0.323	-0.273	0.060
CC	0.411	-0.111	-0.326	0.140
VA	0.386	-0.002	0.887	0.012
RQ	0.412	-0.350	0.014	0.126
RL	0.440	0.010	-0.113	0.055

Source: Authors' illustration from PCA results

5.2. Empirical testing

At the macroeconomic level of analysis, variables are usually characterised by cross-sectional dependence (CD) and non-stationarity. These two technical issues are known to affect the econometric analysis of panel data as they can lead to spurious outcomes. Several studies recommend using second-generation econometric methods to minimise bias and inaccurate results if the two issues are present in the data (Bersvendsen & Ditzen, 2021; Espoir & Ngepah, 2021; Espoir et al., 2021a; Espoir et al., 2021b). Testing for CD in panel dataset is now compulsory because the world economies have become more financially and economically integrated. Due to this integration, the econometric literature firmly concludes that panel datasets are likely to present significant CD (Pesaran, 2004). Thus, we start our empirical analysis by testing for CD of the variables using the semiparametric tests

proposed by Friedman (1937) and the residual-based cross-section dependence test developed by Pesaran (2004). These tests are developed to test the null hypothesis of cross-sectional independence and are relevant for finite and infinite samples. The results of the CD tests are shown in Table 5. We execute the two CD tests for the entire sample group and the regional economic communities (RECs) sub-samples (EAC, COMESA, SADC, and ECOWAS). Before we discuss the results of the CD test, we present in Figure 2 the geographical space for each of the four African RECs, and in Table 6, we list all the countries that are members of each REC.

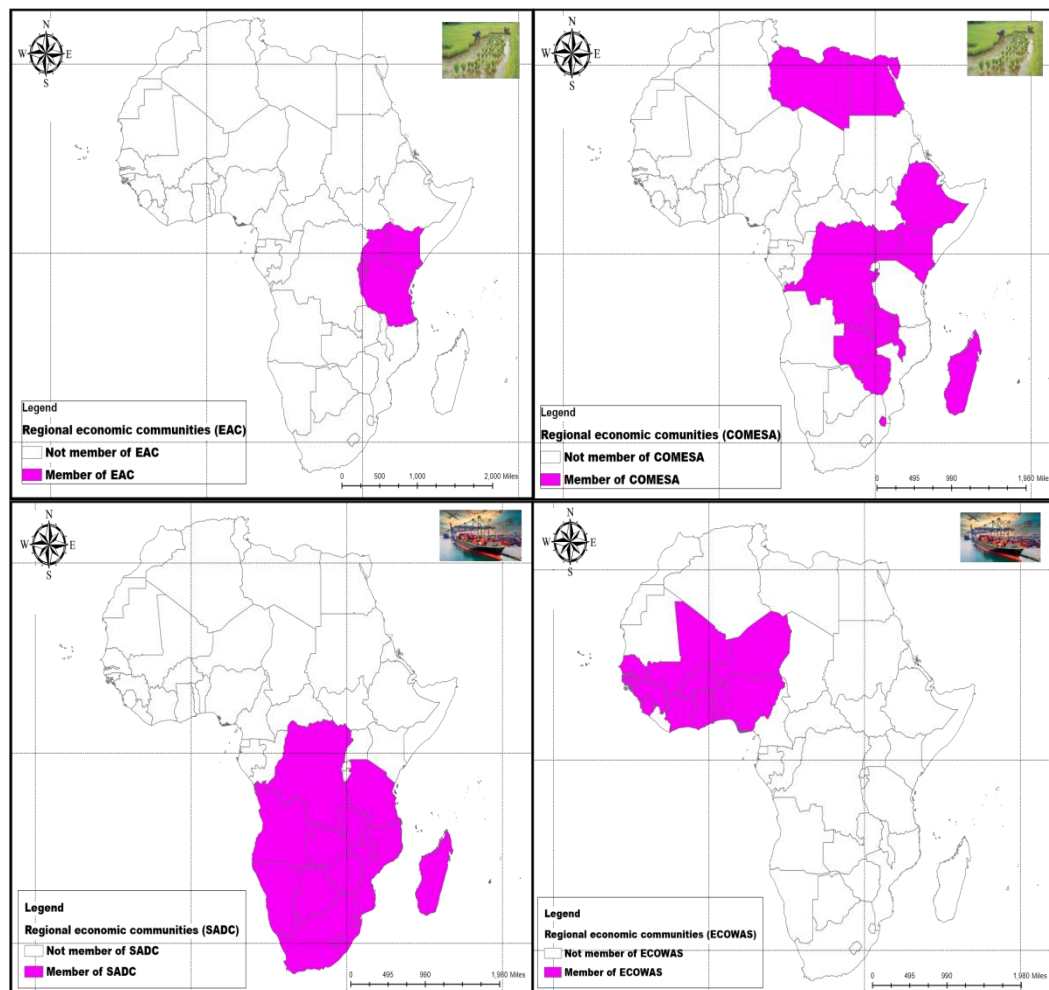


Figure 2: Geographical space of each of the African RECs regions. In the up-left is the geographical space of EAC, in the up-right is the geographical space of COMESA. Also, in the down-left side is the geographical space of SADC and in the down-right side is the geographical space of ECOWAS. Source: Authors' self-painting.

The results of the entire sample and those of RECs show the presence of CD for all variables, as the null hypothesis is strongly rejected at conventional levels of significance. Rejecting the null hypothesis implies that one of the second-generation panel unit root tests should offer more consistent inference (Espoir & Ngepah, 2021).

Given the positive evidence of CD in our panel data, we follow by applying a specific panel unit root test. Specifically, we use the cross-sectionally augmented IPS or CIPS panel unit root test suggested by Pesaran (2007). By allowing for cross-sectional dependence in testing for panel unit root, the CIPS

test augments the conventional Augmented Dickey-Fuller (ADF) regression with the cross-unit averages of lagged levels and first differences of the individual series. In so proceeding, the estimates are obtained for both the cross-country augmented ADF (CADF) statistics and for their simple averages.

Table 5: Cross-sectional dependence results

Test	Variables	A: Full sample	B: EAC	C: COMESA	D: SADC	E: ECOWAS
Pesaran	LnTFP	6.977*** (0.000)	0.909 (0.363)	6.358*** (0.000)	1.959** (0.005)	4.372*** (0.000)
	LnGOVI	20.407** (0.000)	4.607*** (0.000)	4.227*** (0.000)	5.225*** (0.000)	0.607 (0.543)
	LnTRADE	44.718*** (0.000)	6.620*** (0.000)	14.909*** (0.000)	10.187*** (0.000)	8.843*** (0.000)
Friedman	LnTFP	83.001*** (0.000)	29.799*** (0.000)	29.916*** (0.012)	42.215*** (0.000)	52.378*** (0.000)
	LnGOVI	17.988*** (0.000)	45.087*** (0.000)	15.481** (0.041)	18.056*** (0.000)	25.639*** (0.019)
	LnTRADE	328.478*** (0.000)	64.600*** (0.000)	132.368*** (0.000)	90.120*** (0.000)	81.012*** (0.000)

Note: the three stars “***”, “**”, and “*” indicates the rejection of H_0 : existence of cross-sectional independence at 1, 5 and 10% significance level.

The null hypothesis for the unit root test is that the variable is non-stationary. In our testing, we consider two different models: constant, and constant and trend. The results of the panel unit root test are presented in Table 7. As can be observed from this table, one cannot reject the null hypothesis of panel non-stationary for all the variables at the 10% level of significance, when all the variables are tested in their levels for the model with constant. However, for the model with constant and trend, it is clear that the null hypothesis is strongly rejected at the 1% level of significance. Moreover, after transforming all the variables into first difference, which is the first-order differencing, it is now clear for both models (constant, and constant and trend) that the null hypothesis is rejected at the 1% level of significance for all the variables. Accordingly, we concluded that all our variables are integrated of order one and that they could be noted as $I(1)$. The logical implication of this conclusion is that there could exist at least one long-run equilibrium relationship among the variables for the full sample, as well as for the RECs sub-samples. Thus, a need to test for panel cointegration.

To test for possible existence of a long run relationship, we use the cointegration tests developed by Westerlund (2007), which is an error-correction-based panel cointegration test. According to Hossfeld (2010), the Westerlund panel cointegration test is more robust as its account for structural breaks and cross-sectional dependence. The Westerlund test statistics (G_a , G_t , P_a , and P_t) assess if there is an error correction for individual panel units or for the entire panel. These statistics examine the null hypothesis of no cointegration. The G_a and G_t statistics assess whether cointegration is present at least in one panel units. The P_a and P_t statistics check if cointegration is present in the entire panel. In our testing, we obtain robust p-value using bootstrapping with 100 replications. The results are presented in Table 8. For the full sample, the results of the four statistics are statistically significant at the 1% significance level, suggesting the rejection of the null hypothesis. Moreover, the results of the RECs sub-samples also reject the null hypothesis at the 1% significance, except in ECOWAS where the null hypothesis is rejected at the 10% for the G_a statistic. Thus, the empirical characteristics of the variables we examine require estimation in first difference, as the variables are cointegrated in first difference. This is a sufficient condition that is required before estimating a PVAR model for this study.

Table 7: Pesaran (2007) CIPS panel unit root results

	A: Full sample		B: EAC		C: COMESA		D: SADC		E: ECOWAS	
At level										
Model include:	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & Trend	Constant	Constant & trend
LnTFP	-5.028***	-5.047***	-4.409***	-4.546***	-4.857***	-4.821***	-5.127***	-5.051***	-4.501***	-4.584***
LnGOVI	-1.741	-2.693**	-1.728	-2.913**	-1.515	-2.764**	-1.639	-2.818**	-1.787	-2.667*
LnTRADE	-2.442**	-2.756***	-2.069	-2.803*	-2.267**	-2.640*	-2.450***	-2.985***	-3.037***	-3.346***
At First Diff										
Δ LnTFP	-6.009***	-6.202***	-5.939***	-6.149***	-6.190***	-6.402***	-5.812***	-5.960***	-5.851***	-5.948***
Δ LnGOVI	-3.708***	-3.925***	-4.339***	-4.281***	-3.714***	-3.935***	-3.769***	-4.015***	-3.568***	-3.794***
Δ LnTRADE	-5.221***	-5.285***	-4.566***	-4.525***	-4.976***	-5.053***	-5.198***	-5.604***	-5.114***	-5.176***

Notes: (a) *, ** and *** denote variable statistically significant at the 1%, 5% and 10% level respectively. (b) The critical values of CIPS test at 10%, 5% and 1% levels of significance are -2.14, -2.25 and -2.45 for constant, and -2.66, -2.76 and -2.96 for constant plus trend, respectively. Source: authors' computations.

Table 8: Westerlund ECM panel cointegration test results

Statistic	Value	z-value	p-value
A: Full sample			
G_t	-3.004***	-7.291	0.000
G_a	-11.171***	-2.260	0.012
P_t	-28.295***	-15.907	0.000
P_a	-20.422***	-18.037	0.000
B: EAC			
G_t	-3.247***	-2.942	0.002
G_a	-16.813***	-2.741	0.003
P_t	-8.034***	-4.071	0.000
P_a	-17.930***	-4.825	0.000
C: COMESA			
G_t	-3.262***	-5.330	0.000
G_a	-13.231***	-2.618	0.004
P_t	-16.233***	-9.084	0.000
P_a	-20.770***	-10.663	0.000
D: SADC			
G_t	-3.909***	-8.142	0.000
G_a	-15.323***	-3.953	0.000
P_t	-18.783***	-11.554	0.000
P_a	-23.817***	-12.843	0.000
E: ECOWAS			
G_t	-2.896***	-3.498	0.000
G_a	-11.431*	-1.376	0.084
P_t	-11.721***	-5.143	0.000
P_a	-15.562***	-6.489	0.000

Note: The three stars “***”, “**”, and “*” indicates the rejection of H_0 : existence of cross-sectional independence at 1, 5 and 10% significance level. p-value are robust critical values obtained through bootstrapping with 100 replications.

5.3. PVAR results and discussion

In this subsection, we present and discuss the results of the estimation of the PVAR model as specified in Eq. (13) to (15). We use the GMM style option to obtain the estimates of the PVAR model. The first order PVAR results for the full sample are shown in Table 9. The test of over-identifying restriction (Hansen’s J chi2) is equal to 113.54033 ($p = 0.779$). This statistic confirms the goodness of the model, since the null hypothesis that the over-identifying restrictions are valid is verified. First, the results for the agricultural productivity equation reveal that the current agricultural productivity level is negatively correlated to its previous levels in Africa. Also, the results indicate that at 1% significance level, agricultural trade and governance quality are positively significant to ATRFP. This implies that a 1% increase in agricultural trade and governance quality will increase ATRFP in Africa as a whole by 0.12% and 0.01%, respectively. The policy implications of these results are to promote the intra-Africa free trade agreement on agricultural products and improve governance quality across countries in the continent. The result of the positive effect of governance quality on agricultural productivity is consistent with the findings of Lio & Liu (2008) and Bayyurt & Yilmaz (2012). These authors equally contend that better governance indirectly improves agricultural productivity by driving agricultural capital accumulation as well as foreign direct investment. Furthermore, the empirical result on governance quality lends support to the claim of Hayami & Ruttan (1985), indicating that governance is a basic factor explaining the poor economic performance of many developing countries.

Concerning the positive effect of agricultural trade, our finding is consistent with Sunge & Ngepah (2020a). These authors investigated the impact of agricultural trade liberalization on ATRFP growth in

Africa. They find that policies aiming at reducing trade-distorting agriculture support coupled with good governance significantly increases ATFP growth. They also contend that South–South trade productivity gains match and can surpass South-North Trade. Sunge & Ngepah (2020a) finding also lends support to increasing intra-Africa agriculture trade for sustainable ATFP and output growth.

Table 9: Results for the three-variable PVAR model (full-sample and economic regional grouping)

Variables	$\Delta \ln TFP_{(t)}$ (1)	$\Delta \ln TRADE_{(t)}$ (2)	$\Delta \ln GOVI_{(t)}$ (3)
A: Full Sample			
$\Delta \ln TFP_{(t-1)}$	-0.152*** (0.0274)	0.0570** (0.0282)	0.854*** (0.0526)
$\Delta \ln TRADE_{(t-1)}$	0.107*** (0.0120)	0.736*** (0.0190)	0.0597** (0.0241)
$\Delta \ln GOVI_{(t-1)}$	0.028*** (0.0240)	-0.102*** (0.0244)	0.685*** (0.0412)
B: EAC			
$\Delta \ln TFP_{(t-1)}$	1.663*** (0.1903)	-0.202 (0.1610)	-3.723*** (0.4394)
$\Delta \ln TRADE_{(t-1)}$	-1.540*** (0.4892)	0.630*** (0.1202)	2.654** (1.2057)
$\Delta \ln GOVI_{(t-1)}$	0.124*** (0.0357)	-0.034* (0.0182)	0.380*** (0.0813)
C: COMESA			
$\Delta \ln TFP_{(t-1)}$	0.964*** (0.0611)	-0.464*** (0.0401)	-3.673*** (0.2248)
$\Delta \ln TRADE_{(t-1)}$	0.032*** (0.0128)	0.694*** (0.0241)	-0.619*** (0.0467)
$\Delta \ln GOVI_{(t-1)}$	0.161*** (0.0213)	-0.204*** (0.0186)	0.370*** (0.0796)
D: SADC			
$\Delta \ln TFP_{(t-1)}$			
$\Delta \ln TRADE_{(t-1)}$	0.257*** (0.0567)	0.553*** (0.0899)	0.626*** (0.0587)
$\Delta \ln GOVI_{(t-1)}$	0.169*** (0.0112)	0.606*** (0.0269)	-0.176*** (0.0142)
$\Delta \ln GOVI_{(t-1)}$	0.126*** (0.0253)	-0.252*** (0.0429)	0.819*** (0.0497)
E: ECOWAS			
$\Delta \ln TFP_{(t-1)}$	-0.062** (0.0301)	0.022*** (0.0051)	-0.815*** (0.1340)
$\Delta \ln TRADE_{(t-1)}$	2.517*** (0.1494)	0.697*** (0.0394)	11.323*** (0.6408)
$\Delta \ln GOVI_{(t-1)}$	0.028*** (0.0147)	-0.004** (0.0018)	0.919*** (0.0565)
Observations	446	446	446

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Full sample: Hansen's J $\chi^2(126) = 113.54033$ (p = 0.779).

Second, for the agricultural trade equation, the results show that all three variables have a significant impact on the intra-Africa level of agricultural trade. Specifically, the results indicate that the current agricultural trade level is positively correlated to its previous levels. The estimated coefficient for the first lag of agricultural trade is 0.736 and is statistically significant at the 1% level. The estimated elasticity of ATFP on Trade is 0.0570 and is statistically significant at the 1% level. This implies that ATFP improvement enhances the intra-Africa agricultural trade. Finally, the results indicate that governance quality improvement reduces agricultural trade among African countries. This is observed with the negative estimated elasticity on the variable governance. Several studies have estimated a positive and significant effect of trade on growth (Goot et al., 2005; Mendonça et al., 2014). The positive effect of governance may hold in advanced countries but not necessarily in poorer resources countries like those of Africa. However, our results of the negative effect are in contradiction with the positive expected effect. One of the plausible explanations for this finding could reside in the fact that most African countries have low level of governance, which is characterised by political instability and violence, and most importantly corruption. A huge amount of trade flows across African countries passes through the bureaucratic system of corruption via trade tariffs. An improvement of the

bureaucratic quality constrains a significant volume of trade flows of stakeholders embodied into such a corruption system. A similar study on governance institutions and trade flows between Sub-Saharan Africa and its trading partners by the AERC (2020) reports similar findings. It shows that bureaucratic quality improvement in the resource-poor SSA produces negative and significant impacts on exports and imports of the SSA's countries.

Third, regarding the governance quality equation, as expected, the first lagged values of governance quality have positive and significant effects on the current value of governance at 1% level of significance. Specifically, we find a coefficient of 0.685, indicating that a 1% increase in historical norms of governance will increase the current governance quality by 0.7%. Moreover, as expected by the economic theory, we obtain evidence for significant positive effect of ATFP (the first lagged value) on the quality of governance. The estimated coefficient for this variable is 0.854, suggesting that a 1% increase in ATFP will enhance governance quality by about 0.9%. Finally, an increase in intra-Africa trade has a positive and significant effect on the quality of governance at the 1% level of significance level. We find that a 1% increase in intra-Africa Agricultural trade flow improves the quality of governance by about 0.06%. Although the effect of agricultural trade on governance is significant, its magnitude is very weak. This matches the negative effect of governance on agricultural trade.

Before we discuss the RECs results, we focus on evaluating the stability of the full sample's PVAR estimates. we perform the stability condition test of the estimated PVAR model in order to determine the validity and reliability of our results. Table 10 presents the stability condition results for the full sample and the four RECs. As a rule of thumb, each eigenvalue's modulus should completely be less than 1 for a regression to satisfy the condition of the eigenvalue stability test. However, our results are verified as the eigenvalues are strictly less than 1 (see Table 10). Moreover, we perform the same exercise using the root of the companion matrix (see Figure 3). Given that the eigenvalues for the full sample lie within the unit circle, this suggests that our full sample PVAR estimates have stationary roots (Abrigo & Love, 2016; Hamilton, 1994; Lutkepohl, 2005). Henceforth, our estimated PVAR model is valid, unbiased, and the results are reliable for interpretation and policy formulations.

Table 10: Eigenvalue stability condition

	Real	Imaginary	Modulus
A: Full sample			
1	0.733	0.123	0.743
2	0.733	-0.123	0.743
3	-0.196	0.000	0.196
B: EAC			
1	0.791	-0.322	0.854
2	0.791	0.322	0.854
3	0.465	0.000	0.465
C: COMESA			
1	0.628	0.631	0.890
2	0.628	-0.631	0.890
3	0.773	0.000	0.773
D: SADC			
1	0.894	0.000	0.894
2	0.785	0.000	0.785
3	-0.754	0.000	0.754
E: ECOWAS			
1	0.822	0.163	0.838
2	0.822	-0.163	0.838
3	-0.089	0.000	0.089

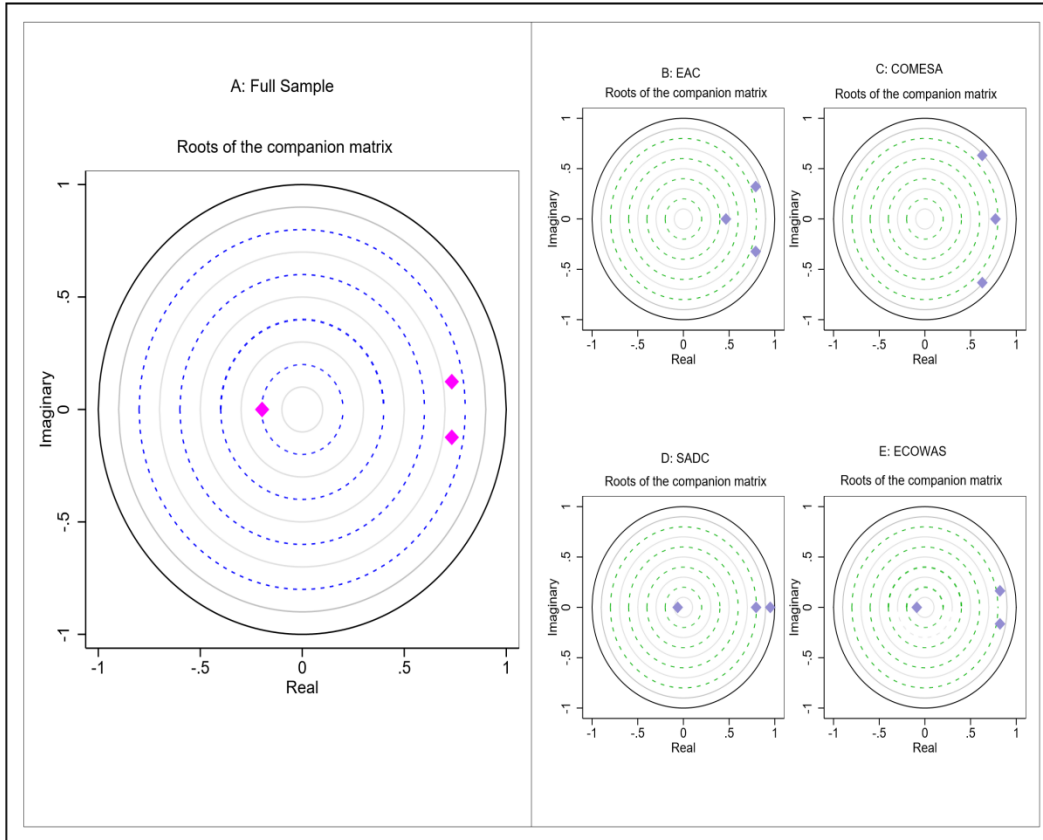


Figure 3: (A) Stability condition for the full sample, (B) Stability condition for East African Community (EAC) countries, (C) Stability condition for Common Market for Eastern and Southern Africa (COMESA) countries, (D) Stability condition for Southern African Development Community (SADC) countries. (E) Stability condition for Economic Community of West African States (ECOWAS). Source: Authors' own estimation based on PVAR results

The regressions of the agricultural productivity equation for the RECs reveal interesting results (see Table 9). First, they show that the current agricultural productivity level is positive and statistically correlated to its previous levels in EAC, COMESA, and SADC at 1% significance level, respectively. In ECOWAS, the results indicate a negative and statistically significant impact at 5% significance level. Concerning the effect of the agricultural trade and governance quality, the results indicate positive and statistically significant effects in all the four RECs. The only exception is the negative effect of the agricultural trade on the ATFP within the EAC region. Overall, the findings reveal that an increase in intra-Africa agricultural trade and governance quality within and between the RECs will enhance the ATFP in the continent. Additionally, the results indicate that the positive effect of the agricultural trade on ATFP is high in magnitude in ECOWAS than SADC and COMESA. This implies that SADC, COMESA and EAC countries still have rooms to improve their ATFP-Trade relationships through a successful implementation of the AfCFTA. Second, for the agricultural trade equation of the RECs, the results show that the current intra-Africa agricultural trade level is positive and statistically correlated to its previous levels in all the four RECs at 1% significance level. Moreover, the results of governance quality show a negative and statistically significant impact at the 1% level of significance. Finally, the results of the ATFP exhibit a positive and statistically significant effect in SADC and ECOWAS, a negative and significant effect in EAC, and a negative but not significant effect in COMESA. Third, for the governance quality equation, the results show that the current governance level is positive and statistically correlated to its previous levels in all the four RECs at 1%

significance level. Also, the agricultural trade results present a positive and statistically significant effect at the 1% level of significance in EAC and ECOWAS, while in COMESA and SADC the effect is negative. Finally, the results of ATFP show a negative and statistically significant effect in all the RECs, except for SADC where the effect is positive. In sum, the results for the RECs indicate that the intra-Africa trade and governance quality improve the ATFP in the African continent. Moreover, the increase in ATFP enhances trade, while governance improvement reduces trade. Also note that our RECs estimates are valid as they pass the stability condition (see Table 10 and Figure 3).

5.4. Panel causality, variance decomposition, and impulse response analysis results

After investigating the long run relationships, we turn our focus on examining the short-run causal relationships between agricultural trade, governance quality and ATFP. We also analyse the results of the variance decomposition and impulse response function. First, for the panel causality relationships analysis, we employ the PVAR Granger causality Wald test. As for the PVAR model, we analyse the causal relationships of the variables for the full sample as well as for the RECs. The results for this analysis are presented in Table 11.

Table 11: Panel VAR-Granger causality Wald test results

	Null hypothesis	χ^2 statistic	p -value	Relationship direction	Conclusion
A: Full sample					
1	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	79.862***	0.000	$\Delta L_n \text{TRADE} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{TRADE}$	4.076***	0.044		
2	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TFP}$	1.383	0.240	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	Unidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	263.242***	0.000		
3	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TRADE}$	17.400***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TRADE}$	Bidirectional causality
	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{GOVI}$	6.132***	0.013		
B: EAC					
1	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	9.907***	0.002	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	Unidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{TRADE}$	1.584	0.208		
2	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TFP}$	12.202***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	71.772***	0.000		
3	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TRADE}$	3.513*	0.061	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TRADE}$	Bidirectional causality
	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{GOVI}$	4.848***	0.028		
C: COMESA					
1	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	6.477***	0.011	$\Delta L_n \text{TRADE} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{TRADE}$	133.636***	0.000		
2	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TFP}$	56.755***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	266.877***	0.000		
3	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TRADE}$	119.760***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TRADE}$	Bidirectional causality
	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{GOVI}$	175.791***	0.000		
D: SADC					
1	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	227.373***	0.000	$\Delta L_n \text{TRADE} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{TRADE}$	37.900***	0.000		
2	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TFP}$	24.776***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	113.900***	0.000		
3	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	34.475***	0.000	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TRADE}$	Bidirectional causality
	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TRADE}$	153.605***	0.000		
E: ECOWAS					
1	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{TFP}$	283.743***	0.000	$\Delta L_n \text{TRADE} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{TRADE}$	18.877***	0.000		
2	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TFP}$	3.812**	0.051	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TFP}$	Bidirectional causality
	$\Delta L_n \text{TFP} \rightarrow \Delta L_n \text{GOVI}$	37.023***	0.000		
3	$\Delta L_n \text{GOVI} \rightarrow \Delta L_n \text{TRADE}$	5.532***	0.019	$\Delta L_n \text{GOVI} \leftrightarrow \Delta L_n \text{TRADE}$	Bidirectional causality
	$\Delta L_n \text{TRADE} \rightarrow \Delta L_n \text{GOVI}$	312.189***	0.000		

Note: The three stars “***”, “**”, and “*” indicates the rejection of H_0 at 1, 5 and 10% significance level.

For the full sample, they suggest strong evidence of a bidirectional causality between agricultural trade and ATFP, and a bidirectional causality between governance quality and agricultural trade. The results also suggest a unidirectional causality between ATFP and governance quality. The direction of the unidirectional causality runs from ATFP to governance quality. At the RECs level, the results of the causal relationships indicate a bidirectional causality between agricultural trade, governance quality, and ATFP. The only exception is within the EAC region where the regression results indicate a unidirectional relationship between the agricultural trade and ATFP. The unidirectional relationship runs from the agricultural trade to ATFP. Policy wise, the results of the causal relationships for the full sample suggest that, in the short run, government policies designed to stimulate and improve the ATFP should also take care of improving trade and governance policies. This is so as these variables move hand in hand with ATFP. This recommendation is also valid among the four RECs in Africa.

Moreover, we apply two additional methods to further explain the magnitude of the causal effects among the three variables of this study. The first is the forecast error variance decomposition (FEVD) and the second is the impulse response function (IRF) analysis of the unrestricted VAR estimation process using orthogonalised Cholesky ordering technique. While the FEVD technique determines the strength of the causal relationship among two variables (Shahbaz, 2012), on the other hand, the IRF determines the effect of a shock to a predictor variable on the predicted variable (Koop et al., 1996). In Table 12, we present the results of the variance decomposition of the three variables for the full sample and RECs. It is worth to note that this analysis is done for the short run (for 5 periods corresponding to the fourth of the study period) and for the long run (for 10 periods).

For the full sample group, panel 1, the response of agricultural trade (TRADE) to own shocks, in the short run, causes 0.925% fluctuations but 0.886% fluctuations in the long run to TRADE. Also, in the short run, shocks in governance quality (GOVI) and ATFP cause 0.0692% and 0.004% fluctuations in TRADE, respectively. In the long run, shocks in GOVI and TFP cause 0.103% and 0.009% variations in TRADE, respectively. This suggests that TRADE is very sensitive to shocks in GOVI when compared to changes in TFP in Africa. A similar interpretation holds for panel 2 and 3 for the full sample. For EAC, panel 4 indicates that the response of TRADE to its own shocks is about 0.594% of fluctuations in the short run, but 0.548% fluctuations in the long run. In the short run, shocks in GOVI and TFP cause 0.026% and 0.379% variations in TFP, respectively. On the other hand, in the long run, shocks in GOVI and TFP cause 0.0729% and 0.1318% variations in TRADE, respectively. As is in the full sample, a similar interpretation holds for panel 5 and 6 for EAC.

For COMESA, panel 7 show that the response of TRADE to its own shocks is about 0.480% of fluctuations in the short run, but 0.418% fluctuations in the long run. In the short run, shocks in GOVI and TFP cause 0.374% and 0.145% variations in TFP, respectively. On the other hand, in the long run, shocks in GOVI and TFP cause 0.343% and 0.238% variations in TRADE, respectively. Also, a similar interpretation holds for panel 8 and 9 for COMESA. For SADC, panel 10 shows that the response of TRADE to shocks in itself reveal that at both short run and long run (i.e., period 5 and 10), own shocks would cause 0.859 and 0.763% fluctuations in TRADE, respectively. In the short run, shocks in GOVI and TFP cause 0.087% and 0.052% variations in TFP, respectively. On the other hand, in the long run, shocks in GOVI and TFP cause 0.186% and 0.050% variations in TRADE, respectively. The same interpretation can be applied for panel 11 and 12 for SADC. Lastly, the results for ECOWAS reveal that, in panel 13, the response of TRADE to shocks in itself in both short run and long run (i.e., period 5 and 10), is 0.981 and 0.970% fluctuations in TRADE, respectively. In the short run, shocks in GOVI and TFP cause 0.008% and 0.010% variations in TFP, respectively.

Table 12: Forecast-error variance decomposition results

Response variable and forecast horizon	A: Full sample								
	Panel 1: Variance decomposition of TRADE (impulse variable)			Panel 2: Variance decomposition of GOVI (impulse variable)			Panel 3: Variance decomposition of LTFP (impulse variable)		
Period	TRADE	GOVI	TFP	TRADE	GOVI	TFP	TRADE	GOVI	TFP
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.006	0.993	0.000	0.021	0.000	0.978
2	0.985	0.013	0.001	0.005	0.897	0.097	0.053	0.003	0.943
3	0.965	0.032	0.001	0.013	0.880	0.105	0.060	0.003	0.936
4	0.944	0.052	0.002	0.023	0.865	0.110	0.065	0.003	0.930
5	0.925	0.069	0.004	0.033	0.854	0.112	0.068	0.003	0.927
6	0.911	0.082	0.006	0.040	0.846	0.112	0.069	0.003	0.926
7	0.900	0.091	0.007	0.046	0.840	0.112	0.070	0.004	0.925
8	0.893	0.098	0.008	0.050	0.836	0.112	0.071	0.004	0.924
9	0.889	0.101	0.009	0.053	0.834	0.112	0.071	0.005	0.924
10	0.886	0.103	0.009	0.054	0.833	0.112	0.071	0.005	0.924
B: EAC	Panel 4: Variance decomposition of TRADE (impulse variable)			Panel 5: Variance decomposition of GOVI (impulse variable)			Panel 6: Variance decomposition of LTFP (impulse variable)		
Period	TRADE	GOVI	TFP	TRADE	GOVI	TFP	TRADE	GOVI	TFP
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.444	0.555	0.000	0.470	0.223	0.306
2	0.810	0.017	0.172	0.535	0.314	0.149	0.525	0.152	0.322
3	0.689	0.025	0.285	0.557	0.191	0.251	0.547	0.108	0.343
4	0.627	0.027	0.345	0.563	0.128	0.308	0.555	0.081	0.362
5	0.594	0.026	0.379	0.563	0.092	0.344	0.557	0.063	0.378
6	0.576	0.024	0.399	0.562	0.070	0.367	0.557	0.051	0.391
7	0.564	0.021	0.413	0.560	0.055	0.384	0.556	0.042	0.401
8	0.557	0.019	0.423	0.558	0.045	0.396	0.554	0.035	0.410
9	0.552	0.017	0.430	0.555	0.037	0.406	0.552	0.029	0.417
10	0.548	0.015	0.436	0.553	0.031	0.414	0.550	0.025	0.423
C: COMESA	Panel 7: Variance decomposition of TRADE (impulse variable)			Panel 8: Variance decomposition of GOVI (impulse variable)			Panel 9: Variance decomposition of LTFP (impulse variable)		
Period	TRADE	GOVI	TFP	TRADE	GOVI	TFP	TRADE	GOVI	TFP
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.083	0.916	0.000	0.208	0.324	0.466
2	0.941	0.031	0.027	0.071	0.696	0.231	0.179	0.220	0.600
3	0.803	0.175	0.020	0.058	0.538	0.403	0.155	0.297	0.546
4	0.613	0.327	0.059	0.052	0.493	0.453	0.123	0.418	0.457
5	0.480	0.374	0.145	0.055	0.526	0.417	0.099	0.423	0.477
6	0.426	0.361	0.212	0.056	0.532	0.410	0.090	0.391	0.518
7	0.418	0.347	0.233	0.054	0.504	0.440	0.090	0.389	0.519
8	0.421	0.348	0.230	0.053	0.493	0.453	0.092	0.405	0.501
9	0.420	0.347	0.231	0.053	0.503	0.442	0.092	0.404	0.502
10	0.418	0.343	0.238	0.054	0.505	0.439	0.091	0.395	0.513
D: SADC	Panel 10: Variance decomposition of TRADE (impulse variable)			Panel 11: Variance decomposition of GOVI (impulse variable)			Panel 12: Variance decomposition of LTFP (impulse variable)		
Period	TRADE	GOVI	TFP	TRADE	GOVI	TFP	TRADE	GOVI	TFP
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.020	0.979	0.000	0.008	0.003	0.987
2	0.923	0.024	0.052	0.030	0.856	0.112	0.104	0.022	0.872
3	0.897	0.044	0.058	0.029	0.823	0.147	0.140	0.029	0.830
4	0.878	0.065	0.056	0.027	0.805	0.166	0.159	0.033	0.806
5	0.859	0.087	0.052	0.026	0.794	0.179	0.170	0.035	0.793
6	0.840	0.109	0.049	0.024	0.786	0.188	0.177	0.037	0.785
7	0.821	0.130	0.048	0.023	0.780	0.196	0.181	0.038	0.780
8	0.801	0.150	0.047	0.022	0.775	0.201	0.183	0.038	0.777
9	0.782	0.169	0.048	0.021	0.772	0.206	0.185	0.039	0.775
10	0.763	0.186	0.050	0.020	0.769	0.210	0.186	0.039	0.774

Table 12 (*continued*)

E: ECOWAS Period	Panel 13: Variance decomposition of TRADE (impulse variable)			Panel 14: Variance decomposition of GOVI (impulse variable)			Panel 15: Variance decomposition of LTFP (impulse variable)		
	TRADE	GOVI	TFP	TRADE	GOVI	TFP	TRADE	GOVI	TFP
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.219	0.780	0.020	0.023	0.027	0.949
2	0.994	0.001	0.005	0.572	0.407	0.013	0.314	0.022	0.663
3	0.990	0.002	0.007	0.711	0.275	0.009	0.416	0.020	0.563
4	0.985	0.005	0.009	0.784	0.206	0.006	0.468	0.018	0.513
5	0.981	0.008	0.010	0.826	0.166	0.005	0.494	0.017	0.487
6	0.977	0.011	0.010	0.851	0.142	0.004	0.507	0.017	0.475
7	0.974	0.013	0.011	0.868	0.126	0.004	0.513	0.017	0.469
8	0.972	0.015	0.011	0.878	0.117	0.004	0.515	0.017	0.467
9	0.971	0.017	0.011	0.884	0.110	0.004	0.515	0.017	0.466
10	0.970	0.018	0.011	0.888	0.107	0.004	0.515	0.017	0.466

On the other hand, in the long run, shocks in GOVI and TFP cause 0.018% and 0.011% variations in TRADE, respectively. This implies that TRADE is very sensitive to shocks in GOVI when compared to changes in TFP in ECOWAS region. The same interpretation can be applied for panel 14 and 15 for ECOWAS.

Next, we estimate the IRFs for the entire sample and the four RECs regions. Precisely, we focus our analysis on the IRFs of the three variables of interest for the full sample only⁶. The IRFs regression includes the confidence intervals represented by the lower and upper lines on the graphs in Figure 3. The lines in the middle are the actual response functions, showing the dynamics of the response of the one variable to shocks of the other variables. It is crucial to note that the IRFs enable the time-dependent significance of each response and provide information on the short-run dynamics of these impacts. We first start analysing the IRFs of the ATFP equation on the full sample data (see Figure 4, Panel A). The results show that the impact of one standard deviation shock in TRADE on ATFP was instantaneously positive but then negative from the third year up to year 10. The results also indicate that the maximum negative effect appears in the third year with a value close to -0.01. Overall, the impact of TRADE on ATFP is not very high. The effect declines rapidly, indicating that the contribution of TRADE to efficiently improving ATFP in the African countries is feeble. The weak impact of TRADE on ATFP in Africa as a whole is in line with our expectations. This is because most African countries' agricultural sectors are not well developed due mainly to several endogenous factors. Those factors include the lack of good resources allocation by governments to stimulate and increase agricultural productivity, insufficient agricultural infrastructures, chronic failure to mobilise investments required to materialize the agricultural plans and policies. Other factors are the failure to improve trade-related capacities for market access and reduce trade-distorting agriculture support and corruption ((New Partnership for Africa's Development (NEPAD), 2002; Sunge & Ngepah, 2020a). In addition, the financial sector is not well developed in the majority of African countries. Due to lack of collateral, small-scale farmers (representing more than 70% of the total agricultural output in Africa) do not get easy access to the internal financial system. This difficulty significantly impacts their farming activities. Thus, this constraint is often experienced in terms of low agricultural productivity and low-quality products, favoring much the South-North trade than the intra-Africa trade (Sunge and Ngepah, 2020b).

Moreover, the results indicate that the response of ATFP to one standard deviation shock in the GOVI was positively increasing up to 3 years. Then, it starts declining, and the positive impact of

⁶ We limit the analysis and interpretation of the IRFs results to the full sample. However, for RECs IRFs results, a similar interpretation is applied based on the findings in Figure 3.

shocks die completely around 10 years. Looking at the overall impact, the cumulative effect is positive suggesting that governance quality can be utilised as an effective policy tool to increase ATFP in the African continent. Thus, improving governance quality may help to increase ATFP and agricultural production in the short-term. This result is in line with some existing empirical findings confirming the fundamental role of governance quality in ATFP, agricultural output, and economic growth (Lio & Liu, 2008, Bayyurt & Yilmaz, 2012; Sunge & Ngepah, 2020a; Bah et al., 2021). It also supports the idea that improving the quality of governance is a crucial and an efficient way to attract foreign investment in the agricultural sector (Assa, 2018; Wako, 2021; Oduola; 2021).

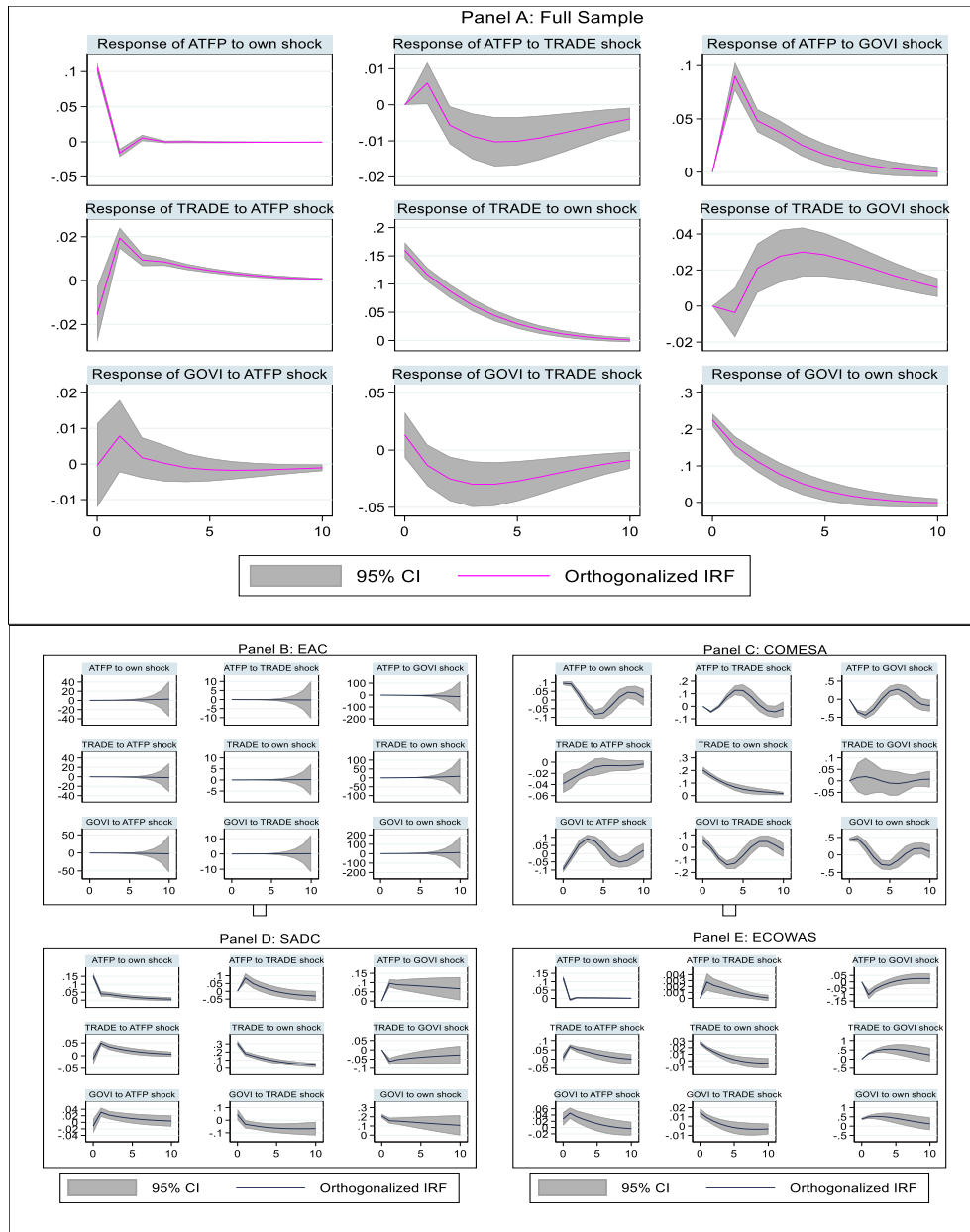


Figure 4: Panel (A) is the entire sample impulse responses, (B) East Africa countries (EAC) impulse responses, (C) Common Market for Eastern and Southern Africa (COMESA) impulse responses. (D) Southern African Development Community (SADC) impulse responses. (E) Economic Community of West African States (ECOWAS) impulse responses. To compute the IRFs, note that we use the Monte Carlo simulation, in which the parameters of the model are re-calculated 200 times using the estimated PVAR coefficients and their variance–covariance matrices as underlying distribution.

For the IRFs of the TRADE equation (see Figure 3, Panel A). The results show that the impact on TRADE as a result of one standard deviation shock to ATFP was positively increasing up to 2 years and start to decline for the rest of the period to become zero at 10 years. However, the declining impact of the ATFP on TRADE may be explained by the fact that Sub-Saharan Africa is the only region where agricultural labor productivity has not risen significantly over the past half-century (Fuglie, 2018). Thus, it is possible to argue that the low productivity growth has affected the overall agricultural production, which may adversely influence TRADE. Furthermore, the results indicate that the effect on TRADE as a result of one standard deviation shock to GOVI was negative up to 2 years. Then its start increasing from 2 to 5 years before declining to an estimate of 0.01 at 10 years.

For the quality of governance equation, the results indicate that the response of GOVI to one standard deviation shock in ATFP was positively increasing up to 2 years. Then, it starts declining, and the positive impact of shocks vanished progressively to reach zero around 10 years. Considering the overall effect, we conclude that the cumulative impact is zero, implying that ATFP plays no significant role in terms of improving the quality of governance in the African continent. Moreover, the results show that the impact on GOVI as a result of one standard deviation shock to TRADE was negatively decreasing up to 3 years and start to increase for the rest of the period to become zero at 10 years. Finally, the impact of GOVI to own shock was positive but decreasing over time and reach a zero effect at 10 years.

5.5. Robustness check

We assess whether our PVAR results are sensitive to another measure of ATFP. We calculate a MLPI using DEA. We then use this measure to check for robustness of the PVAR results in Table 9. It is crucial to mention that we limit our sensitivity analysis to data of the entire sample of 47 African countries due to space constraint. The results of this analysis are presented in Table 13. The estimation provides a test of over-identifying restriction (Hansen's J chi2) equal to 74.821 ($p = 0.967$). This statistic indicates the goodness of the model, since the null hypothesis that the over-identifying restrictions are valid is verified. Turning our attention to the estimates, first, the results for the ATFP equation reveal that the current agricultural productivity level is negatively correlated to its previous levels. The results show a statistically significant effect at the 1% significance level. Second, the results show that the agricultural trade and governance quality variables are positively significant to ATFP. This implies that a 1% increase in agricultural trade and governance quality will increase ATFP in Africa. This finding for the ATFP equation is similar to that in Table 9 in both the sign and significant of the estimates.

Table 13: Results for the three-variable PVAR model using MLPI-DEA data (full-sample)

Variables	$\Delta \ln TFP_{(t)}$	$\Delta \ln TRADE_{(t)}$	$\Delta \ln GOVI_{(t)}$
	(1)	(2)	(3)
$\Delta \ln TFP_{(t-1)}$	-0.249*** (0.00259)	9.099*** (0.0656)	4.139*** (0.0297)
$\Delta \ln TRADE_{(t-1)}$	0.00663*** (0.00104)	0.763*** (0.0381)	0.266*** (0.0215)
$\Delta \ln GOVI_{(t-1)}$	0.0121*** (0.00219)	-0.00274 (0.0210)	0.866*** (0.0270)
Observations	446	446	446

Standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Test of overidentifying restriction: Hansen's J chi2(99) = 74.82138 ($p = 0.967$)

Second, for the agricultural trade equation, the results indicate also that ATFP has a significant positive effect on the intra-Africa agricultural trade, while GOVI has a negative but insignificant effect. Third and finally, the GOVI equation results indicate that ATFP and GOVI have positive and statistically significant effects on government quality. These findings corroborate the results reported in Table 9.

6. Conclusion and policy recommendation

According to the World Bank Doing Business report, Africa is among the worst performing regions, as measured by the share of intra-African agricultural trade (FAO and AUC, 2021). The African Continental Free Trade Area (AfCFTA) is a critical step toward African economic integration and increased intra-African trade. Its objective is not only ambitious, but also far-reaching, since it aims to accelerate Africa's industrialisation and capitalize on vast possibilities in many industries by removing current tariff and non-tariff trade barriers, among other things. According to the World Bank (2013), Africa's agriculture and agribusiness sector may grow to USD 1 trillion by 2030 under AfCFTA. However, a crucial issue to be interrogated is, what will be the effects between African countries' agricultural trade, governance quality, and agricultural total factor productivity (ATFP) within the ambit of AfCFTA.

This study investigates the long-run effects between intra-Africa agricultural trade, governance quality and agricultural total factor productivity (ATFP). We do so by employing a panel vector autoregressive (PVAR) model in a Generalised Method of Moment (GMM) estimation framework. We use the PVAR estimation framework because of its ability to analyse interactions of several variables simultaneously and also provides the possibility to deal with unobserved individual heterogeneity.

The findings of this study are threefold. First, our results show that agricultural trade and governance quality have a positive and significant effect on agricultural total factor productivity (ATFP). These findings have policy implications for promoting the intra-African free trade agreement on agricultural goods and improving governance quality across the continent. Also, the results demonstrate that all three factors have a substantial influence on the intra-African level of agricultural trade in the agricultural trade equation. The findings show that the present level of agricultural trade is positively associated with past levels. This means that improving ATFP benefits intra-African agricultural trade. In terms of the governance quality equation, the initial lagged governance quality values have a positive and significant influence on the current value of governance. We also find evidence of a significant and positive influence of ATFP (the first lagged value) on governance quality. Finally, we find that an increase in intra-Africa trade has a favorable and substantial effect on governance quality.

The second unique feature of our study is that, we extend our analysis to regional economic communities (RECs) to understand the diversity that exists between agricultural trade, governance quality, and agricultural total factor productivity (ATFP) within the Africa region. Our findings demonstrate that present agricultural productivity in EAC, COMESA, and SADC is positive and statistically associated with past levels. However, within the ECOWAS bloc, our findings reveal a negative and statistically significant impact of current agricultural total factor productivity (ATFP) on past levels. In terms of the impact of agricultural trade and governance quality, our findings show positive and statistically significant effects in all four RECs. Overall, we conclude that an increase in intra-Africa agricultural trade and governance quality within and between the RECs will enhance agricultural total factor productivity (ATFP) in Africa. Furthermore, our findings show that the beneficial impact of agricultural trade on ATFP is greater in ECOWAS than in SADC, COMESA and EAC blocs. This means that a successful implementation of the AfCFTA still leaves opportunity for

SADC, COMESA, and EAC countries to strengthen their ATFP-Trade ties. More specifically, our results demonstrate that the present intra-Africa agricultural trade level is positive and statistically correlated to its past levels in all of the four RECs. Furthermore, governance quality has a negative and statistically significant effect on agricultural trade. Finally, the ATFP findings reveal a positive and statistically significant effect in SADC and ECOWAS, a negative and statistically significant effect in EAC, and a negative but not statistically significant effect in COMESA. Also, for governance quality, our findings demonstrate that present governance level in the four RECs is positive and statistically correlated with past levels. Agricultural trade also shows a positive and statistically significant effect in EAC and ECOWAS, but a negative effect in COMESA and SADC. Finally, agricultural productivity has a negative and statistically significant effect in all of the RECs, with the exception of SADC, where the effect is positive. We conclude that, intra-Africa trade and governance quality enhance ATFP throughout the African continent. However, a rise in ATFP improves trade, but improved governance lowers trade.

Subsequently, we assess the short-run causal relationships between agricultural trade, governance quality and ATFP. We find significant evidence of a bidirectional causation between agricultural trade and ATFP, as well as a bidirectional causality between governance quality and agricultural trade, throughout the full sample. The findings also point to a one-way causal relationship between ATFP and governance quality. ATFP to governance quality is the unidirectional causality's direction. Within the RECs, evidence of causal relationships shows a bidirectional causation between agricultural trade, governance quality, and ATFP. The EAC region is the sole exception, where we find evidence of a unidirectional relationship between the agricultural trade and ATFP. This relationship runs from agricultural trade to ATFP.

In terms of policy direction, we advise that given evidence of causal relationships within the full sample, government measures aimed at stimulating and enhancing the ATFP should also address trade and governance issues simultaneously. Concerning governance issues for example, we recommend that institutional bureaucracy with inherent problems such as corruption and political instability and violence should be addressed at the regional economic level where the negative consequences are primarily felt. By building trustworthy and dependable institutions, African countries may solve their structural inadequacies and complementary weaknesses. A regional integration strategy such as the Africa Continental Free Trade Area (AfCFTA) is going to be very crucial if the continent is to play its rightful role and maximize returns within the global trade arena.

Furthermore, we recommend a rapid implementation of the AfCFTA agreement. However, given the diversity in the relationship between the intra-African agricultural trade, good governance and ATFP across the African RECs regions, we suggest that the implementation of the AfCFTA should be idiosyncratic to each region's structural economies. This should enable to obtain the expected outcome based on each REC internal specialties. Also, we encourage the promotion of good governance, particularly in agriculture policy implementation. Finally, we recommend future research to specifically focus their attention to country-specific cases to capture more country-related issues in this relationship.

Appendix

Table 1: Data description and sources

Variables	Description	Source
Agricultural Value-Added Output	Agricultural Gross Production Value (constant 2014-2016 thousand US\$)	FAO Statistics
Farm Machinery	Number of 40-CV tractor-equivalents of farm machinery in use	FAO Statistics
Livestock	1000 head of cattle-equivalents by size (Hayami-Ruttan weights)	FAO Statistics
Agricultural Labour	1000 persons economically active in agriculture, 15+ yrs, male & female	FAO Statistics
Agricultural Land	Land used for the cultivation of crops and animal husbandry. The total of areas under "Cropland" and "Permanent meadows and pastures."	FAO Statistics
Fertilizers	Metric tonnes of N, P ₂ O ₅ , and K ₂ O nutrients for fertilizer consumption	FAO Statistics
Fertilizer Price Index	Global fertilizer price index measured relative to real prices in 2010 (where 2010 = 100)	Our World in Data
Agricultural Trade	(Agricultural exports + agricultural imports)/ Agriculture value-added, constant USD billions	ReSAKSS
Governance Index	Constructed using six indicators of governance: Political stability and Absence of Violence, Government effectiveness, Control of Corruption, Voice and Accountability, Regulatory Quality, and the Rule of Law	Authors
TFP Index	The Total Factor Productivity Change Index	Authors

Source: Authors' computation.

Table 3: Country-level ATFP (1995=100)

Country	Growth accounting		Country	Growth accounting	
	1996-2018	MLPI-DEA		1996-2018	MLPI-DEA
Benin	100	100	Seychelles	101	100
Burkina Faso	101	99	South Africa	102	100
Cabo Verde	99	100	Tanzania	100	99
Côte d'Ivoire	100	100	Zambia	101	100
Gambia	97	99	Zimbabwe	98	99
Ghana	101	100	Egypt	101	100
Guinea	98	99	Burundi	99	100
Guinea-Bissau	98	99	Rwanda	97	100
Mali	100	100	Libya	100	100
Niger	100	100	Chad	96	100
Nigeria	99	99	Tunisia	99	100
Senegal	102	102	Algeria	102	100
Sierra Leone	100	100	Morocco	101	100
Angola	98	99	Mauritania	98	100
Botswana	102	100	São Tomé and Príncipe	99	100
Comoros	98	100	Uganda	95	100
DRC	99	103	Equatorial Guinea	98	100
Eswatini	99	100	Kenya	97	100
Lesotho	100	104	Ethiopia	98	100
Madagascar	99	100	Gabon	98	100
Malawi	99	100	Cameroon	102	100
Mauritius	98	100	Congo Republic	98	100
Mozambique	100	100	CAR	97	100
Namibia	100	100	Full sample	99.82	100.19

Table 6: List of countries classified into regional economic communities (RECs)

EAC (5)	COMESA (16)	SADC (16)	ECOWAS (14)
Kenya	Burundi	Angola	Benin
Uganda	Rwanda	Botswana	Burkina Faso
Burundi	DRC	Comoros	Cabo Verde
Rwanda	Comoros	DRC	Côte d'Ivoire
Tanzania	Egypt	Eswatini	Gambia
	Ethiopia	Lesotho	Ghana
	Kenya	Madagascar	Guinea
	Libya	Malawi	Guinea-Bissau
	Madagascar	Mauritius	Mali
	Malawi	Mozambique	Niger
	Mauritius	Namibia	Nigeria
	Seychelles	Seychelles	Senegal
	Eswatini	South Africa	Sierra Leone
	Uganda	Tanzania	Togo
	Zambia	Zambia	
	Zimbabwe	Zimbabwe	

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Compliance with ethical standards

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