Has bank credit really impacted agricultural productivity in the Central African Economic and Monetary Community?

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Abstract

Purpose – This paper investigates the impact of bank credit on agricultural productivity in the Central African Economic and Monetary Community (CEMAC) from 1990 to 2019. Studies' results on the impact of bank credit on agricultural productivity are not conclusive. The studies demonstrate diverse outcomes which are debatable. The results are conflicting.

Design/methodology/approach – Agricultural value added (AGRVA) to the gross domestic product (GDP) proxies agricultural productivity while domestic credit to the private sector by banks (DCPSB), broad money supply, land, inflation (INF), physical capital (PHKAP) and labour supply are explanatory variables. The autoregressive distributed lag technique is utilized.

Findings – The co-integration test results show a long-run co-integration among the variables. The findings disclose that DCPSB, land and PHKAP impact positively on the AGRVA. Broad money supply, INF and labour impact negatively on the AGRVA to the GDP.

Research limitations/implications – The results suggest that the CEMAC governments should encourage effective ways to increase bank credit flow to private enterprises in the agricultural sector through efficient bank's intermediation.

Practical implications – The governments should create more agricultural banks and improve the operation of existing ones to ensure direct credit to agricultural activities. The Bank of Central African Economic and Monetary Community should apply aggressive policy which eliminates all the bottlenecks undermining credit flow to the private sector in mutualism with agricultural productivity.

Social implications – The commercial banks should give more credit to private sector to mutually benefit the agricultural sector and the banking sector. The governments of the CEMAC economies should expand funding into the capital market which considerably boosts agricultural productivity.

Originality/value – Studies' results on the impact of bank credit on agricultural productivity are not conclusive. The studies demonstrate diverse outcomes which are debatable. The results are conflicting; some

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reveal positive impacts, some show negative impacts and others indicate U-shape behaviour. Hence, research is required to fill the lacuna.

Keywords Bank credit, Agricultural productivity, CEMAC, ARDL, BEAC
Paper type Research paper

1. Introduction

Financing agriculture in the Central African Economic and Monetary Community (CEMAC) has remained a crucial and progressive process since the countries' independence in the 1960s through the banking system and stock market (Fulginiti *et al.*, 2004). According to Levine and Zervos (1998), the banks and stock markets provide diverse financial services to farmers. Both the banking sector development and stock market liquidity positively foretell economic growth, capital formation and productivity improvements. Industrially, Rajan and Zingales (1998) postulated that the state of banking sector development reduces the cost of external finance to firms, thereby encouraging productivity. Wurgler (2000) indicated that even if banking sector development does not lead to higher investment, it efficiently allocates the existing investments to encourage productivity. Moreover, the efficacy of this theory solely depends on the sectors' priorities of every nation's economy and the financial institutions' behaviour towards lending to agricultural firms, smallholder farmers and households to boost productivity.

The banking sector being the main supplier of credit to different economic sectors is an integral part of countries' financial systems. Bank credit to agriculture is the credit from financial institutions which is directed to the agricultural investments. It facilitates the purchase and usage of new technology in agriculture and promotes the lead technology enterprises (World Bank, 2018). A well-established banking system eases the exchange of goods and services through financial services. It equally mobilizes savings through efficient channels to productive investments. The bank as a financial intermediary is expected to provide opportunities for the public to save income that is not spent on consumption (Datta and Sahu, 2021; Omoruyi and Osawmonyi, 2013). The banks use accumulated savings to extend credit facilities to businesses, investors and other entrepreneurs. Hence, the banks support and promote efficient resource allocation in an economy. Generally, a healthily robust and developed banking sector is crucial to sustain economic activities, promote different economic sectors' growth and ensure financial stability (Ali *et al.*, 2014; Omoruyi and Osawmonyi, 2013).

According to Abdulai and Bahahudeen (2013), 51.2% of commercial banks' shares are held by the governments in the CEMAC region. The agricultural banks provide agricultural credits to boost agricultural enterprises through cooperatives and invest in the transportation of agricultural products. The goal of microcredits is to assist rural population to improve their agricultural output thereby alleviating poverty and hunger (Sahu *et al.*, 2021). In all, CEMAC countries have assets that give them a comparative advantage to produce varieties of commodities. Therefore, this comparative advantage gives CEMAC a strategic position in Central Africa to propagate its financial operations such that agricultural output could increase (Bamou and Master, 2007). In this light, banking sector development is the increasing ability of the banks to efficiently execute these functions (King and Levine, 1993). Much literature reviews maintain that bank credit promotes productivity and economic growth (Beck and Levine, 2004; Estrada *et al.*, 2010; Hassan *et al.*, 2011; King and Levine, 1993; Levine, 1997).

Agriculture is known to be one of the human race's first economic occupations over the centuries and generations (Asaleye *et al.*, 2018). Two kinds of agriculture exist in the CEMAC region: subsistence cultivation and commercial agriculture. The subsistence agriculture is the sort of cultivation whereby the agriculturist and his family produce in small scale solely for family consumption. It is labour intensive practice unlike the commercial cultivation that uses huge capital. Heavy machines are not used for cultivation, since less and divided land is available (Asaleye *et al.*, 2018; Belaid *et al.*, 2017; Brown *et al.*, 2016). The commercial agribusiness is where the agriculturalist grows crops for sale. It is large-scale cultivation on vast land using machines. This farming type requires much capital to boost the agriculturists' returns. Commercial agriculture equally requires huge capital and financial investments to purchase inputs like land, machines, fertilizers, pesticides and seedlings. The availability of these inputs with the right combination of labour increases agricultural productivity (Zakaria *et al.*, 2019).

Agricultural productivity is defined as the ratio of the value of total farm outputs to the value of total inputs employed in agriculture cultivation (Onwumere *et al.*, 2012). According to Idachaba (1995), agricultural productivity is the increase in agricultural sector's contribution to the gross domestic product (GDP) of a country. Some concepts view productivity as the relationship between output and the input which produces it (Saxon, 1965). Shafi (1984) viewed it as an index ratio of local agricultural output to the index of total inputs utilized in agriculture production. Undeniably, agricultural productivity measures exist, amongst which are agriculture value added, total productivity factor, yields per hectare of land, etc. Anyanwu *et al.* (1997) argued that agricultural productivity promotes the economic development of an emerging nation in several ways by increasing food supply for domestic consumption, providing the raw material for industrial use, expanding the domestic markets for the manufacturing sector, increasing domestic savings and foreign exchange earnings from agricultural exportation.

Agricultural productivity is a vital justifying element used to increase sustainable agricultural growth over the years. Substantial revenue is generated by the agricultural sector which increases real income (Akudugu, 2016; Christiaensen and Demery, 2007). The sector does not only employ an estimated 70% of the workforce in low-income countries, it contributes about 32% of the GDP (Maity and Sahu, 2020; Salami and Arawomo, 2013). The agricultural sector remains an essential economic puller for emerged and emerging countries which continues to play a significant role in reducing poverty and hunger especially in low-income countries (FAO, 2018a). According to Beaman *et al.* (2015), low agricultural productivity brings poverty and hunger. Additionally, a majority of households in developing economies live and depend directly or indirectly on agriculture for livelihood. The great contribution of the agricultural sector to the economic growth makes agriculture a vital component for countries' growth and development (World Bank, 2020). Agricultural productivity is still lagging in many African countries with huge proportions of land uncultivated and high unemployment. Africa's value added per worker also lags behind compared to other world regions. This implies that there is a need to raise agricultural productivity to achieve sustainable economic growth.

The Food and Agricultural Organization (FAO, 2018b) indicates that hunger is habitually calculated using the frequency of undernourishment. Hunger is the inability to acquire enough food to meet energy dietary requirements of human beings. Current statistics still point to an increase in world hunger after a protracted decline. Additionally, statistics from the Food Insecurity Experience Scale indicate that close to 10% of the world population is exposed to abject food insecurity, which are about 770 million people. The prevalence rate of world undernourishment improved from 13.1% in 2007 to 10.9% in 2017 while the prevalence rate of severe food insecurity worsen from 8.9% in 2016 to 10.2% in 2017 (FAO, 2018b). In the CEMAC region, roughly 45% of the populace are affected by malnutrition and 10% of the population face acute food deficit. This is due to low agricultural productivity and economic growth (World Bank, 2018).

African countries are beginning to recognize the need to engage in agriculture after decades of inattentive policies, poor taxation and limited investment opportunities.

The Maputo Declaration by the African Union (AU, 2003) ordered for 10% investment of countries' budgets into agriculture and reinvest 6% annual growth rate of agriculture. Also, the Malabo Declaration dwelled on the previous declaration and prescribed a double agricultural productivity growth (AU, 2014). In accordance with Udry (2015), farmers' heterogeneity should be considered when adopting essential policy interventions. The study of Dhrifi (2014) indicates an urgent need to make agriculture demand-driven. Also, there is a greater use of crop output to feed animals which serve as meat for proteins (FAO, 2018b). The FAO estimates that the investments required in developing countries to sustain the agricultural productivity and expansion exceed the current food demand trends. The challenging issue is to increase bank credit required for investments to boost agricultural productivity and reduce hunger.

Hence, much is required to raise agricultural productivity, to alleviate the population's poverty and hunger. Increase in food production would reduce food prices, especially in the hinterlands to benefit the growing urban poor masses. The rate of world population growth, with the lessons from the 2008 global financial crisis, motivates research on whether or not bank credit impacts agricultural productivity (FAO, 2018b). Limited studies have been conducted on the impact of bank credit on agricultural productivity in the CEMAC. Given the time lag in return to agricultural investment and the effects of climate and environmental factors from global temperature, research is vital to determine the impact of bank credit on agricultural productivity (Ayinde *et al.*, 2011). This study would be useful to economic operators, governments, bank managements and farmers.

2. Literature review

2.1 Theoretical review

2.1.1 Endogenous growth theory. The endogenous growth theory was propounded by Robert Solow and Trevor Swan in 1956. The theory is also referred to as the Solow–Swan model. This theory explains that endogenous growth results from a combination of capital, labour and technology. This theory elucidates that stock market proxies like market capitalization, all-share index, number of listed equities, number of deals, value of deals, value of transactions and stock market turnover apply a considerable effect on agricultural growth.

2.1.2 Information asymmetry hypothesis. This theory was propounded by Eugene Fama in 1970. The theory is applied in line with Akerlof *et al.* (1970) where only few persons among the parties involved in a transaction have accurate and full information, whereas the other parties have residual information. The parties are stock market participants and farmers. Information asymmetry may originate from the farmers who conceal information on the effective purpose of their activities and the intended use of borrowed funds. It could also emanate from the stock market dealers when they forecast lucrative returns from agricultural output and lure the farmers into future or forward contracts with credit. However, banks sometimes lend money to agricultural investors at high interest rates to alleviate the problem of information asymmetry.

2.1.3 Theory of moral hazard. This theory was propounded by Akerlof (1970) and subsequently upgraded by Rothschild and Stiglitz (1976); the theory postulates a situation where the possibility of loan default increases when borrowers fail to reveal the genuine purpose of the borrowed funds. The theory stipulates that farmers intentionally conceal the purpose of their borrowing from the banks. Moral hazard exists due to the dominance of wealthy landholders who borrow cheaper credit given the collateral security they possess while the poor borrowers are given limited loans (Simtowe *et al.*, 2006). Arrow (1963) stated that moral hazard is the phenomenon of exploiting private information to gain advantage in an incomplete contract during information asymmetry. Musara and Olawale (2012) equally posited that moral hazard manifests where the bank borrowers take actions that negatively impact the banks' returns.

2.1.4 Adverse selection theory. This theory was propounded by Akerlof (1970) and later upgraded by Rothschild and Stiglitz (1976); the theory demonstrates a situation where the probability of loan default increases when interest rate increases. Also, the quality of borrowers gets worsened with the increase in borrowing cost (Musara and Olawale, 2012). Adverse selection occurs in the credit markets when the formal credit institutions are not fully aware of borrower's creditworthiness. Therefore, some credits worthy borrowers are left out when the credit market tries to mitigate the risk of default by raising the rate of interest (Binswanger and Deininger, 1997; Klonner and Rai, 2005). The theory of adverse selection implies that lenders can misjudge the activities of agricultural investors and farmers, hence financing the wrong person instead of the right one. The adverse selection theory implies a situation, whereby the lenders do not know the real action, borrower's asset and the situation where the lender knows everything about one borrower's activities but cannot verify it. The trustworthy clients are disfavoured at the expense of the unscrupulous ones (Stiglitz, 1998).

2.2 Empirical review

Onder and Ozyildririm (2013) investigated the privately and publicly owned banks lending transactions in Turkey from 1992 to 2010, to establish the impact of bank credit on productivity and economic growth. The study investigated the impact of banks facilities on agriculture, infrastructure and election periods with ordinary least square (OLS) multiple regression. The findings showed that banks facilities positively impacted agriculture, infrastructure and election era. Chi *et al.* (2021) examined the relationship between financial deepening and manufacturing sector productivity of Cameroon from 1970 to 2018 applying the Engle–Granger two-step co-integration and autoregressive distributed lag technique. The manufacturing value added measured manufacturing sector productivity, while credit to the private sector, broad money supply and trade openness proxied financial deepening. The findings indicated a long-run relationship between financial deepening and manufacturing sector productivity. The error correction term unveiled that financial deepening and manufacturing sector productivity congregate to long-run equilibrium. The results showed that credit to the private sector and broad money supply impacted positively on manufacturing sector productivity whereas trade openness impacted negatively on short-run manufacturing sector productivity.

Kumar *et al.* (2017) employed IV 2SL estimation techniques to analyze large, national farm household level data from Indian economy to establish the impact of institutional credit on farm income and household consumption expenditures. The study revealed that formal credit played a significant role in enhancing net farm income and per capita monthly household expenditure for the farmers in India. Also, formal credit social safety net generated some consequences that led to income reversals for rural households. Orji *et al.* (2020) evaluated the causal relationship between agricultural credit and Nigerian agricultural output based on Pairwise Granger causality test. The results indicated that causation between agricultural financing and agricultural output did not exist. Reuben *et al.* (2020) examined the impact of ACGSF on Nigerian agricultural output from 1998 to 2017 employing the ordinary least square method. The findings unveiled that ACGSF significantly and positively affected Nigerian agricultural output. Okafor (2020) investigated the effect of banks credit on Nigerian agricultural development using the ordinary least square approach. The findings showed that banks credit and ACGSF significantly and positively affected agricultural output. Sekyi *et al.* (2019) examined the impact of informal credit on rural agricultural productivity in Savannah ecological zone of Ghana using econometric analysis. The results showed that credit has a positive influence on rural agricultural productivity.

Ogbuabor and Nwosu (2017) examined the impact of deposit money bank credit on agricultural productivity in Nigeria utilizing an error correction model on time series data from 1981 to 2014. The findings illustrated that a long-run relationship existed between the variables. The results showed that deposit money bank credit had a significantly positive long-run effect on agricultural productivity and negligibly impact in the short run. Rehman *et al.* (2017) used econometric techniques to estimate data from 1960 to 2015 in Pakistan, to demonstrate the relationship between agricultural GDP and bank credit to agriculture. The variables used were loan disbursement, cooperative loan, total disbursement, total food output and crop surface area. The study observed that total food production and loan disbursement had a significantly positive impact on AGDP with insignificant impact on cropped area. Chandio *et al.* (2016) analyzed the impact of formal credit on agricultural output in Pakistan using secondary data from 1996 to 2015 employing regression analysis. The findings showed that formal credit had a positively significant impact on agricultural output.

Obilor (2014) equally showed remarkable contributions to bank credit on agriculture output, indicating that Agricultural Credit Guarantee Scheme Fund in Nigeria had a significantly positive impact on agricultural productivity. With data from 1970 to 2013 employing the error correction model, Nnamocha and Eke (2015) determined that bank credit affected agricultural output in Nigeria in the long run. The findings revealed that bank credit had a long-run effect on agricultural output. Examining the impact of bank and public sector financing activities on agricultural output in Nigeria, Ibe (2014) found that commercial bank credit to agricultural sector, government financial allocation to agriculture and agricultural product prices significantly affected agricultural productivity in Nigeria.

Osabohien *et al.* (2020) evaluated the relationship between access to bank credit and agricultural performance in Nigeria from 1998 to 2018 applying autoregressive distributed lag model. The findings indicated that bank credit had a short- and long-run significant positive effect on agricultural performance. Mubaraq (2021) evaluated the thresholds effect of ACGSF on Nigerian agricultural performance from 1981 to 2019 using threshold regression. Agricultural performance was measured by real agricultural GDP. The findings revealed an insignificant U-shaped association between ACGSF and real agricultural GDP. The ACGSF significantly and positively affected real agricultural GDP with ₦1,060,389 and ₦5,951,809 thresholds. The results suggested that sustained increase in agricultural loans is guaranteed and inclusion of smallholder farmers in the Nigerian agricultural space promoted agricultural performance.

The study of Ikenna (2012) using time series data from 1979 to 2009 to establish the long-run and short-run impact of financial policies on credit mobilization in Nigeria with Granger causality showed that the deregulation of any financial system had a negative influence on the credit allocated to the agricultural sector. The results pointed out that in both short and long run, financial liberalization had an insignificantly negative impact on the agricultural sector. With OLS, Agunuwa *et al.* (2015) showed that there was a positive association between commercial banks' credit and agricultural productivity in Nigeria. Ogbanje *et al.* (2010) examined the effect of commercial banks' loan on agricultural GDP in Nigeria from 1981 to 2007 and stated that commercial banks' loan had a significantly positive effect on agricultural GDP applying simple regression. Osuji and Chigbu (2012) studied the impact of financial development on economic growth in Nigeria from 1960 to 2008 using Granger causality testing and the error correction method. Gross domestic product measured economic growth while broad money supply and credit to the private sector measured financial development. The results indicated that broad money supply and credit to private sector positively related to Nigerian economic growth.

Hassan (2017) estimated the effect of financial sector development on agricultural growth in Pakistan from 1981 to 2015, adopting the Cobb–Douglas production function. Two measures for financial sector development used were broad money as a percentage of GDP and agricultural loan payout. The findings indicated a significantly positive relationship between agricultural growth and capital, bank credit and liquid liability with a vector autoregressive model. Baffoe *et al.* (2014) studied the relationship between credit and agricultural production in Ghana. The results showed that farmers who had access to credit had larger average profit as their profitability was statistically different from farmers who did not have access to credit.

Chisasa and Makina (2013) examined the impact of bank credit on agricultural output in South Africa from 1970 to 2009, using OLS estimates with the Cobb–Douglas production function. The study observed that bank credit had a significantly positive impact on agricultural output. However, Alvaro *et al.* (2012) used panel data from surveys conducted in 2006 and 2008 to study the impact of access to credit on farm production of fruit and vegetable growers in Chile. The results revealed that short-term credit had no effect on agricultural productivity. Ubah (2009) found that the role of agricultural credit in agricultural productivity was statistically negligible in Nigeria. Tamga (2017) studied in Cameroon to find out if the banking sector development had an influence on the development of agriculture from 1965 to 2014. The findings showed that there was a bidirectional relationship between banking sector development and agricultural development using Granger causality and co-integration.

Chi *et al.* (2020) investigated the long-term causal relationship between banking sector development and agricultural productivity in the CEMAC nations from 1990 to 2018 using autoregressive distributed lag and vector error correction model techniques. The findings indicated that banking sector and agricultural productivity in the CEMAC region are related in the long run. The results revealed bidirectional causality between domestic credit to the private sector by banks (DCPSB) and agricultural value added (AGRVA) to the GDP. This insinuated that in the CEMAC region, agricultural productivity and banking sector development operated in mutualism. To test the effect of financial development on agriculture productivity in Africa the estimation technique, Dhrifi (2014) used was the system generalized method of moment. The study noted that without the institutional quality the coefficient of financial development proxied by domestic credit to private sector was significantly negative showing that financial system did not improve agricultural productivity in African countries.

Izhar and Tariq (2009) found that commercial banks' credit was non-significant to promote agricultural production in India. Girabi and Mwakaje (2013) studied the impact of microfinance on Tanzanian farm productivity. The findings showed that agricultural credit beneficiaries had higher agricultural productivity than non-credit beneficiaries using descriptive statistics and analysis of variance. Owuor and Shem (2012) examined the impact of agricultural credit on food production using switching regression model with Heckman sample correction method. The results indicated a significantly positive impact of agricultural credit on food production. Onoja (2017) investigated the impact of financial development on agricultural productivity in San Francisco using panel regression. The findings showed that credit to agriculture was the main channel through which countries enhanced productivity from the financial markets and financial sector development. Credit to agriculture contributed positively to agricultural productivity through direct crop inputs but negatively through agricultural value added as ratio of GDP.

Zakaria *et al.* (2019) investigated the impact of financial sector development on South Asian agricultural productivity between 1973 and 2015. The results showed that financial development has an inverted U-shaped effect on agricultural productivity, which implied that agricultural productivity first increased with an increase in financial development and then it declined when financial development further increases. Sriram (2007) argued that the causality of agricultural output with increase in credit cannot be clearly established in India using the Cobb–Douglas production function. Chi and Kesuh (2020) examined the long-run causal link between banking sector development and real estate growth in the Nigerian emerging economy from 1990 to 2018, applying the autoregressive distributed lag and vector error correction model. The study hypothesized no causal link between banking sector development and real estate growth. The results showed that banking sector development and Nigerian real estate sector growth are related. This implied that a long-run relationship existed between banking sector and real estate growth. The results revealed no direction of causality between banking sector development and Nigerian real estate growth. Oriavwote and Eshenake (2014) examined the impact of financial sector development on economic growth using GDP to measure economic growth and domestic credit to the private sector with multiple regression technique. The results indicated that financial development had no impact on economic growth based on the statistical insignificance of credit to the private sector.

Anh *et al.* (2020) investigated the impact of bank credit on Vietnamese agriculture performance from 2004Q4 to 2016Q4 applying indicator saturation break test, autoregressive distributed lag bounds test alongside Toda-Yamamoto Granger causality test. The results unveiled a short- and long-run positive impact of agricultural credit on agricultural output. Moreover, a unidirectional causality flowed from agricultural credit to agricultural output. Bahsi and Cetin (2020) examined the impact of agricultural credit on Turkish agricultural production from 1998 to 2016 applying ordinary least squares approach. The findings revealed that agricultural credit significantly and positively impacted agricultural output.

Literature is conflicting on the impact of bank credit on agricultural productivity. There are studies which show that bank credit significantly impacts agricultural productivity positively (Anh *et al.*, 2020; Bahsi and Cetin, 2020; Chisasa and Makina, 2013; Onder and Ozyildririm, 2013). Others indicate that bank credit has negative impact on agricultural productivity (Dhrifi, 2014; Ikenna, 2012). Some studies indicate bidirectional causality between bank credit and agricultural productivity (Chi *et al.*, 2020; Tamga, 2017). Others show unidirectional causality between bank credit and agricultural productivity (Osuji and Chigbu, 2012). Zakaria *et al.*'s (2019) results showed an inverted U-shaped effect of bank credit on agricultural productivity. Hence, this study investigates the impact of bank credit on agricultural productivity in the CEMAC from 1990 to 2019. The base year is chosen due to the implementation of the structural adjustment program in the CEMAC nations by the International Monetary Fund and World Bank. The closing year is determined by data availability.

3. Data and methodology

This study employed the *ex post facto* (after the event) research design utilizing secondary data gleaned from the world development indicators. The necessary pre- and post-diagnostic checks like descriptive statistics, unit root, cross-sectional dependence test, Hausman test inherent in panel data estimations, Wald and normality tests are performed to justify the properties of variables. Breusch *et al.* (1980), Pesaran (2004), CD, Pesaran (2004) scaled and Baltagi and Badi (2012) bias-corrected scaled were applied. The panel unit root test employed Levin *et al.* (2002) and Im *et al.* (2003) tests to establish the series stationarity. The Levin *et al.* (2002) test assumes an identically common unit root test process with cross-sections and Im *et al.* (2003) ensure the unit's cross-sectional independence. The variables used in this study include AGRVA to the GDP, DCPSB, inflation (INF), land, physical capital (PHKAP) and labour (LAB). The variables are chosen based on data availability alongside multicollinearity and parsimonious models. The CEMAC countries include Cameroon, Central African Republic, Chad, Congo Republic, Equatorial Guinea and Gabon. Agricultural value added to the GDP is the measure for agricultural productivity while DCPSB measures bank credit. Inflation, land, PHKAP and labour (LAB) are mediating variables.

3.1 Method of estimation

This study utilizes pretests like descriptive statistics, unit root test, correlation, cross-sectional dependence, Hausman test and co-integration tests before the autoregressive distributed lag (ARDL) to establish the impact of the exogenous variables on the endogenous variable. In accordance with Hossfeld (2016), panel unit root test is grouped into first and second generations. The first generation panel unit root tests include Levin *et al.* (2002) and Im *et al.* (2003). Basically, the tests are derived from the usual augmented Dickey–Fuller (ADF) unit root test in time series analysis. However, there is assumed cross-sectional independence. The random process y_t in the ADF unit root test for one variable estimates the model as follows:

$$\Delta y_t = \rho y_{t-1} + \sum_{p=1}^{p} \phi_p \Delta y_{t-p} + \gamma_l D_l + \varepsilon_t, t = 1, \ldots, T \quad (1)$$

Here D_l, being $l = \{1, 2, 3\}$ represent a vector term, which shows whether the technique uses the intercept, none, intercept without trend or intercept and trend. The ADF statistics verifies the null hypothesis that the series has no unit root and the alternative that the series has stationarity. Hence, H_0: $\rho = 0$, H_1: $\rho < 0$. The ADF panel test estimates the following model:

$$\Delta y_{i,t} = \rho_i y_{i,t-1} + \sum_{p=1}^{pi} \phi_{pi} \Delta y_{it-p} + \gamma_{il} D_{il} + \varepsilon_{it}, t = 1, \ldots, T, i = 1, \ldots N \quad (2)$$

Given the unit root test results show variables stationary with orders zero and one, the autoregressive distributed lag model is applied to explore the impact of bank credit on agricultural productivity in the CEMAC zone. The ARDL model gives long- and short-run coefficients estimates at the same time irrespective of whether or not the variables are of order I(0), I(1) or mutually integrated Pesaran *et al.* (1999). The ARDL is equally well suited for small sample data. The elasticity nature of ARDL provides the opportunity to examine the dynamic structure and the impacts estimate inferences. In addition, ARDL is consistent for co-integration estimation Ahmed *et al.* (2014), Al-Malkawi *et al.* (2012) compared to Engle and Granger (1987). This study adapted the model used by Chisasa and Makina (2013) in the analysis of growth and productivity theoretically and empirically. The function is widely utilized to present the correlation between output and inputs. The model simplifies the economy where production output (*P*) is given by the labour (*L*) and capital (*K*) involved. Chisasa and Makina (2013) stated the following equation:

$$P(L, K) = b\alpha L\beta K \quad (3)$$

Here, α and β are the respective output elasticity coefficients of labour and capital. These constant values are defined by technology. b represents the intercept.

The adapted model from Chisasa and Makina's (2013) time series analysis was stated as shown below considering the panel nature of this analysis.

$$Y_{it} = AK_{it}^{\alpha} L_{it}^{\beta} e^{\mu_{it}} \quad (4)$$

where Y is agricultural productivity, A is the constant term, K is capital and L is labour. The parameters α and β are the capital and labour elasticity coefficients on agricultural output, respectively, which lie between 0 and 1, i.e. $0 < \beta < 1$, $0 < \alpha < 1$. i is the number of countries, t is time period and μ is random error term. The study investigates the impact of bank credit on agricultural productivity considering that bank credit is vital for agricultural productivity. Incorporating bank credit (DCPSB) in the function, Equation (4) gives

$$Y_{it} = AK_{it}^{\alpha} L_{it}^{\beta} DCPSB_{it}^{\gamma} Z_{it}^{\phi} e^{\mu_{it}} \quad (5)$$

The parameter γ is the elasticity coefficient of bank credit on agricultural productivity which oscillates between 0 and 1, i.e. $0 < \gamma < 1$. Applying logarithm to Equation (5) becomes

$$\ln Y_{it} = \beta_0 + \alpha \ln K_{it} + \beta \ln L_{it} + \gamma \ln DCPSB_{it} + \mu_{it} \tag{6}$$

Apart from bank credit, other variables influence agricultural productivity like land, INF, PHKAP and labour. After inclusion of the other variables, Equation (6) forms

$$AGRVA_{it} = \beta_0 + \beta_1 DCPSB_{it} + \beta_2 Land_{it} + \beta_3 INF_{it} + \beta_4 PHKAP_{it} + \beta_5 LAB_{it} + \pi_{it} + \mu_{it} \tag{7}$$

where

$AGRVA_{it}$ is agricultural value added (% of GDP);

$DCPSB_{it}$ is domestic credit to the private sector by banks;

$Land_{it}$ represents agricultural land;

INF_{it} is the inflation rate;

$PHKAP_{it}$ represents physical capital;

LAB_{it} is the total labour force supplied;

β_0 is the intercept;

$\beta_1 - \beta_5$ are the coefficients to be estimated;

μ_{it} represents the stochastic error term and

π_{it} captures the specific effects in the panel.

Theoretically, the different variables are explained as follows: AGRVA to the GDP as percentage (Chisasa and Makina, 2013; Tamga, 2017). The annual AGRVA growth rate is based on constant local currency. Domestic credit to the private sector by banks is the credit provided by the banking sector to the private sector through banking system intermediations services. Domestic credit to the private sector from the banking sector involves all credit to all the sectors in the economy, excluding credit to the central government (World Bank, 2018). Agricultural land is the arable land surface area that is under continuous use for crops production and pastures breathing (World Bank, 2018). Land is arable when it is utilized for crops production for a short time. Land is an essential factor in agricultural production such that an increase in agricultural land raises productivity and a reduction in land decreases productivity. Physical capital is calculated from gross fixed capital consumption percentage of GDP. Physical capital is used to acquire agricultural equipment and infrastructure, which aids to improve agricultural productivity (Chisasa and Makina, 2013; Zakaria *et al.*, 2019). An increase in capital increases agricultural productivity and vice versa.

Inflation is the rate of increase in the costs of production which reduces the purchasing power of money. Inflation refers to the continuous increase in the general price level in the economy which signals macroeconomic stability. When the general price level in the economy increases, the cost of production increases, agricultural productivity falls, limited food supply in the market brings about high demand which causes farmers to produce more to meet demand. Labour force consists of people aged 15 years and above who provide the workforce for the production of goods and services within a specified timeframe (FAO, 2018a, b). It involves the employed and unemployed people who are seeking jobs (Chisasa and Makina, 2013). Increase in agricultural labour force increases productivity and vice versa.

4. Discussion of results

4.1 Descriptive statistics

From Table 1, the mean, maximum, minimum and standard deviation values are applied to robust check the results. The variables normality level is ascertained from the values of skewness, kurtosis and Jarque–Bera probability. The values show that the mean AGRVA value for each nation varies from 3.329081 minimum to 55.77192 maximum values. The DCPSB average value ranges from 2.097239 minimum to 38.23270 maximum. The broad money supply has a maximum value of 44.13835 and a minimum value of 7.218083. The standard deviation values reveal that the AGRVA with value 15.77162 deviates furthest from the mean and land deviates least from the average with value 0.835609. The skewness of the variables shows that all the variables exhibit positive skewness except labour which is negatively skewed. DCPSB, M_2 and INF indicate leptokurtic activities while AGRVA, land, PHKAP and labour have platokurtic features. The series is not normally distributed based on the Jarque–Bera probability. Some macroeconomic environment factors from the individual CEMAC countries could explain the outcomes.

4.2 Estimated unit root test

From Table 2, the suggested panel unit root tests using Levin, Lin, and Chu; Im, Pesaran, and Shin, Augmented Dickey Fuller (ADF)-Fisher Chi-square and Philip Peron (PP)-Fisher Chi-square tests were used (Levin *et al.*, 2002). With Schwarz information criteria (SIC), automatic lag selection using intercept without trend, the variables are integrated of orders I(1) and I(0). The unit root test results predict a long-run impact of bank credit on agricultural productivity based on I(1) order of integration.

4.3 Correlation analysis

Table 3 shows that land and labour are positively correlated with AGRVA to the GDP while DCPSB, $M_{2,}$ INF and PHKAP negatively correlate with AGRVA to the GDP. Evidence of multicollinearity is absent because the parameters' coefficients are nearer to zero relative to the estimated 0.7 brink value. Land strongly correlates positively with the AGRVA.

4.4 Johansen–Fisher combined and Kao Residual panel Co-integration tests

In Table 4, the co-integration tests between the explanatory variables and the explained variable are performed using the Johansen–Fisher combined and Kao residual panel co-integration tests as suggested by Maddala and Wu (1999). The Johansen co-integration test has seven hypothesized co-integrating equations which focused on the Trace and Max-Eigen statistical tests values. The results show that the Trace test has five co-integrating equations and the Max-Eigen test has four co-integrating equations out of seven panel hypothesized test equations given that the equations were statistically significant at 5% level. The results indicate that co-integration exists within the variables, thus the null hypothesis of no co-integration is rejected. Using the Kao residual co-integration test, the results show a significant t-statistic coefficient at 10% level. The findings validate a long-term impact of the exogenous variables on the endogenous variable in the CEMAC states.

4.5 Panel ARDL regression

Since this study used panel data analysis, various countries' specific random and fixed effects are considered and the Hausman test is employed to determine whether the fixed effect or random is more appropriate. The Hausman test verifies exogeneity of the unobserved error variables. Table 5 shows the panel ARDL performed using AGRVA as the explained variable to determine the impact of long- and short-term elasticity coefficients of bank credit.

Table 1.
Descriptive statistics

	AGRVA	DCPSB	M2	LNLAND	INF	PHKAP	LNLAB
Mean	17.99063	8.772718	17.12469	11.74291	5.266171	16.63022	14.51260
Median	12.97831	7.473767	15.42315	11.52552	2.068615	15.69583	14.61523
Maximum	55.77192	38.23270	44.13835	13.12106	47.04008	37.66611	16.24486
Minimum	3.329081	2.097239	7.218083	10.85070	−29.69107	6.294841	12.43860
Std. Dev.	15.77162	6.167085	5.901186	0.835609	12.66325	7.906487	1.142028
Skewness	1.125951	1.731552	1.694874	0.775701	0.901340	0.560166	−0.282244
Kurtosis	2.902952	7.069816	7.111574	2.130833	5.107665	2.276065	1.859724
Jarque–Bera	25.40239	142.7825	141.9772	15.81150	38.45952	8.896116	8.094377
Probability	0.000003	0.000000	0.000000	0.000369	0.000000	0.011701	0.017471
Sum	2158.875	1052.726	2054.963	1409.149	631.9406	1995.626	1741.512
Sum Sq. Dev.	29600.53	4525.919	4144.055	83.09082	19082.60	7438.991	155.2032
Observations	120	120	120	120	120	120	120

Source(s): Constructed by author from E-views

Table 2. Estimated unit root test

	Levin, Lin and Chu	Im, Pesaran and Shin W-stat	ADF – Fisher Chi-square	PP – Fisher Chi-square	Integration order
AGRVA	−3.31092***	−3.22411***	28.6378***	13.4503***	I(1)
DCPSB	−4.04339***	−4.27075***	37.8187***	13.3287***	I(0)
M_2	−7.08521***	−8.20968***	65.8965***	72.3389***	I(1)
LNLAND	−6.08555***	−4.95014***	35.2650***	57.9500***	I(1)
INF	−9.92589***	−8.32445***	68.5266***	69.8781***	I(0)
PHKAP	−7.87584***	−8.41064***	68.8996***	77.9174***	I(1)
LNLAB	−3.72895***	−3.33879***	26.3523***	13.3302	I(0)

Source(s): Conceptualized by author from E-views, (***) denotes 1% significance level

Table 3. Correlation analysis

	AGRVA	DCPSB	M2	LNLAND	INF	PHKAP	LNLAB
AGRVA	1.000000						
DCPSB	−0.230800	1.000000					
M2	−0.492268	0.583339	1.000000				
LNLAND	0.902392	−0.293553	−0.406632	1.000000			
INF	−0.033836	−0.232776	−0.279282	−0.008880	1.000000		
PHKAP	−0.487758	0.103988	0.381404	−0.299159	0.022768	1.000000	
LNLAB	0.501854	0.060020	−0.115300	0.502551	−0.094667	−0.344883	1.000000

Source(s): Author's set up from E-views

Table 4. Johansen-Fisher combined and Kao residual panel co-integration tests

Hypothesized no. of CE(s)	Fisher Stat.* (Trace test)	Fisher Stat.* (Max-Eigen test)
None	172.2***	180.1***
At most 1	144.2***	90.75***
At most 2	65.16***	37.87***
At most 3	34.03***	25.06***
At most 4	15.59**	8.599
At most 5	13.06	12.29
At most 6	10.73	10.73
Kao Residual Co-integration test		
ADF		−1.457066*

Source(s): Author's construction from E-views, (***), (**) and (*) indicate 1%, 5% and 10% significance levels, respectively

The results reveal that DCPSB, land and PHKAP have significant positive impacts on the AGRVA. Broad money supply, INF and labour negatively impact AGRVA to the GDP at 5% level of significance. The findings show that a unit increase in DCPSB, land and PHKAP increase the AGRVA by 62.7%, 5237.5% and 37.3%, respectively. A unit increase in M_2, INF and labour decreases the AGRVA by 77.7%, 41.6% and 1580.4%, respectively. The results show that bank credit affects AGRVA significantly by 62.7% annually. The results of DCPSB agree with the findings of Agunuwa *et al.* (2015), Chi *et al.* (2020), Chisasa and Makina (2013) and Hassan (2017) but disagreed with the findings of Dhrifi (2014), Ikenna (2012) and Mubaraq (2021).

Variable	Coefficient
Long-run coefficients	
DCPSB	0.627481*** (2.761739)
M2	−0.776527** (−1.995344)
LNLAND	52.37544** (2.106614)
INF	−0.415716*** (−3.371952)
PHKAP	0.373289*** (2.716796)
LNLAB	−15.80488*** (−3.807855)
Short-run coefficients	
ECT	−0.145977
D(DCPSB)	−0.594809
D(M2)	0.536710
D(LNLAND)	420.4699
D(INF)	0.019412
D(PHKAP)	0.001326
D(LNLAB)	−25.71664
C	−50.13545
Hausman test	74.428229***

Source(s): Author's compilation from E-views, (***) and (**) indicate 1% and 5% significance levels, respectively

Table 5. Panel ARDL regression

5. Conclusion and policy implications

This paper investigates the impact of bank credit on agricultural productivity in the CEMAC from 1990 to 2019. Annual secondary data sourced from world development indicators are used. Agricultural productivity is measured by AGRVA to the GDP as the endogenous variable. The exogenous variables comprise DCPSB, broad money supply, land, INF, PHKAP and labour force. The Johansen–Fisher and Kao Residual panel co-integration test is performed to determine co-integration among the variables. The findings reveal that a long-term co-integration exists among the variables. To obtain the long-run coefficients, the autoregressive distributed lag technique is utilized. The findings disclose that DCPSB, land and PHKAP significantly and positively impacts the AGRVA in the long run. Broad money supply, INF and labour have a negative impact on AGRVA to the GDP in the long term.

Conclusively, the results show that bank credit significantly and positively affects agricultural productivity in the CEMAC countries. The results suggest that the CEMAC governments should encourage effective ways to increase bank credit flow to private enterprises in the agricultural sector through efficient bank's intermediation that will boost agricultural productivity. The governments should create more agricultural banks and improve the operation of existing ones to ensure that credit directed to agricultural activities is effectively and efficiently utilized. The Bank of Central African Economic and Monetary Community (BEAC) should apply aggressive policy which eliminates all the bottlenecks undermining credit flow to the private sector especially credit that mutually benefits the agricultural productivity and banking sector. Hence, the commercial banks should give more credit to private sector to mutually benefit the agricultural sector and the banking sector. The governments of the CEMAC economies should expand funding into the capital market which considerably boosts agricultural activities and productivity.

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