A Story on Intersectoral Linkages, Evidenced from West African Countries

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Abstract

The study reviews growth-development theories in a clear and explicit attempt to reassess the dynamism of the sectoral relationship and see if this relationship is empirically plausible in western Africa. This study examines the relationship between the agricultural and non-agricultural sector by modeling the dynamic link between these sectors. The result of the study reveals dynamic and positive sectoral relationship, justifying the necessary growth path for these economies. Variables such as unemployment, Trade openness, expenditure on education, contribute largely and positively to sectoral growth in West Africa.

Keywords: *Agricultural growth, Multiplier effect, Structural Transformation, Unbalanced growth.*

Batı Afrika Ülkelerinden Bulgularla Sektörler Arası Bağlantılar Üzerine Bir Hikaye

Öz

Çalışma sektörel ilişkinin dinamizmini yeniden değerlendirmek ve bu ilişkinin Afrika'nın batı kesiminde ampirik olarak makul olup olmadığını görmek için açık ve belirgin bir girişimle büyüme-kalkınma teorilerini gözden geçirmektedir. Batı Afrika ülkeleri için ülkeler arası verilerden yararlanan bu çalışma, tarımsal ve tarım dışı sektör arasındaki ilişkiyi, bu sektörler arasındaki dinamik bağlantıyı modelleyerek incelemektedir. Çalışma sonucunda elde edilen sonuç, dinamik ve pozitif bir sektörel ilişkiyi ortaya koyarak bu ekonomiler için gerekli büyüme yolunu ortaya koymaktadır. İşsizlik, ticarete açıklık, eğitim harcamaları vb. değişkenler sektörel büyümeye büyük ve olumlu katkı sağlamaktadır.

Anahtar Kelimeler: *Tarımsal büyüme, Çarpan etkisi, Yapısal Dönüşüm, Dengesiz büyüme.*

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Introduction

There is a wide swath of academic studies on the nature of growth, intersectoral interactions, and the spillover effects of growth, especially in development economics. The major conclusion always bothers down to the forward linkage understanding of growth. Many of these studies do not take into consideration the reverse linkage of growth—that growth can cause and can be caused—especially concerning sub-Saharan Africa (SSA). In addition, most developing economies are unbalanced economies[1] and, as a result, they mostly favor an unbalanced growth theory. This creates suspicion as to whether the forward-linkage growth model is indeed the best approach to development in Africa. Therefore, there is a need to understand the dynamics of growth in these SSA economies. Furthermore, it remains a debate on how reverse-growth models work, especially in a two-sector economy. Perhaps, understanding the nature and dynamics of reverse sectoral growth relationship is particularly important in achieving inclusive growth and economic development in the least developed economies.

Clearly, African growth models have largely been deficient along the lines of structural transformation[2]. It is even more difficult to gauge the degree and rate of structural transformation in Africa (McMillan et al., 2014). Although economic growth for most African country has been important for 15 years (African Development Bank, 2018), the structural transformation even for the best amongst these economies largely remain unclear. Economies with more diversified production and exports tend to have higher per capita income growth. As such, little can be accounted for in literature when it comes to structural transformation amongst African economies. Africa's share of manufacturing has decreased over the last decade. Africa accounts for (all of Africa, not just SSA) less than 1% of overall world manufacturing exports, and this has decreased slightly since 2010[3]. The dwindling share of manufacturing could suggest a similar pattern to deindustrialization in other areas of the world. Deindustrialization—reduced overall employment in manufacturing as a share of total employment—is a pattern that can be seen all over the world (Bigsten and Tengstam, 2012). Although agriculture remains the largest employer of labor and the mainstay of most African economies, the migration of labor from agriculture to other sectors—particularly the Service sector—of the economy as a precursor for growth is obvious. However, there is little agreement as to whether this has contributed to a rise in productivity and thus to structural transformation (McMillan et al., 2014). According to one point of view, instead of benefiting from manufacturing, labor, and other economic tools, Africa has moved from conventional agriculture to unregulated, low-productivity facilities in cities (Ndungu, 2021). This contrasts sharply with the growth of other developing economies that have reached the structural transformation phase in recent decades. The structural transitions in African countries resulted in lower productivity as labor migrated out of a weak, yet higher (in terms of productivity) agricultural sector, to a broad low-demand service sector (African Development Bank, 2018).

The current debate on the importance of the sectoral interrelation should bother on the reverse-link between the agricultural sector, manufacturing/industry, and the service sector, particularly in Africa. As expounded in the Comprehensive African Agricultural Development Agenda (CAADP), the agricultural sector's importance in the region is apparent in its contribution to overall GDP, which is generally large in the global sense. The strong contribution

[1] Unbalanced growth is a natural path of economic development it is a situation whereby countries at any one point in time reflect their previous investment decisions and development to a resource-realistic perspective. Thus, Investment in one sector is expected to stimulate the growth of another sector (Ellerman, 2004).

[2] a phase in which a largely agricultural economy transitions into a diversified manufacturing economy.

[3] Africa's share of global manufacturing fell from about 3% in 1970 to less than 2% in 2013 (Page, 2018).

of the agricultural sector to GDP also underscores the restricted diversification and dependency of most African economies on agriculture. On average, agriculture contributes 15 per cent of the overall GDP. Still, it varies from below 1.9 per cent in Botswana to more than 50 per cent in Sierra Leone (WDI, 2021), indicating a wide variety of economic systems. In addition, agriculture recruits more than half of the overall labor force (FAO, 2016) and provides livelihoods for many small-scale farmers within the rural community: over 580 million Africans rely on agriculture, a staggering 48 per cent of Africans (78 % in East Africa) derive their livelihood from agriculture (NEPAD, 2015). Undoubtedly agriculture is important in Africa; the question remains, could the agricultural sector be helped by the growth in other sectors?

In the last 30 years, the African agricultural sector has witnessed somewhat of a revamp. Its value has almost tripled (+160 per cent), demonstrating a rise that clearly beats the growth rate of world agricultural production across the same period (+100 per cent), almost equal to that of South America (+174 per cent) and below but equivalent to that of Asia (+212 per cent) (NEPAD, 2015)). Regardless, there is still more to be done; the economies of most African countries are characterized by weak industry, reliance on subsistence or semi-subsistence agricultural practices, and largely undiversified extractive industries incapable of creating employment and generating revenue. For this reason, it is argued that the next green revolution should commence in Africa. Africa should be the pioneer of a 'third industrial revolution' focused on overall ICT usage and decentralization of resources (EPRS, 2016). Therefore, it is in the interest of a greater majority of African economies—many of which are considered developing—to take on more progressive views regarding the transformation and diversification of their economies. A keyway to achieving this will be to understand the dynamics of the relationship between the African most productive sector (agriculture), and Africa's fastest growing sector (service), and the industrial sector. Transforming African economies should be premised on the nature of the relationship between the sectors. This is particularly important as the growth in one sector can spill over to another sector (s) thus facilitating structural transformation and inclusive development.

Intersectoral interaction is not new to development economists. Several studies[4] have been carried out to give very basic explanations for this interaction. According to (Subramaniam and Reed, 2009), the centrality of inter-sectoral relationships in promoting productivity is demonstrated in its role in influencing technological change and improving technical efficiency amongst economies. Traditionally, the (Harris et al., 1970) framework is used in analyzing a two-sector growth interaction model. However, the Harris–Todaro hypothesis incorporates another unknown, namely the unemployment rate. A paradigm under which the hypothesis is embodied in the model must be underpinned by the urban wage principle. Thankfully, however, the endogenous growth model has offered a new way of understanding intersectoral linkage and interactions. The major issue facing most developing countries (all 13 West African countries considered are developing countries) is understanding the nature of growth in agriculture, service, and industry, a how best to link them. If these sectors are interrelated to each other, then a concurrent plan to grow these sectors can then be hatched to make rapid economic growth achievable. As earlier described, to achieve economic development for developing economies like most African countries, it is imperative that the agricultural sector is of foremost consideration due to its importance to the livelihood of these economies. Thus, to proliferate economic growth, it is important to explore the influence West African agriculture has on West African non-agricultural sectors (and vice versa) and identify the best strategies to action on how to capitalize on these growths and promote the linkages between them. Accordingly, the main objective of the paper is to examine the inter-

[4] Contemporary literature such as (Imai et al., 2016b), , (Gollin, 2010), (Bosworth and Collins, 2008), (Ashok Gulati, Sheggen Fan, 2015), (Martin and

sectoral linkages between a two-sector model, that is agriculture, and non-agriculture (industry and services) in West Africa's economy and their implication on agriculture. The study verifies whether the advancement of the West African non-agricultural sector(s) contributes to the advancement of the agricultural sector and if the reverse is also valid for West African states. Despite the increase in literature favoring endogenous growth models, to the best of our understanding, a few growth studies (except for (Evert J. Los and Cornelis Gardebroek, 2015)) have been done to address the growing problems associated with the least developed economies as a collective entity of interest rather than a part of a larger global study, particularly SSA countries. This study addresses this gap by focusing on the West African endogenous growth model, and by investigating the dynamics and interaction between the traditional agricultural sector and the direct and resultant effects of these growths on West African economy(s). In the context of the empirical literature reviewed, the main objective of this paper is to examine the dynamic nature of the relationship between the agricultural and non-agricultural sectors and establish the linkages between these sectors (agriculture, and non-agriculture) in Africa using West African countries as a case study.

In the context of this article, growth is decomposed into agricultural and non-agricultural growth. Agricultural growth will mean any activity that qualifies as agricultural production. The non-agricultural sector is the aggregation of the industry and service sectors. This study is structured in such a way that each chapter addresses a specific heading: the first part is the introduction; the second part is the review of convergence and growth models; the third part addresses methodological review; the fourth part provides the result and discussion; the last part is the conclusion and policy recommendations.

Overview of intersectoral linkages

In the earlier part of the 19th century, agriculture's role in economic growth was usually considered an afterthought. The rule then, was to focus on an industry-led growth model. Rightly so because the industry was considered the backbone of any economy (Tiffin and Irz, 2006). However, the green evolution witnessed in Asia shifted the paradigm and resets the growth debate(s). This new paradigm meant that agriculture, which has served as the key driver of the Asian Green Revolution, is now being considered as a worthy alternative to or at the very least a complement to the growth models (Diao et al., 2007). The evidence from the Asian Green revolution suggests that in the context of development and growth, a greater emphasis must be placed on the agricultural sector. This ideology has diffused into developing African countries whose new development strategies seems to be challenging the premise of industrial-led growth models (Tiffin and Irz, 2006). The new shift in the development plan of many poor African countries favoring an agricultural-led growth model suggests a newfound belief in their respective agricultural sector.

Agricultural growth as necessary condition for growth

In the work of (Federico, 2005), agriculture perform three essential roles: factor role, product role, and market role. Each role is distinct and inter-related. For instance, the factor role implies the supply of inputs: manpower and capital to other sectors. The product role refers the output of the agricultural sector that satisfy the food demand of and earn foreign currency in form of export for the country. Lastly, the market role implies demand created by the agricultural sector for the product of non-agricultural sector.

Generally, most empirical studies can be categorized under these roles. Central to (Schultz, 1953) food problem theory is the agricultural product role. (Schultz, 1953) explained that underdevelopment in developing nations is because of the large percentage of the income and labor of the citizens of these countries spent on procuring food. This idea provides an insight into the causality between agriculture and economic growth, i.e., an increase in agricultural productivity is most likely associated with an increase in economic growth. The factor role of

agriculture as argued in the work of Tiffin and Irz, (2006) is such that there is dual labor mobility flow from the agricultural sector to other sectors of the economy. (Lewis, 1954) dual-sector model is the foundation of this assumption. (Adelman, 1984) hypothesis of an agricultural demand-led industrialization suggest that the income generated from higher agricultural productivity raises domestic demand for industrial product. Thus, this idea was further expounded upon by (Dethier and Effenberger, 2012), and is clearly attributed here as the market role of agricultural sector.

Agriculture led growth theory is not without criticisms. There are views that are rather agro-pessimistic which argues that agriculture is a relatively low productivity sector, and thus it is very uncertain whether simulating growth in the agricultural sector could lead to economic growth in a broad sense (Gollin, 2010). (Kiminori Matsuyama, 1992) questioned the premise of Schultz's food-problem hypothesis in a globalized view. He suggests that food scarcity—that prompt a large percentage of developing nation' citizen income and labor to be spent on food procurement—can be alleviated by importing food to meet the domestic demand. Schultz (1953) however expounded that importing food may be too costly for developing countries (Evert J. Los and Cornelis Gardebroek, 2016). With the intention to disparage the agricultural-led growth model, (Byerlee et al., 2005) suggests that resource rich developing countries can supply their resource to the international commodity market. Therefore, such countries can afford to depend on food import and will not need to modernize and develop their agricultural sector before a broad process of economic growth can commence. However, not every country is resource rich. Therefore, Bylere's view cannot hold true for every country.

Reverse role of economic growth on the agricultural sector

We now turn to literatures that explores the reverse impact of broad economic growth on agricultural growth. There are several arguments to state for agricultural sector benefiting from a broad economic growth sense. Advanced technology and inputs become more available from the service sector and may improve agricultural productivity (Evert and Gardeborek, 2016). Besides, the agricultural sector could also benefit from organizational innovation (known as capacity building and human development). Arguably, technological change is crucial to furthering development of the agricultural sector. (Gardner, 2003)'s findings from a study of 52 developing countries suggest that there is a significant positive interaction between the growth in the value added per agricultural worker and GDP per capital. However, his findings are short of explaining the role agriculture played in this interaction, i.e., is agriculture the major contributor towards this growth.(Tsakok and Gardner, 2007)'s analysis of on four different economies (United States of America, England, South Korea, and China) confirms that agricultural development is a necessary precondition for economic transformation.

Material and Method

Data

The data for the variables in the model were obtained from the databases of various institutions for the years 2007-2019. Detailed information about the data obtained from different institutions is given in Table 1.

The data were extracted from World Development Indicators (WDI) (2017). The data on education were extracted from World Bank data on education and literacy rate. The World Bank's World Governance Indicators (http://info.worldbank.org/governance/wgi/index.asp) was used for the establishment of institutional qualities proxy.

This research covered the period 2007-2019 for 16 West African Countries. Following (Christiaensen et al., 2011) and (Imai et al., 2016a). This analysis is based on two-year moving average data.

15 ECOWAS countries were included in the research, except for Mauritania, which is not a member country of Ecowas, but shares geographical proximity to other Ecowas

countries—hence is a West African Country. There are some cases of missing data for a few countries, hence the need for unbalanced panel data. Accordingly, two main groups, low-income, and French-speaking blocks countries were re-calibrated to satisfy the systems GMM N>T condition (Table 2).

Table 1: Databases of Variables

Variables	Explanation	Source
Agricultural, non-agricultural growth: Service and Industry	Agricultural per capita value added Non-agricultural: Service and Industry per capita value-added	World Development Indicators (WDI)
Share of Mining	Rent on mining as percentage of GDP	World Development Indicators (WDI)
Precipitation	Average rainfall (per year in mm)	climateknowledgeportal.worldbank.org
Temperature	Average annual temperature of country i	climateknowledgeportal.worldbank.org
Investment	Total investment (% of GDP)	World Development Indicators (WDI)
Education	Government expenditure on Education as a percentage of GDP; a measure that we find more intuitive as it covers key areas of educational spendings and research.	World Development Indicators (WDI)
Political Stability	It measures perceptions of Political Stability and Violence, No Terrorism, political instability, including terrorism, and/or the possibility of politically driven violence. The estimate allows the country to give a score in the standard normal distribution units on the total indicator, ie, from about -2.5 to 2.5.	World Bank's World Governance Indicators
Trade Openness	(X+M)/GDP: the sum of export and import averaged by the GDP of country i.	Authors' calculations; World Development Indicators (WDI)
Unemployment Rate	The unemployment rate of the country i.	World Development Indicators (WDI) sourced from ILO
Government Effectiveness	measures the quality of public services, civil service, policy formulation, policy implementation and credibility of a government's commitment to improve people/s livelihood. It is on a scale of -2.5 to +2.5, where the higher the index the less the corruption indicated.	World Development Indicators (WDI)
Control Of Corruption	This captures the corruption perception of the citizenry of a country i on a scale of -2.5 to +2.5, where the higher the index the less the corruption indicated	World Development Indicators (WDI)
Inflation	The proxy used for inflation is CPI.	World Development Indicators (WDI)

Table 2: Income and institutional difference Classification of West African Countries

Low-Middle Income West African Countries	Low-Income West African Countries
Cote'diviore	Benin
Ghana	Burkina Faso
Mauritania	The Gambia
Nigeria	Guinea
Senegal	Cape Verde
	Liberia
	Mali
	Niger
	Sierra Leone
	Togo
	Guinea Bissau

Table 3: Language Classification of West African Countries

French speaking West African Countries	English speaking and Portuguese West African Countries
Cote'diviore	Ghana
Guinea	Nigeria
Mauritania	The Gambia
Togo	Sierra Leone
Senegal	Cape Verde (Portuguese)
Benin	Liberia
Burkina Faso	Guinea Bissau (Portuguese)
Mali	
Niger	

Method

Following empirical studies on structural models, this paper revisits the dynamic nature of the relationship between the agricultural and non-agricultural sectors. We applied dynamic panel data estimation techniques to West African cross-country data. This panel approach allows for a more direct exploration of the indirect effects of growth in each sector (Christiaensen et al., 2011). A three-sector simple model has been used to evaluate the interaction between the agricultural and non-agricultural sectors. The first equation determines the agricultural sector's GDP, thus evaluating the factors that are expected to

influence the growth of this sector. Similarly, the second equation determines the non-agricultural sector's GDP.

In agricultural sector growth model agricultural GDP growth per capita ($dlnY_{it}^{agric}$) in country i at time t is assumed to depend on both lagged levels of per capita agricultural GDP growth and lagged levels of per capita agricultural GDP growth ($Y_j dlnY_{it-j}^{agric}$). In addition, we consider a vector Xit of country-specific exogenous or predetermined explanatory factors. $dlnY_{it}^{agric} = \varepsilon_{j=1}^{p} + \alpha_j dlnY_{it-j}{}^{agric} + \varepsilon_{j=1}^{q} Y_j dlnY_{it-j}^{service} + \varepsilon_{j=1}^{j} Y_j dlnY_{it-j}^{Industry} + X_{it} \cdot \beta_1 + Z_{it} \cdot \beta_2 + \eta_i + \epsilon_{it}$ …….. (1)

where:

Y_i is the log of the first difference 2 years average of the agricultural sector for country i.

X_{it}= a vector of explanatory variables, (precipitation and temperature to account for rainfall in agriculture)

Z_{it}= Endogenous factor matrix this includes the share of mining in the country's GDP, investment, GDPEducation, trade openness, Unemployment rate, and Inflation.

Similarly, in non-agricultural sector growth model non-agricultural GDP growth per capita ($dlnY_{it}^{non-agric}$) is expressed as a linear function of lagged agricultural and non-agricultural GDP growth per capita as well as observed and unobserved country specific exogenous explanatory factors.

$dlnY_{it}^{servicec} = \varepsilon_{j=1}^{p} + \alpha_j dlnY_{it-j}{}^{service} + \varepsilon_{j=1}^{q} Y_j dlnY_{it-j}^{agric} + \varepsilon_{j=1}^{j} Y_j dlnY_{it-j}^{Industry} + X_{it} \cdot \beta_1 + Z_{it} \cdot \beta_2 + \eta_i + \epsilon_{it}$……(2)

$dlnY_{it}^{industry} = \varepsilon_{j=1}^{p} + \alpha_j dlnY_{it-j}{}^{indusrty} + \varepsilon_{j=1}^{q} Y_j dlnY_{it-j}^{agric} + \varepsilon_{j=1}^{j} Y_j dlnY_{it-j}^{service} + X_{it} \cdot \beta_1 + Z_{it} \cdot \beta_2 + \eta_i + \epsilon_{it}$……(3)

where Y is the log of the first difference 5 years average of the non-agricultural sector for country i.

X_{it}= a vector of explanatory variables, e.g precipitation to account for rainfall in agriculture

Z_{it}= Endogenous factor matrix this includes the share of mining in the country's GDP, investment, GDPEducation, trade openness, Unemployment rate, and Inflation.

The explanatory variables are the share of mining in the country's GDP, investment, education, political stability, trade openness, control of corruption, government effectiveness, share of education in GDP, unemployment rate, Inflation, Temperature, and precipitation. These variables were chosen based on previous studies, and intuitive reasoning. The resource curse could also have an impact on agricultural growth by reducing the domestic prices of agricultural trade-ables following Dutch disease type appreciation of the real exchange rate. Hence, to capture this effect, studies such as (Christiaensen et al., 2011; Imai et al., 2016b) included a variable share of the mining as the proxy for this effect. (Hassan, 2016; Imai et al., 2016b) agreed that investment and economic growth have a positive relationship. Diffusion of technology (in the form of transfer of technical-know-how) from developed nations to developing nations is expected to have a positive effect on economic growth.

Trade openness which will be assigned a proxy the rate of country i total import added with its export to its GDP, i.e (total import + total export)/ GDP. Empirically it was significant to include this variable for any Sub Saharan African (SSA) country. This is because the years of trade liberalization are tagged as the dark ages for SSA economies.

Exchange rate is the ratio of country i's currency to the US dollar. The relationship is expected to be positive. However, after careful examination, this variable was omitted due to correlation (i.e many of the countries in West Africa dispense similar currency i.e. French Afrique C. F. A).

It is arguably true that climate change affects agricultural productivity; a key player in changing climate are temperature and rainfall. Precipitation is employed to account for the average annual rainfall. This follows the approach of (Christiaensen et al., 2011; Imai et al., 2016b), and in contrast to (Christiaensen et al., 2011; Imai et al., 2016b), the study included temperature to capture the total effect of climate change on agriculture.

Empirically, the relationship between education and economic growth is positive. It is a popular narrative that with an increase in years of schooling/education, there is a spillover effect in the form of an increase in human capital development, technology, and innovation, all of which bring about growth Imai et al. (2016), Christiensen et al. (2011) employed literacy rate in school years, but this study argues that the share of GDP spending on education is a more appropriate variable. This variable covers broad areas of interests such as—investment in education, research funding, and a highly educated workforce boosts the return on research and development and guarantees that discoveries are more quickly integrated into the economy's productive structure.

Two-stage dynamic model was employed to analyze the three equations specified above. Panel data was used. Panel data are a combination of cross-section and time-series data. Therefore, observations in panel data involve at least two dimensions; a cross-sectional dimension and a time-series dimension (Hsiao and Zhou, 2018).

From the equations above, the inclusion of a lagged dependent variable together with the other regressors in equations (1), (2), and (3) implies the dynamic nature of the panel data. The existence of the lagged parameter contributes to the endogeneity problem that must be addressed carefully. Fixed Effects (FE) and Random Effects (RE) have deficiencies in addressing the presence of a lagged dependent variable in the models. This is because, in both techniques, the lagged dependent variable is correlated with the disturbance term, ε_{it}. Besides, μ_{it} (the fixed effect term) is correlated with the lagged dependent variable. Therefore, FE cannot be used because when the lagged dependent variables are correlated with the disturbance term.

Moreover, pooled OLS cannot be used either, due to the correlation between the lagged dependent variable and the error term, εit. Thus, applying

pooled OLS to dynamic panel equations leads to bias and inconsistent estimates of OLS. Transforming the lagged dependent variable does not negate the individual-specific effects, μ_{it} whose correlation violates the underlying assumptions necessary for the consistency of OLS. (Baltaigi, 2015) asserted that using the "Least Squares Dummy Variables" (LSDV) transformation leads to biased and inconsistent estimates. The bias is of order $1/T$ and is a problem in panel data sets where T is small (Stephen, 1981).

The Generalized Method of Moments (GMM), which produce consistent parameter estimates for a finite number of time intervals, T, and a large cross-sectional dimension, N, is proposed for the estimation of dynamic panel data (Blundell and Bond, 1998; Bond, 1991; Bond and Hoeffler, 2001). There are two methods namely Difference (DIFF)-GMM and System (SYS)-GMM.

Arellano and Bover (1995) and (Blundell and Bond, 1998)designed System GMM. The method is perceived as more superior than difference GMM. (Bond and Hoeffler, 2001) suggest that this approach is capable of correcting unobserved country heterogeneity, omitted variable bias, measurement error, and possible endogeneity which sometimes affect growth estimates.

This approach incorporates a system of the relevant regressions expressed in first differences and levels. First-differentiation checks for non-observed heterogeneity and omitted variable bias, as well as the time-invariant component of the measurement error, also correcting for endogeneity bias employing the explanatory variable's instrumentation. In a system GMM method, estimating two models' equations minimize possible bias and inconsistency associated with a simple GMM estimator of the first difference (Blundell and Bond, 1998). Blundell and Bond (1998) suggest that lagged weak instruments generate low levels when the explanatory variables are persistent over time.

The validity of the GMM estimator depends on the reliability of the instruments. As argued by Arellano and Bond (1991) and Blundell and Bond (1998), two specification tests are required. First, the Sargan / Hansen test of over-identifying restrictions that test the instrument's overall validity. The null hypothesis is that all instruments are exogenous as a group. The second test examines the null hypothesis that the error term, ε_{it} of the differentiated equation, especially in the second order (AR2), is not serially correlated. The null hypothesis of both tests should not be rejected.

Findings

This section provides empirical findings with regards to explaining the interrelation of West African countries agricultural and non-agricultural growth equations (1), (2) and (3) for a two-year average panel for three cases – (i) a full west Africa country sample (Case 1), (ii) low-income West African countries (Case 2), and (iii) French speaking west African countries (case 3). The first case is the niggard case. A case with only the lag of log of non-agricultural (or agricultural) value-added per capita (the first lag), the log of agricultural (or non-agricultural) value-added per capita, and the share of the mining industry. Other explanatory variables mentioned in the methodology above Table 4, Table 5 and Table 6 report the estimation results of equations (1), (2) and (3) for the three cases.

Table 4 below shows that the growth in the service sector has a a positive effect on agricultural growth, based on the full sample that is, in Cases 1. In Case 2, it is also positive and significant for low-income West African countries, and for French speaking west African countries. This elucidates that agriculture and service sector have a closer linkage. These findings disagree with Christiaensen et al., (2011), who showed that there is no effect from agricultural growth to non-agricultural growth—service and industrial sector aggregation. There appear to be no relationship between the growth in the agricultural sector and the service sector. In fact, in case 2 and case 3, there is a negative relationship between the agricultural sector and the service sector. The findings disagree with the findings of Imai et al. (2016) who showed that the elasticity of non-

agriculture growth to agricultural growth is positive and elastic. Our understanding of this negative effect is based on the earlier argument (Gollin, 2010) of a weak industrial sector that is incapable of contributing to agricultural growth, i.e., the weak industrial sector's growth is inelastic and as a result does not support growth in the agricultural sector.

Table 4. Dynamic Linkage between Agricultural Sector and Non-Agricultural Sector

Dynamic panel-data estimation, two-step difference GMM			
Dependent variable = D_AGDP			
	Case 1	**Case 2**	**Case 3**
Wald chi2(8)	23.23	165.66	57.76
Prob > chi2	**0.0031*** **	**0.000*** **	**0.000*** **
D.Log agricultural value added per capita (L1)	**0.1920 (0.051)** **	**0.1711(0.001)*** **	0.4887(0.449)
D.Log service value added per capita(endogenoues)	**0.4753 (0.036)** **	**0.2814(0.016)** **	**0.1622(0.040)** **
D.Log industry value added per capita(endogenoues)	0.005(0.913)	-0.0057(0.623)	-0.0883(0.675)
D Log of tradeoppenness index (endogenoues)	-0.588 (0.809)	-0.0847(0.321)	-0.3756(0.606)
D Log of Expenditure on education (endogenoues)	**0.0614 (0.063)** **	0.0035(0.937)	0.0980(0.306)
D Log of averge annual precipitation	**0.1869 (0.020)** **	**0.2251(0.091)* **	**2.7112(0.044)** **
Dlogunemployement(endogenoues)	**0.0139 (0.090)* **	**0.0172(0.000)** **	**0.0214(0.08)* **
D log Temp	**-0.2765 (0.817)**	-0.5652(0.478)	-3.5669(0.324)
Arellano-Bond test for AR(1) in first differences:	0.45277 (0.607)	-1.3887(0.6419)	-0.7219(0.4704)
Arellano-Bond test for AR(2) in first differences:	-1.2136 (0.2249)	-1.4968(0.2948)	-0.9847(0.3248)
Sargan test of overid. restrictions: chi2(4)	Robust standard erros were used for the slusters	Robst standard errors	Robust standard erros were used for the slusters
Number of obs	54	30	31
Number of groups	14	8	8
Number of Instruments	33	31	32

*, **and ***-signifies 1, 5 and 10% level of statistical significance.

As in Imai et al. (2016), there is a strong persistent effect in share of spending on education and unemployment rate in case 1. as depicted in the positive coefficient estimate of the lagged dependent variable, increasing unemployment would imply more supply of able-bodied labour to the agricultural sector. Also, rainfall (modeled as exogenous variables) has a positive and significant relationship with agriculture, while temperature (modeled as exogenous variables) has a negative and significant relationship with growth in the agricultural sector. Interestingly, however, openness to trade do not affect agricultural growth. In Case 2, a model for the low-income West African countries, Except for temperature and share of spending on education—which are not significant--the results are similar with those of Case 1 above. Further, like Case 3—a model of French speaking West African countries, the results are a mirror of case 2.

The implication of these findings is that education and service and unemployment rate have a positive relationship with agricultural growth. Agriculture is West Africa is labor intensive, as such, an increase in the supply of labour created by unemployed youths can improve agricultural growth provided the youths have practical understanding of farming and are equipped with

the technical know-how. However, this is hardly the case, and explains the present characteristics of the agricultural sector in West Africa: a sector that is labor-intensive, largely utilizes rudimentary tools, is limited research in biotechnology and animal breeding, and is largely comprised of small-scale farmers and fabricated farmlands. Thus, it is uncertain if unemployment rate would be a good thing for the well-being of these countries. However, it is absolutely plausible that the presently unemployed persons can be equipped to contribute to the agricultural sector in the short run. Whereby, in the long run, increasing human capital, technical knowledge, and the ability of the region to move agricultural goods and services collectively as a block and individually as a state across and within borders will certainly have a beneficiary relationship with the growth of agriculture in this region.

Table 5. Dynamic Linkage Between Industry, Service, And Agricultural Sector Sector

Dynamic panel-data estimation, two-step difference GMM			
	Case 1	**Case 2**	**Case 3**
Number of obs	58	32	31
Number of groups	15	8	8
Number of Instruments	35	33	30
Wald chi2(7)	26.94	16.32	13.14
Prob > chi2	**0.000*** **	**0.0121** **	**0.022** **
Dependent variable D.Log Industry GDP			
Variables	Case 1	Case 2	Case 3
D.Log Industry value added per capita (L1)	**-0.2843(0.197)**	-0.5142(0.977)	-0.009(0.982)
D.Log agricultural value added per capita(endogenoues)	-0.3903(0.111)	7.1714(0.971)	0.344(0.691)
D.Log service value added per capita (endogenoues)	**0.5665(0.094)***	-8.8035(0.961)	**1.810(0.036)** **
D.Log inflation(endogenoues)	-0.2639(0.762)	-5.6052(0.565)	-------
Log gross capital formation (endogenoues)	0.1034(0.142)	2.96185(0.729)	**0.1475(0.0554)***
Log Unemployment(endogenoues)	**-0.0449(0.042)*** **	--------	-------
Log of Expenditure on education (endogenoues)	**0.2076(0.055)** **	0.7126(0.698)	**0.1532(0.044)** **
Arellano-Bond test for AR(1) in first differences:	z = -.6435(0.5199)	-0.03935(0.9686)	-1.0052(0.3148)
Arellano-Bond test for AR(2) in first differences:	z = -1.1795 (0.2832)	-0.8293(0.9229)	0.86615(0.3861)
Sargan test of overid. restrictions: chi2(16)	= Robst standard errors	Robst standard errors	Robst standard errors

*, **and ***-signifies 1, 5 and 10% level of statistical significance.

It is agreed that there is always causation running from the agricultural sector to the non-agricultural sector. The linkage between the agricultural sector can be discussed based on the type of linkage[5] that exists in the region. In case 1, this theory was tested and accounted for. There is indeed no significant relationship running from the agricultural sector to the Industrial sector. On the other hand, there is a positive relationship between growth in the service sector and the industrial sector. This positive coefficient implies that the linkages between Service and Industrial sectors are substantive. It is a widely romanticized thought that service spurs growth in

[5] Supply linkage which stipulates the linkage between agriculture and other sectors. Demand linkage implies the linkage between agricultural sector and non-agricultural sector to satisfy input-demand of the latter.

manufacturing—a subsector of the industrial sector. In case 2, Unemployment rate has a significantly negative effect on the industrial sector. This is understandably the postulates of several growth theories[6]. Spending on education was equally found to be positive and significant. Human capital is the driving force in development, a highly educated workforce boosts, amplify returns, and guarantees that discoveries are more quickly integrated into the economy's productive structure. Inflation and Gross capital formation (investment) too were found to be insignificant. In case 2, due to the N>T restriction, Unemployment was removed from the case two model, and in case three, inflation and unemployment were removed. In case 2, none of the variables were significant. In case three, growth in service, Gross Capital formation, and education were found to be positive and significant. Intuitively, this makes sense, demand from a thriving service sector creates a supply growth in the industrial sector. The inputs needed to sustain the growth in the service sector are the very outputs of the industrial sector.

Table 6. Dynamic Linkage Between Service, Industry, And Agricultural Sector Sector

Dynamic panel-data estimation, two-step difference GMM			
	Case 1	**Case 2**	**Case 3**
Number of obs	54	30	31
Number of groups	14	8	8
Number of Instruments	35	31	31
Wald chi2(7)	35.90	407.97	64.05
Prob > chi2	**0.000*** **	**0.0000*** **	**0.000*** **
Dependent variable D.Log ServiceGDP			
Variables	Case 1	Case 2	Case 3
D.Log Servicevalue added per capita	**0.1492(0.071)***	**0.1371(0.014)****	**-0.17341(0.069)***
D.Log agricultural value added per capita(endogenoues)	**0.0959(0.017)****	**0.3774(0.016)****	**0.4623(0.059)***
D.Log industry value added per capita (endogenoues)	0.0336(0.708)	0.0155(0.777)	0.2874(0.203)
D.Log inflation(endogenoues)	**-0.9914(0.022)****	-0.0422(0.562)	-0.0578(0.749)
Log rent on minning (endogenoues)	**0.1106(0.089)***	**0.01296(0.078)***	-0.0031(0.652)
Log Grosscapitalformation(endogenoues)	**0.1106(0.067)***	----	------
Log of Expenditure on education (endogenoues)	**0.0281(0.05)****	**0.00232(0.096)***	**0.1535(0.08)***
Arellano-Bond test for AR(1) in first differences:	z = -0.6885(0.5201)	-1.0699(0.5650)	-1.2302(0.2186)
Arellano-Bond test for AR(2) in first differences:	z = 0.5918 (0.5540)	-1.5298(0.2161)	0.7815(0.4345)
Sargan test of overid. restrictions: chi2(16)	= Robst standard errors	Robst standard errors	= Robst standard errors

*, **and ***-signifies 1, 5 and 10% level of statistical significance.

In table 6, estimates of equation 2, the equation for the service sector is presented. There are significant causations from the agricultural sector, Inflation, rent on mining, gross capital formation, and expenditure on education. In case 1, the causation from agricultural growth to service sector, rent on mining, gross capital formation (a proxy for investment), and expenditure on education are all positive and significant. While the growth of inflation on growth of the service

[6] see Modeling the effect of unemployment augmented industrialization on the control of unemployment by Pushkar Kumar Singh et al., 2022.

sector was negative and significant. In case 2 and case 3, Gross capital formation was omitted, nonetheless, agricultural growth, rent on mining, and expenditure on education were positive and significant. Putting things into context, growth in agricultural sector is a manifestation of increasing productivity, when such is sustained, they undoubtedly are expected to affect growth in both the industry and the service sectors. In addition, the labor force flows from the agricultural sector to the non-agricultural sector. This, in turn, creates employment for able-bodied persons. Furthermore, a thriving agricultural sector implies an increase in income for those employed in the agricultural sector. The farming household employs this income in satisfying their demand for durable goods such as clothes, shoes, bags, cars, etc. These findings do corroborate with Federico's (2005) explanations of the roles of agriculture and the empirical findings of (Tiffin and Irz, 2006) of the same.Undoubtedly, investment in education is intrinsically linked with human capital development. Human capital enhances non-agricultural growth (Mei-ling, 2014). The effects of education for the West African States (WAS) can be characterized by the frontiers[7] upon which education is being discussed.

The effects for countries that are far from the frontier are expected to be negative, implying that, education does reduce economic growth. In countries close to the technological frontier, it is expected that education does have a positive effect on economic growth. Countries in-between technological frontiers are expected to have a mixed result(Aghion et al., 2009). This does imply that for West African countries. The region is expected to be in-between the technological frontier or at the technological frontier[8] However, it is rather too difficult to pinpoint the region to a particular frontier. This is so because, while investment in education is desirable, it also depends on how much spending the countries invest in research, innovation, and just how far they are from the technological frontier.

Although, the findings from this study informs us that, spending on education does have a positive elasticity on growth or vice versa as reported in the findings of (Christiaensen et al., 2011) and Imai et al. (2016). We cannot insist that this will always be the case[9], because, in the absence of the right political will to curb brain drain by providing an enabling environment for research and researchers, and the infrastructural and institutional design to enable good quality education, education would not necessarily benefit this region.

Conclusion and policy recommendation

The aim of the paper was to investigate the dynamic and long-run linkages between the agricultural sector and the non-agricultural sector. With guidance from literature, three models were specified to achieve the aim of the study.

The models were estimated using System Dynamic Panel estimates, the result confirms that indeed there is a dynamic and long-run linkage running from the sectors to one another depending on the variables augmentations.

Further, other variables such as unemployment, inflation, expenditure on education, precipitation, temperature, share of mining, and gross capital formation were also found to be significant in determining this effect. The findings established empirically the structural transformation theory and the variables that are important to achieving it.

The implication of this for policy is that given the geographical and mutuality of their collective struggles for development, there is the need for governments in Western Africa, to aggressively formulate and implement policies, as well as encourage policies that are focused on improving

[7] Frontier here implies the orientation of the education, the quality, and the system of education. Some educational systems are characterized by innovation and technology, thus implying a quality assured by the state's technological frontier.

[8] Since the coefficient of education is positive.

[9] Here the variable education is in years of schooling, this variable could not be decomposed into primary, secondary and tertiary education. Hence, the variable only shows the accumulated number of schooling years which does not necessarily explains the quality of education.

and strengthening the relationships between their agricultural sector and the non-agricultural sector.

In addition to strengthening the relationship between the agricultural sector and the non-agricultural sectors, West African countries should tend to trade alliances that protect the region's mutual sustainability, integrity, and diffusion of technology.

From the forgone, the links between both the agricultural sector and non-agricultural sector can be strengthened if the production linkages, demand linkages, and savings-investment linkages are capitalized upon.

Forward linkage from the agricultural sector to the non-agricultural sector(s) which is the present norm has hardly advanced development in WAS. The alternative is to enhance reverse linkages from the non-agricultural sector to the agricultural sector. This can be achieved by creating deliberate imbalances in the non-agricultural sector to favor the agricultural sector.

Further, the policy framework described above should aim at integrating both the agricultural and the non-agricultural sectors to benefit each other enormously in the form of diffusion of technology and innovation, information pathways, and horizontal integration.

References

Acemoglu, D., Robinson, J., 2012. Why nations fail, Revija Za Socijalnu Politiku. https://doi.org/10.3935/rsp.v21i3.1238

Adelman, I., 1984. Beyond export-led growth. World Dev. 12, 937–949. https://doi.org/10.1016/0305-750X(84)90050-0

African Development Bank, 2018. African Economic Outlook, Building Today, a Better Africa Tomorrow.

Aghion, P., Bacchetta, P., Rancière, R., Rogoff, K., 2009. Exchange rate volatility and productivity growth: The role of financial development. J. Monet. Econ. 56, 494–513. https://doi.org/10.1016/j.jmoneco.2009.03.015

Anyanwu, J.C., 2013. Characteristics and Macroeconomic Determinants of Youth Employment in Africa. African Dev. Rev. 25, 107–129. https://doi.org/10.1111/j.1467-8268.2013.12019.x

Ashok Gulati, Sheggen Fan, and S.D., 2015. The Dragon and the Elephant: Agricultural and Rural Reforms in China and India, Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis.

Baltaigi, B.H., 2015. Economic analysis of Panel data, 3rd ed. John Wiley & Sons Ltd, Chichester, West Sussex.

Bigsten, A., Tengstam, S., 2012. Working Paper No . 2012 / 32 International Coordination and the Effectiveness of Aid.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. J. Econom. 87, 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bond, S., 1991. Some tests of specification for panel data:monte carlo evidence and an application to employment equations. Rev. Econ. Stud. 58, 277–297. https://doi.org/10.2307/2297968

Bond, S., Hoeffler, A., 2001. GMM Estimation of Empirical Growth Models. CEPR Discuss. Pap. / Cent. Econ. Policy Res. Discuss. Pap.

Bosworth, B., Collins, S.M., 2008. Accounting for growth: Comparing China and India. J. Econ. Perspect. 22, 45–66. https://doi.org/10.1257/jep.22.1.45

Byerlee, D., Diao, X., Jackson, C., 2005. Agriculture , Rural Development , and Pro-poor Growth. Agriculture 21, 1–15.

Christiaensen, L., Demery, L., Kuhl, J., 2011. The (evolving) role of agriculture in poverty reduction-An empirical perspective. J. Dev. Econ. 96, 239–254. https://doi.org/10.1016/j.jdeveco.2010.10.006

Dethier, J.J., Effenberger, A., 2012. Agriculture and development: A brief review of the literature. Econ. Syst. 36, 175–205. https://doi.org/10.1016/j.ecosys.2011.09.003

Diao, X., Hazell, P., Resnick, D., Thurlow, J., 2007. The role of agriculture in development: Implications for Sub-Saharan Africa. Res. Rep. Int. Food Policy Res. Inst. https://doi.org/10.2499/9780896291614rr153

Ellerman, D., 2004. Revisiting Hirschman on Development Assistance and Unbalanced Growth Author (s): David Ellerman Published by : Palgrave Macmillan Journals Stable URL : https://www.jstor.org/stable/40326135 REVISITING HIRSCHMAN ON DEVELOPMENT. East. Econ. J. 30, 311–331.

EPRS, 2016. Africa's economic growth - Taking off or slowing down?, European Parliament Research Service. https://doi.org/10.2861/443750

Evert J. Los and Cornelis Gardebroek, 2015. Unravelling the links between agriculture and economic growth: a panel time series approach for post-WW II Africa Evert J. Los and Cornelis Gardebroek. Unpubl. Artic. Wageningen University, The Netherlands Hollandseweg.

FAO, 2016. Agriculture in Sub-Saharan Africa : Prospects and challenges, in: Agriculture in Sub-Saharan Africa: Prospects and Challenges for the next Decade. OECD-FAO AGRICULTURAL OUTLOOK 2016-2025 © OECD/FAO 2016.

Federico, G., 2005. Chapter Title : PATTERNS OF GROWTH : THE INPUTS Book Title : Feeding the World Book Subtitle : An Economic History of Agriculture , 1800-2000 Book Author (s): Giovanni Federico Published by : Princeton University Press Stable URL : https://www.jstor.org, in: Feeding the World Book. Princeton University Press, p. 67.

Gardner, B.L., 2003. Causes of rural economic development. Agric. Econ. 32, 21–41. https://doi.org/10.1111/j.0169-5150.2004.00012.x

Gollin, D., 2010. Chapter 73 Agricultural Productivity and Economic Growth. Handb. Agric. Econ. https://doi.org/10.1016/S1574-0072(09)04073-0

Harris, J.R., Todaro, M.P., Harris, B.J.R., Todaro, M.P., 1970. Migration , Unemployment and Developmnent : A Two-Sector Analysis 60, 126–142.

Hassan, M.S., 2016. Trade Poverty Nexus : An Empirical Investigation from Pakistan Trade Poverty Nexus : An Empirical Investigation from Pakistan 500–520.

Hsiao, C., Zhou, Q., 2018. Panel Parametric, Semi-parametric and Nonparametric Construction of Counterfactuals-California Tobacco Control Revisited.

Imai, K.S., Cheng, W., Gaiha, R., 2016a. Dynamic and long-term linkages among agricultural and non-agricultural growth, inequality and poverty in developing countries. Int. Rev. Appl. Econ. 31, 318–338. https://doi.org/10.1080/02692171.2016.1249833

Imai, K.S., Cheng, W., Gaiha, R., 2016b. Dynamic and long-term linkages among agricultural and non-agricultural growth, inequality and poverty in developing countries. Int. Rev. Appl. Econ. 31, 318–338. https://doi.org/10.1080/02692171.2016.1249833

Kiminori Matsuyama, 1992. Agricultural Productivity, Comparative Advantage, and Economic Growth. J. Econ. Theory 58, 317–334.

Lewis, A.W., 1954. Economic Development with Unlimited Supplies of Labour, Manchester school of Economics and Social Studies. New York: McGraw-Hill.

Martin, W., Mitra, D., 2001. Productivity growth and convergence in agriculture versus manufacturing. Econ. Dev. Cult. Change 49, 403–422. https://doi.org/10.1086/452509

McMillan, M., Rodrik, D., Verduzco-Gallo, Í., 2014. Globalization, Structural Change, and Productivity Growth, with an Update on Africa. World Dev. 63, 11–32. https://doi.org/10.1016/j.worlddev.2013.10.012

Mei-ling, S., 2014. Empirical analysis on the relationship between human capital investment and economic growth in rural areas : Based on the data of Henan. J. Chem. Pharm. Res. 6, 378–382.

Ndungu, F.K., 2021. https://doi.org/10.24297/ijmit.v16i.8941. Int. J.

Manag. Inf. Technol. 16, 42–58. https://doi.org/10.24297/ijmit.v16i.8941 Effect

NEPAD, 2015. AGRICULTURE IN AFRICA.

Page, J., 2018. Rethinking africa's structural transformation:The Rise of New Industries, Foresight Africa: Top priorities for the continent in 2018.

Schultz, T.W., 1953. Book reviews.

Stephen, N., 1981. Biases in Dynamic Models with Fixed Effects Author (s): Stephen Nickell Published by : The Econometric Society Stable URL : http://www.jstor.org/stable/1911408 Accessed : 12-05-2016 17 : 03 UTC. Econometrica 49, 1417–1426.

Subramaniam, V., Reed, M., 2009. Agricultural Inter-Sectoral Linkages and Its Contribution to Economic Growth in the Transition Countries Authors Agricultural Inter-Sectoral Linkages and Its Contribution to Economic Growth in the Transition Countries.

Tiffin, R., Irz, X., 2006. Is agriculture the engine of growth? Agric. Econ. 35, 79–89. https://doi.org/10.1111/j.1574-0862.2006.00141.x

Tsakok, I., Gardner, B., 2007. Agriculture in economic development: Primary engine of growth or chicken and egg? Am. J. Agric. Econ. 89, 1145–1151. https://doi.org/10.1111/j.1467-8276.2007.01075.x

Abbrevations

EPRS	European Parliamentary Research Services
FAO	Food and Agricultural Organization
WDI	World Development Indicator
GDP	Gross Domestic Product
ECOWAS	Economic Community of West African Countries
SSA	Sub Saharan Africa
FDI	Foreign Direct Investment
NEPAD	New Partnership for Africa's Development
ILO	International Labor Organization