Access to Credit and Agricultural Productivity: Evidence from Maize Producers in Benin

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Abstract

The use of improved technologies in agriculture is seen as a way to increase agricultural productivity in developing countries. However, the weakness of agricultural financing impedes the ability of producers to acquire the requisite technologies for the development of their activity. While a large part of the literature highlights the positive effects of access to credit in terms of productivity, there is a growing body of works warning of its limited effects, thus calling for country-specific analysis. This article therefore contributes to the debate and aims to determine the impact of access to credit on agricultural productivity in Benin. To do this, we use the endogenous switching regression model to control for potential selection and unobserved heterogeneity issues associated with this impact analysis. The data used comes from the statistical databases of INRAB (National Institute of Agricultural Research of Benin), an institution affiliated to the Beninese Ministry of Agriculture. The results show that education, the amount of fertilizer used, the adoption of improved seed varieties are factors that determine producers' access to credit. Farmers' access to credit leads to an increasing of productivity around 30.67% and requires a comprehensive and coherent public action.

Key-words: Access to credit, Agricultural productivity, Endogenous Switching Regression model, Benin.
1. Introduction

Agriculture is a key sector of the Beninese economy. This sector is the main source of food, employment, and income. The agricultural sector contributes nearly 35% to the gross domestic product, employs nearly 70% of the working population and generates more than 80% of export earnings (MAEP, 2017). Because of its importance, public authorities have chosen to develop agricultural sectors more, in particular the food sectors that were hitherto neglected in favour of cash products such as cotton. In this perspective, the maize sector is ranked in second position out of the six (06) flagship agricultural sectors behind cotton (PAM, 2017). While the level of production of this cereal, widely consumed in Benin, makes it possible to cover household food needs\(^1\), the marketable surpluses generated are still not sufficient enough to meet the country's foreign exchange needs (MAEP, 2017). Insufficient surplus may be associated with low yield. For example, maize yield declined between 2011 and 2015, from 1422 kg/ha to 1281 kg/ha, with an average production of 1347 kg/ha over the same period. Lower yields could lead to lower income levels. Available statistics show a drop in real terms of the annual income per capita between 2011 and 2015, going from 154,070 FCFA\(^2\) to 148,424 FCFA, i.e. a decrease of about 3.7% (INSAE / EMICoV, 2015). As a result, the standard of living in rural areas decreased. The literature also shows that farmers in low-income countries are mostly poor (Cervantes-godoy and Dewbre, 2010; Salami et al, 2010). The studies point out that low productivity is one of the underlying factors for the low standard of living among farmers.

Sustained agricultural productivity is indeed necessary to reduce hunger and poverty in developing countries (DCs) like Benin (Noufé, 2020; Gupta and Gupta, 2020; Schneider and Gugerty, 2011; Devkota and Upadhyay, 2013). In the same way, Devkota and Upadhyay (2013) show that productivity growth contributes considerably to poverty reduction, through several channels among which are changes in real income as shown by Schneider and Gugerty (2011). Agricultural growth has important effects on the rest of the economy and therefore contributes to overall economic development. The effects are especially important in a context where the structure of the Beninese economy is characterized by the preponderance of agriculture.

However, productivity in the agricultural sector is still very low in many African countries (Nakano and Magezi, 2020). Large areas of arable land have remained untapped. Zedillo (2015) estimates the total unused arable land on the continent at almost 60%. Progress in improving agricultural productivity over the past three decades has been disappointing for majority of African countries according to the Africa Progress Panel (2010). In sub-Saharan Africa, agricultural productivity levels, although increasing, are still far behind those of other developing regions (Magrini et al., 2017). However, projections indicate that the next decade will be marked by rapid population growth, rising incomes, and urbanization which will exert pressure on the demand for food products. Recent production paths clearly show that this growing demand will not be able to be satisfied (OECD and FAO, 2016). These stylized facts pose the challenge of improving agricultural productivity in Africa in general and in Benin in particular.

The empirical literature identifies several factors which may explain low productivity. Exogenous factors such as climatic changes, invasions of insect pests, floods, etc., which are out of the control of farmers, also affect productivity levels. In addition to these constraints, there are other factors described as endogenous which are linked to the decisions of farmers. These include the low rate of adoption of modern technologies, such as chemical fertilizers, modern varieties and poor agronomic practices (Nakano et al., 2016; Otsuka

\(^1\) Maize is the first cereal crop in terms of production and is widely consumed in South Benin (see MAEP, 2016).

\(^2\) The FCFA is the local currency of Benin used by the countries of the West African Economic and Monetary Union (UEMOA) 1FCFA = 0.0015Euro.
and Larson, 2016). In this same vein, other works emphasize the lack of access to credit as an obstacle to the adoption of better technologies and agricultural practices (Guirkinger and Boucher, 2008; Moser and Barrett, 2006). Credit has been found to be key to improving agricultural productivity since Carter's seminal article (1988).

The low productivity of smallholder farmers is seen as the result of the effect of credit constraints. Theoretically, credit constraints have a negative impact on agricultural productivity. The poor, without sufficient collateral, are generally excluded from formal financial services because of high transaction costs and information asymmetries that increase formal banks’ reluctance to offer them these services (Stiglitz and Weiss, 1981; Akerlof, 1970). As a result, most poor smallholders are often unable to invest in new technologies or in the acquisition of inputs such as fertilizer, improved seeds, etc. (Higgins and Leturque, 2010; Markelova et al, 2009; Conning and Udry, 2007). For Feder et al. (1990), credit allows producers to have the necessary resources they need to cover the financing needs induced by the production cycle. This agricultural production cycle is particularly long because of the period between sowing and harvesting. The availability of credit allows for greater consumption and greater use of purchased inputs, which increases farmers' production and subsequently their income.

It is therefore not surprising that a large part of the literature shows the positive effects of producers' access to credit on agricultural productivity (Akudugu, 2016; Zafar and Arzoo, 2016; Khandker and Koolwal, 2014; Guirkinger and Boucher, 2008) even though some studies have shown that these effects are sometimes limited (Carter, 1989). Nevertheless, a number of recent studies perceive as challenging the many virtues of agricultural credit showing that the effects are not as predictable as one might think (Nakano and Magezi, 2020; Agbodji et al, 2019; Njeru et al, 2016). For example, Agbodji et al (2019) find contrasting results, highlighting a negative impact of cash credit on productivity. Nakano and Magezi (2020) draw attention to the insufficiency of a credit improvement policy in guaranteeing increased productivity. Such results highlight variations in the effects of access to credit and therefore call for specific reflections within countries.

This research follows this logic and provides answers to a number of questions for the specific case of Benin. What is the impact of access to credit on agricultural productivity in Benin? What are the determinants of access to credit in Benin? What are the channels through which access to credit affects productivity in Benin? The general objective of this study is to determine the impact of access to credit on agricultural productivity. It therefore intends to provide additional empirical evidence on the role of credit in increasing agricultural productivity in Benin. Most of the existing works on this issue in Benin broadly focuses on the determinants of access to credit or the financing mechanisms in agricultural sectors (Assogba et al, 2017; Sossou, 2015; Adégbola et al, 2009; Kodjo et al, 2003). However, few have focused on the interrelationships between agricultural credit and productivity (Djato, 2001). The results will therefore be very useful to public authorities by allowing them to better refine strategies to improve access to finance for producers. To achieve this, we estimate the productivity of farmers according to two identified regimes, namely those who have access to formal credit and those who do not. We rely on the results of the endogenous switching regression model using survey data to estimate the yield of factors of production when farmers are endogenously sorted between the two regimes.

The rest of the paper is structured as follows. Section 2 contextualizes the study by identifying productivity issues that constraint the majority of rural households in Benin. Section 3 reviews the existing literature on the agricultural performance with financing constraints. Section 4 presents the data used as well as the
Section 5 displays the descriptive statistics by highlighting the possible interrelationships between the main variables of the study and presents the main econometric results. Section 6 summarizes the major findings and draws the policy implications.

2. Financing and productivity challenges of agriculture in Benin

Agricultural production in Benin, like in other developing countries (DCs), is mainly practiced by smallholder farmers. The average land area is estimated at 1.7 ha with about 34% of farms covering less than one (01) hectare. Smallholders, estimated at about 550,000, account for nearly 95% of the output of the agricultural sector (MDAEP and UNDP, 2015). This sector has a preponderant share in GDP, averaging nearly 36% (WFP, 2017). Despite the importance of agriculture in Benin’s economy, the sector faces many financing challenges.

Agricultural financing in Benin, like in most sub-Saharan African countries, has long been provided by the public authorities. These direct State interventions in rural financial markets ended up in failure in the 1960s and 1970s, leading to the questioning of the state’s mandate in financing agriculture in favour of the Structural Adjustment Programs (SAP) in 1980s. The return of the Government to the agricultural sector was observed gradually towards the end of the 2000s, notably from 2006 following the change of regime which occurred in the country’s top leadership. The authorities then expressed the desire to make agriculture the backbone of the economy. The 2007-2008 food crisis further reinforced this and lead to the establishment of an emergency plan to support food security (PUASA). In addition to this plan, subsidies were established in order to support increased food production.

The various agricultural financing instruments planned in Benin are supposed to combine public actions with private initiatives (MAEP, 2016). The intent to develop the agricultural sector, as displayed by the public authorities, will result in the development of the strategic plan to revive the agricultural sector and the national plan of agricultural investment (PSRSA/PNIA). Despite the political will, the development of the agricultural sector is slowed down by the low level of funding. In fact, the resources allocated from the national budget and external funds established with the support of technical and financial partners to finance the implementation of the PSRSA, indicate a low level of funding for the sector. For illustration purposes, with an estimated agricultural investment of 1531.05 billion FCFA between 2011 and 2015, only 742.31 billion FCFA were invested by both the State and the private sector, i.e. a financial execution rate of 48.48% (See Table 1).

<table>
<thead>
<tr>
<th>Table 1: Financing of the Agricultural Sector Strategic Recovery Plan (PSRSA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td>Annual forecast</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Annual Realizations</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Annual Deviation</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Annual financial execution rate (%)</td>
</tr>
</tbody>
</table>

Note: All amounts on line (a) are in billions of FCFA and those on line (b) are in millions of Euros. The conversions are based on the exchange rate in effect on April 10, 2019, i.e. € 1 = FCFA 655.957. The annual financial execution rate is obtained by dividing...
the annual achievements to the annual forecasts. The annual deviations are given by the difference between the objectives set at the start of the year (annual forecasts) and the annual achievements.

Source: Authors, MAEP (2016).

The gaps in funding results in ineffective public administration including “the National Fund for Agricultural Development (FNDA)” created in 2014 and confirmed in 2017. The FNDA is indeed the main instrument expected to finance agricultural activities. The counters dedicated to implement this fund have not been operational since their establishment. The activities of this fund were only launched in 2018. In the absence of operationalization of the main financing instruments, actors in agricultural value chains continue to turn to decentralized financial services (DFS) to obtain funding despite the difficult conditions they face accessing finance and the inappropriate services they receive in respect to agricultural activities. Farming households continue to struggle in their attempts to develop their farms because of the lack of an adequate financing mechanism.

Producers, especially cotton farmers, have for a long time relied on FECECAM whose activities have been able to prosper thanks to a credit repayment mechanism favoured by the public monopoly in the sector (Wampfler and Mercoiret, 2002). These important initiatives, however, struggle to be effective. Most of the products provided by microfinance institutions (MFIs) in the agricultural sector are often either poorly designed or poorly adapted to the needs of the sector. This lack of access to credit is exacerbated by the virtual absence of an appropriate agricultural insurance mechanism. The nature and frequency of risks in agriculture demotivate insurance structures to provide insurance products to this sector. The experiences in this field are very recent in Benin and relate to the actions of private operators who include AMAB.

The association of farmers applying for group credit has not always been accompanied by a sustained increase in access to credit because of the high arrears resulting from the rejection of the solidarity guarantee by some members (MDAEP and UNDP, 2015). The situation in central Benin illustrates this difficulty. Agricultural cooperatives in this region are still not very familiar with the behaviour and history of their members, particularly in terms of loan repayments. This uncertainty about the credit repayment capacity associated with the hazards affecting agriculture justifies, among other things, the pronounced shortfall of financing in this sector. Due to the lack of adequate means to enlarge cultivated areas, many farmers in Benin, like in developing countries, work on a small scale.

These production constraints hinder public policies that are mainly aimed at the diversifying agriculture. Indeed, the potential of agriculture in Benin, particularly with regard to food crops, is still poorly exploited despite the increase in production. However, the public authorities have opted to develop the food sectors hitherto left behind in favour of cash crops such as cotton. In this perspective, the corn sector is ranked second out of the six (06) flagship agricultural sectors after cotton (WFP, 2017). If the level of production of this cereal makes it possible to cover the food needs of households, the fact remains that the generated marketable surpluses are not sufficient enough to meet the country’s real needs (MAEP, 2017). Meeting farmers' specific financing needs would significantly increase production and put maize in the range of cash crops that generate significant foreign exchange for the country and reduce poverty among farmers.

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3 The FNDA was created in 2014 by decree n° 2014-100 of January 31, 2014 but was not really operational. A more recent decree n° 2017-304 dated June 21, 2017 with the same purpose was taken by the new political regime.
4 Federation of Local Agricultural Mutual Credit Banks.
5 Benin Mutual Agricultural Insurances
The above development clearly indicates the challenges of financing in the agricultural sector and call for attention from public authorities. However, the effectiveness of public policies requires clarification of the relationship between financing and the performance issues.

3. Literature review

The issue of access to credit and agricultural productivity is well discussed in the literature. But there is no consensus on the nature of the impact. This lack of consensus in the literature on the effect of access to credit could be explained by the socio-economic realities and the initial agricultural endowments that characterize producers from one country compared to another (Seck, 2019). Moreover, this lack of consensus could be justified by the across country variations in the strategies employed by the public authorities to finance the agricultural sector. Indeed, it is well documented that the banking and non-banking financial systems are reluctant to finance agricultural activities given the risks inherent to the sector and the problem of information asymmetry raised by Akerlof (1970). Thus, financial institutions generally make their decisions by considering the uncertainties in the credit market due to imperfection of information (Stiglitz and Andrew, 1983).

Overall, the empirical literature identifies three trends in terms of the impact of credit on agricultural productivity. Firstly, there are those who point out the positive effects of credit in terms of improving agricultural productivity (Diallo et al., 2020; Agbodji et al., 2019; Akudugu, 2016; Kashif et al., 2016; Khandker and Koolwal, 2014; Guirkinger and Bourcher, 2008). Secondly, some studies conclude that credit has a limited or even neutral effect on productivity (Njeru et al, 2016; Khan et al., 2013). Thirdly, other studies see credit as having a negative effect (Kanako and Magesi, 2020; Agbodji et al., 2019).

Diallo et al. (2020) provided empirical evidence on the need to promote agricultural credit in production. They show that farmers accessing credit have a higher production than their counterparts at 37.32%. In the same vein, Ali et al (2014) find that the removal of credit constraints leads to an increase in agricultural productivity of at least 17%. Akudugu (2016) reveals a significant relationship between credit from formal and informal sources and agricultural production. He also shows the interactions between informal credit and farm size; formal and informal credit with farm size have a positive and significant effect on production. In their study on the nexus between credit and productivity constraints, Guirkinger and Bourcher (2008) conclude that the productivity of constrained households is determined by their endowments of productive assets. In addition, they find that formal credit constraints negatively impact the efficiency in resource allocation. These main results suggest the importance of credit in the performance of farmers. However, limited or neutral effects of credit on agricultural productivity have also been highlighted in the literature.

A growing body of research shows that credit access does not translate into increased agricultural productivity (Nwaru and Onuoha, 2010). Njeru et al. (2016) find that there is no difference in fertilizer use and yield between farmers who have access to credit and those who do not. Nwaru and Onuoha (2010) even find a better performance by farmers who do not benefit from credit compared to beneficiaries. Seck (2019) interprets this result as a sign of an inappropriate lending system. The poor performance of the farmers who benefited is also highlighted by Khan et al. (2013). The latter explain this as resulting from application of high interest rate, the delays generally noted in setting up loans, and the cumbersome administrative procedures.

Regarding the negative effects of credit on productivity, Nakano and Magezi (2020) are categorical. According to their findings, improving access to credit is not enough to increase the adoption of technologies
by smallholder farmers and lead to increased agricultural productivity and welfare. Agbodji et al. (2019) distinguish the effects by the type of credit. They specifically show a negative effect of cash credit on maize productivity versus a positive effect of in-kind credit. The precariousness and low purchasing power of small farmers explain these results. Due to a lack of sufficient savings and due to extreme poverty, small farmers sell their harvest even if it means resorting to borrowing at a future date to meet basic needs such as housing, health and education. As a result, loans obtained by these farmers are not used to acquire other factors of production such as improved seeds.

In view of the controversies raised from the literature, the issue of the role of credit in agricultural performance is still relevant. This study therefore contributes to enriching the available literature on the impact of access to credit on agricultural productivity assuming that credit is a key factor of improved agricultural productivity.

4. Methodology and data

This section presents the data that will be used in this study and describes the methodological approach that will be followed.

4.1. Data

The data used in this study come mainly from the statistical databases of the National Institute of Agricultural Research of Benin (INRAB) attached to the Ministry in charge of agriculture. The data were collected as part of a survey conducted in 2016 for the Agricultural Policy Analysis Program (PAPA). The survey aimed to determine the optimal conditions for increased production of maize and cotton in Benin. Thus, this survey was conducted among a sample of 490 maize producers in 49 communes of Benin. These communes were selected with respect to their appropriate agroecological conditions. Of the 490 respondents, 356 respondents produce maize for household consumption while 134 produce improved maize seed.

The collected data provides detailed information on the socio-economic characteristics of producers. The administered questionnaire also addresses issues such as credit constraints, use of improved maize varieties, use of inputs, costs and quantity of production, and yield. This study focuses on the relationship between access to credit and productivity. To do this, only data on maize producers for household consumption were considered. Indeed, as previously specified, the two groups of producers do not face the same technical constraints of production. For instance, the risk faced by the producer of maize for consumption differs from the risk pertaining to the use of credit for the purpose of seed production. Thus, the sample from which the empirical analyses are made comprises a total of 356 producers. For reasons related to the errors contained in nine (09) observations, they have been deleted. The remaining 347 observations will be used in this study.

4.2. Methodology

This section describes the empirical approach used to analyse the impact of access to credit on agricultural productivity and the extent of the productivity lost due to the lack of access to financial services by farmers in Benin. Specifically, it is a matter of assessing the differences in productivity between producers who have access to credit and those who do not. Estimating the effects of access to credit poses two methodological problems: unobserved heterogeneity and sample selection bias.
To control for these potential problems of selection and unobserved heterogeneity, we apply the Endogenous switching regression model to estimate the yield of farmers that have access to credit and those who do not (Ali and Deininger, 2012, Guirkinger and Boucher, 2008, Lokshin and Sajara, 2004, Freeman et al, 1998). In a first step, a probit model is used to estimate the determinants of farmers' access to credit from a number of socio-economic and credit variables identified as theoretically likely to influence the availability of access to or non-access to credit. Second, regressions of productivity models are applied separately depending on whether or not the producer has access to credit.

Let us consider \( d_i^* \), a latent variable that defines the status of the producer with or without access to credit and \( y_i \) his level of productivity.

The regression model with change of regime is specified as follows:

\[
\begin{align*}
    y_i &= \begin{cases} 
        y_{1i}^a = \alpha^a X_i + \beta^a Z_i + \mu_{1i}^a & \text{si } d_i = 1 \\
        y_{0i}^n = \alpha^n X_i + \beta^n Z_i + \mu_{0i}^n & \text{si } d_i = 0 
    \end{cases} \\
    d_i^* &= \gamma X_i + \delta W_i + \vartheta_i \\
    d_i &= \begin{cases} 
        1 & \text{si } d_i^* > 0 \\
        0 & \text{si } d_i^* \leq 0 
    \end{cases}
\end{align*}
\] (1) (2) (3)

Where \( a \) and \( n \) are the exponents of credit access and non-access, respectively. In equation 3, the binary variable \( d_i^* \) takes the value 1 if the latent variable \( d_i^* \) in equation 2 is strictly positive; which corresponds to the situation where the producer has access to credit. Otherwise, the binary variable \( d_i \) takes the value 0; which implies instead that the farmer does not have access to the credit market.

In equations 1 and 2, \( X_i \) denotes a vector of variables that can influence both the state of access to credit and the productivity \( y_i \) such as the characteristics of the producer such as age, gender, the level of education. \( W_i \) is a vector of variables that do not directly influence the productivity of the producer but intervene in the access to credit such as the follow-up of a specialized training by the producer. \( Z_i \) refers to all variables that affect only the farmer's productivity without having any influence on whether or not he has access to credit, for example, hired labour or family labour, and inputs (fertilizer, improved seeds, etc.). \( \alpha, \beta, \gamma \) and \( \delta \) are parameters to be estimated. The error terms in the two regimes (\( \vartheta_i, \mu_{1i}^a, \mu_{0i}^n \)) are assumed to follow a trivariate normal distribution with a zero mean and a covariance matrix equal to \( \Omega \).

Unobserved factors affecting the selection regime may also affect the productivity of the farmer. Lee (1978) and Maddala (1983) note that the terms \( \mu_i \) and \( \vartheta_i \) can be correlated and make estimators from ordinary least squares (OLS) inconsistent. To address this problem with the regime change regression model, the estimation of the selection and productivity equations is performed simultaneously using the full information likelihood method. This method has the advantage of obtaining estimates of robust standard errors, in contrast to methods that proceed step by step by estimating the equations separately (Guirkinger and Boucher, 2008, Petrick, 2004, Lee, 1978).

Under the assumptions made on the distributions of the error terms of Equations 1 and 2, and according to Lokshin and Sajara (2004), the log likelihood function of the switching regression model is given by:
\[
\ln L = \sum_t \left[ d_t \left( \ln(F(\eta_{1t})) + \ln(f(\mu_{1i}/\sigma_1)/\sigma_1) \right) \\
+ (1-d_t) \left[ \ln(1-F(\eta_{2t})) + \ln(f(\mu_{0i}/\sigma_2)/\sigma_2) \right] \right]
\]

Where \( F(.) \) a cumulative normal distribution function, \( f(.) \) is a normal density distribution function and:

\[
\eta_{ji} = \frac{(\gamma X_i + \delta W_i) + \rho_j \varepsilon_i / \sigma_j}{\sqrt{1 - \rho^2_j}}, \text{ with } j = 1,2
\]

With \( \rho_1 = \sigma_{1v}/\sigma_v \sigma_1 \) the correlation coefficient between \( \delta_i \) and \( \mu_{1i} \); \( \rho_2 = \sigma_{2v}/\sigma_v \sigma_2 \) the correlation coefficient between \( \delta_i \) and \( \mu_{0i}^n \), with \( \sigma_{1v} \) and \( \sigma_{2v} \) respectively the covariance of \( \delta_i \) and \( \mu_{1i}^n \), \( \delta_i \) and \( \mu_{0i}^n \). \( \sigma_v \), \( \sigma_1 \) and \( \sigma_2 \) represent the respective standard deviations of \( \delta_i \), \( \mu_{1i}^n \) and \( \mu_{0i}^n \).

The results of estimating Equation 4 using the full information likelihood method will be used to determine the potential productivity gains or losses resulting from the removal of access to agricultural credit or the level of productivity that could be reached by farmers without access to credit if they saw the removal of barriers to access to credit. The procedure will therefore consist of estimating of \( \Delta y_i = y_{1i}^a - y_{0i}^m \) for farmers who do not have access to credit. Using Equations 1 and 2, and according to Guirkinger and Boucher (2008), the expected value of the productivity differential \( \Delta y_i \) conditionally in the state of no access to credit \( (d_i = 1) \) is given by:

\[
E(\hat{\Delta} y_i | d_i = 1) = (\hat{\alpha}^a - \alpha^a)X_i + (\hat{\beta}^a - \beta^a)Z_i
\]

Where \( \hat{\alpha} \) and \( \beta \) are parameters to be estimated from the regression model with change of regime.

The higher the value of the differential forecast, the greater the loss of the productivity due to the lack of access to credit. If this is the case, then it would be urgent to put in place a mechanism to correct the problems of imperfections in the credit market to improve access to financial services for small farmers.

Prior to the estimation of the different models that have just been described, we will present the descriptive analysis showing the possible links between the main variables of the study. This descriptive analysis is discussed in Section 5.

5. Results and discussions

5.1. Descriptive analysis

As part of this work, a descriptive analysis is done before the actual econometric estimates. Thus, a descriptive analysis was performed on the main variables included in the study. Table 2 below presents the main results. From the results in Table 2, it appears that the surveyed maize producers recorded an average yield of 1283.38 Kg per ha with a maximum yield of 5650 Kg/ha against a minimum of 183.33 Kg/ha. The variability around this average is of the order of 761.25 Kg/ha. Producers achieved this average yield while averaging an area of 2.39 ha. The largest area planted by the producers in the sample is 4 ha compared to a minimum of 0.1 ha. In order to plant this area, a number of factors of production have been used. In fact, the producers surveyed used on average 198.83 kg of inputs per hectare, 94.74 kg of seed on a plot. In addition, the surveyed producers have an average age of 52.05 years with the oldest aged 95 versus 30 for the youngest producer.
Table 2: Descriptive statistics of the main variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Yield (Kg/ha)</th>
<th>Age (years)</th>
<th>Land area (ha)</th>
<th>Quantity of inputs used per hectare (kg/ha)</th>
<th>Quantity of seeds used on the plot (Kg)</th>
<th>Capital per hectare (FCFA/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1283.38</td>
<td>52.05</td>
<td>2.39</td>
<td>198.83</td>
<td>94.74</td>
<td>8247.53</td>
</tr>
<tr>
<td>Minimum</td>
<td>183.33</td>
<td>30</td>
<td>0.1</td>
<td>0</td>
<td>5</td>
<td>6574.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>5650.00</td>
<td>95</td>
<td>4</td>
<td>1342</td>
<td>250</td>
<td>69661.80</td>
</tr>
<tr>
<td>Std, Dev,</td>
<td>761.25</td>
<td>10.49</td>
<td>0.84</td>
<td>102.17</td>
<td>58.52</td>
<td>5468.80</td>
</tr>
<tr>
<td>Obs.</td>
<td>356</td>
<td>356</td>
<td>356</td>
<td>356</td>
<td>356</td>
<td>356</td>
</tr>
</tbody>
</table>

Source: Authors from PAPA data, 2016.

Trying to fill the resource gap, some producers resort to financial institutions. Out of the 356 producers in the sample, 19.94% have access to credit against 80.06% who do not. A cross-analysis was performed between yield and access to credit as shown in Table 3. Approximately 19.94% with access to credit produce an average of 1672.268 Kg per ha against 1186.499 Kg per ha for producers without access to credit (80.06%). Farmers who have access to credit therefore realize an average yield slightly above the average of their counterparts who do not have access to it. The Chi2 test of equality between the means reveals that this difference observed between these two groups is significant. This result predicts a positive effect of access to credit on yield. In contrast, producers with access to credit have an average of 2.29 ha, which is below the average for all producers (2.38 ha) and that of producers who do not have access to credit. In fact, those who do not have access to credit exploit an area of 2.41 ha, which is therefore above the average for all producers. However, the equality test carried out shows that the difference in the farmed area observed between the two groups of producers is not significant.

Table 3: Socioeconomic characteristics of producers according to access to credit

<table>
<thead>
<tr>
<th>Variables</th>
<th>All</th>
<th>No access to credit</th>
<th>Access to credit</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (kg/ha)</td>
<td>1283.38</td>
<td>1186.499</td>
<td>1672.268</td>
<td>-4.969***</td>
</tr>
<tr>
<td>Area (ha)</td>
<td>2.386</td>
<td>2.409</td>
<td>2.294</td>
<td>1.034</td>
</tr>
<tr>
<td>Capital productivity</td>
<td>0.172</td>
<td>0.160</td>
<td>0.221</td>
<td>-4.607***</td>
</tr>
<tr>
<td>Age (years)</td>
<td>52.05</td>
<td>52.05</td>
<td>52.06</td>
<td>-0.008</td>
</tr>
<tr>
<td>Gender (Man=1) (*)</td>
<td>96.63</td>
<td>96.14</td>
<td>98.59</td>
<td>-1.023</td>
</tr>
<tr>
<td>Peasant Organization (*)</td>
<td>33.71</td>
<td>30</td>
<td>49</td>
<td>-3.14***</td>
</tr>
<tr>
<td>Education (At least primary=1, No level=0) (*)</td>
<td>50.3</td>
<td>49.8</td>
<td>52.1</td>
<td>-0.344</td>
</tr>
<tr>
<td>Adoption of improved seed (Yes=1) (*)</td>
<td>57.3</td>
<td>53.7</td>
<td>71.8</td>
<td>-2.788***</td>
</tr>
</tbody>
</table>

Note: *** , ** and * indicate the significance levels at the 1%, 5% and 10% thresholds respectively. (*) indicates that the statistics presented are in percent.

Source: Authors from PAPA’s data 2016.

In addition, access to credit differs sensitively across regions of the country. Overall, the trend shows that problems of access to credit are common in all regions of Benin. Farmers who have access to credit are largely in Northern region, where more than half of the producers in the sample (53%) are concentrated.

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6 This result has confirmed by the kernel density (see Figure 2).
However, the North is also the region of the country where the problem of inaccessibility to credit is more pronounced (Fig. 1). North Benin is also the region where population density is lowest thus allowing for access to large areas of agricultural land. Unfortunately, most farmers in this region do not have access to credit. However, as described in Figure A1 in the appendix, we find that access to credit could lead to an increase in the yield per hectare for these producers in the North.

Despite these statistics, we note that the best performances in terms of average yield were obtained overall in the South and the Centre (see Figure A1 in the appendix). However, it is not easy to show the likely effect of access to credit on the producers' performance in terms of yield based only on these descriptive statistics. We therefore conducted further analysis using econometric techniques and present the estimates in the next section.

5.2. Determinants and impacts of access to credit

This section presents the main econometric results regarding the effects of access to credit on the productivity of farmers. The estimated coefficients of the variables by the full information maximum likelihood method using endogenous switching regression model are reported in Table 4. The estimated correlation coefficient between the credit access equation and the productivity equations ($\rho$) is significantly different from zero. The results confirm that there are both observable and unobservable factors that determine farmers' access to credit and their productivity depending on whether or not they have access to credit. The significance of the correlation coefficient between the access to credit equation and the productivity equation of farmers who have access to credit suggests that there was self-selection in accessing credit. Likewise, the differences in the coefficients of the productivity equation of farmers with access to credit and those without access illustrate the presence of heterogeneity in the sample.
More concretely, the estimates lead to two main results. They make it possible to identify the main determinants of farmers' access to credit. The main explanatory factors of agricultural productivity depending on access or not to credit are also highlighted.

Table 4: Estimation of the endogenous switching regression model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Not access to credit</th>
<th>Access to credit</th>
<th>Selection Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: Yield (kg/ha)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.001</td>
<td>-0.001</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.005)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Gender (Male=1, Female=0)</td>
<td>-0.166</td>
<td>0.173</td>
<td>0.404</td>
</tr>
<tr>
<td></td>
<td>(0.122)</td>
<td>(0.260)</td>
<td>(0.361)</td>
</tr>
<tr>
<td>Education (At least Primary School=1, None=0)</td>
<td>-0.069</td>
<td>0.233*</td>
<td>0.231*</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.125)</td>
<td>(0.140)</td>
</tr>
<tr>
<td>Fertilizer (kg/ha)</td>
<td>0.395***</td>
<td>1.003*</td>
<td>0.582**</td>
</tr>
<tr>
<td></td>
<td>(0.078)</td>
<td>(0.514)</td>
<td>(0.239)</td>
</tr>
<tr>
<td>Log Fertilizer cost (FCFA)</td>
<td>-0.165***</td>
<td>-0.531**</td>
<td>-0.299***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.239)</td>
<td>(0.111)</td>
</tr>
<tr>
<td>Use of improved seeds (Yes=1, No=0)</td>
<td>-0.054</td>
<td>0.227</td>
<td>0.546***</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.212)</td>
<td>(0.201)</td>
</tr>
<tr>
<td>Central region</td>
<td>0.119*</td>
<td>-0.297</td>
<td>-0.466*</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td>(0.241)</td>
<td>(0.250)</td>
</tr>
<tr>
<td>Northern region</td>
<td>0.124*</td>
<td>0.253</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.223)</td>
<td>(0.217)</td>
</tr>
<tr>
<td>Extension services (Yes=1, No=0)</td>
<td>0.060*</td>
<td>-0.231</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.032)</td>
<td>(0.150)</td>
<td></td>
</tr>
<tr>
<td>Log Capital per ha (FCFA)</td>
<td>0.161**</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
<td>(0.126)</td>
<td></td>
</tr>
<tr>
<td>Agriculture as principal activity (Yes=1, No=0)</td>
<td></td>
<td></td>
<td>0.123</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.160)</td>
</tr>
<tr>
<td>Member of Peasant Organization (Yes=1, No=0)</td>
<td></td>
<td></td>
<td>0.156</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.108)</td>
</tr>
<tr>
<td>Constant</td>
<td>5.341***</td>
<td>6.862***</td>
<td>-1.217*</td>
</tr>
<tr>
<td></td>
<td>(0.583)</td>
<td>(1.524)</td>
<td>(0.640)</td>
</tr>
<tr>
<td>σ</td>
<td>0.386***</td>
<td>0.702*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.702)</td>
<td>(1.34)</td>
<td></td>
</tr>
<tr>
<td>ρ</td>
<td>-0.936***</td>
<td>0.892**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.121)</td>
<td></td>
</tr>
<tr>
<td>Wald test of indep. eqns. (chi2(2))</td>
<td>93.010</td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Prob</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log pseudolikelihood</td>
<td>-274.643</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td>356</td>
</tr>
</tbody>
</table>

* p<0.1; ** p<0.05; *** p<0.01
Source: Authors from PAPA’s data 2016.

From the results reported in column (3) of Table 4, it appears that education, the amount of fertilizer used, the adoption of improved seed varieties and the geographic location determine producers' access to credit.
Thus, farmers who have at least the primary level, are likely to have access to credit. Education increases the probability of farmers having access to credit in that it gives them the ability to master administrative procedures more easily. In addition, education appears to be one of the objective criteria that reassures lenders about the ability of farmers to learn more easily the best production techniques which appear to be the least risky. This result is consistent with that of Assogba et al. (2017) on a sample of producers in north-eastern Benin.

Saqib et al. (2018) find that farmers' access to credit increases with the level of education allowing better technical knowledge, a better understanding of markets and credit facilities. Farmers with many years of education therefore have a high probability of obtaining credit (Samson and Obademi, 2018; Mitra et al, 2018). Amjad and Hasnu (2007) indicate that the levels of education of household heads enabled them to cope with the procedures required to access loans. From this perspective, education plays a fundamental role in borrowing decisions and reduces the transaction costs of credit. Abedullah et al. (2009) in a study from Pakistan also find a significant relationship between access to credit and education. Due to the illiteracy of the majority of the farmers, they may not fully understand the procedures for accessing loans in formal institutions. Farmers with no education level are not able to understand and complete loan application forms on their own (Abedullah et al., 2009).

Access to credit is also positively associated with the use of fertilizers by farmers. The use of agricultural inputs such as fertilizer requires producers to incur expenses and leads them to seek loans from financial institutions. A similar case can be made for the adoption of improved seed varieties by farmers. The adoption of best practices that would lead to increased production indeed represents intangible guarantees that further reassures loan officers in financial institutions. Houeninvo et al (2019) have also shown that the adoption of improved seed varieties is associated with an increase in productivity allowing farmers to increase their income.

Regarding the explanatory factors of farmers' productivity, there are differences depending on their access to credit or not. The estimated parameters of the productivity model for farmers without access to credit and those who do have access to it are reported in columns (1) and (2) respectively. The use of fertilizers is crucial in explaining productivity whether it is farmers with or without access to credit. The determining role of fertilizers in the growth of agricultural productivity as we have demonstrated is also widely demonstrated in the literature (Rehman et al, 2019; Chandio et al, 2019; Asante et al, 2019). The total cost of seeds also appears to be negatively associated with productivity for both categories of farmers. An increase in these costs, as one would expect, negatively affects the productivity level of farmers with access to credit. However, Samson and Obademi (2018) note that the cost of seeds positively influences the productivity of farmers. Their result may be justified by the quality of the seeds, which would be a function of their purchase cost. Thus, the quality of seeds translated by the high cost is likely to increase productivity among farmers.

In addition, the results suggest that the productivity of farmers without access to credit is also determined by geographic location, extension services and capital per hectare. Among producers without access to credit, being located in the central and northern regions of the country positively influences productivity.

From the results thus obtained, we determined whether or not access to credit generates a gain in productivity. The findings suggest that farmers with access to credit obtain a productivity gain compared to those without access to credit (see Table 5 and Figure 2). Indeed, there has been an improvement in the productivity of farmers with access to credit. Access to credit leads to an increase in yield per hectare.
estimated at 1502.983kg/ha against 1150.141kg/ha for the counterfactual, i.e., an estimated increase of 30.67%. Several reasons can justify this good performance recorded among farmers with access to credit. Otsuka and Larson (2016) argue that access to credit enables farmers to adopt the best production technologies and acquire quality inputs. Access to credit offers the possibility for farmers to hire quality labour on their farms, which ensures they set up production under the most optimal conditions.

Table 5: Productivity difference according to access to credit or not

<table>
<thead>
<tr>
<th>Access to credit</th>
<th>No access to credit</th>
<th>Average treatment effect on treated (ATT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) (E(\hat{y}_{it}^a</td>
<td>d_{it} = 1))</td>
<td>(B) (E(\hat{y}_{it}^n</td>
</tr>
<tr>
<td>Yield (Kg/ha)</td>
<td>1502.983</td>
<td>1150.141</td>
</tr>
</tbody>
</table>

Note: (A) is the observed yield of maize; (B) the expected yield under the counterfactual.
\(d_{it} = 1\) if farmers have access to agricultural credit; \(d_{it} = 0\) otherwise.
\(\hat{y}_{it}^a\): Maize yield if farmers have access to agricultural credit.
\(\hat{y}_{it}^n\): Maize yield if farmers do not have access to agricultural credit.
Source: Authors, based on estimation results.

Figure 2: Kernel density of the logarithm of yield according to access to credit. Source: Author based on data from PAPA.

6. Conclusion

Agricultural productivity in developing countries (DCs) remains low and below the attainable levels. Insufficient productivity is a threat to food security in these countries where poverty levels are worrying. The poor access of producers to financial services such as agricultural credit is one of the factors that explain this low productivity. This article aimed to determine whether or not access to credit improves agricultural productivity in Benin. The analysis is based on the estimation of the Endogenous Switching Regression (ESR) model. The results identified the main factors that determine farmers’ access to credit on the one hand and farmers’ productivity on the other. Indeed, this study shows that education, the amount of fertilizer used,
the adoption of improved seed varieties and geographical location determine producers' access to credit. Also, the results of the ESR model suggest that farmers with access to credit present a higher productivity level compared to farmers who do not.

In view of the results of the impact assessment of access to credit, some measures could be taken to refine the public intervention strategies that aim to support the agricultural sector, in particular the food sectors. In fact, the National Agriculture Development Fund (FNDA), which is the relay of the Regional Agricultural Development Fund, will have to redefine the instruments and/or means of promoting agricultural financing. The results of this research suggest that actions should be taken both at the upstream level to facilitate access to finance and the downstream level to ensure the efficiency of credit in terms of productivity. Thus, to facilitate producers' access to credit, it will be necessary to encourage the intensification of literacy programs for the benefit of farmers. Likewise, it is necessary to initiate extension actions in order to support most of the farmers to adopt improved seeds since the adoption of improved varieties of seeds is likely to reassure the financial operators who see in it a sure way to increase productivity. A better subsidy policy that supports access to improved seeds should also be considered in order to make them more accessible to producers.

Moreover, it is also necessary to take measures to enable farmers in the southern part of the country to access credit. While it is true that the farmers in the south of the country work on small areas, it is also obvious that financial support granted to these farmers would lead to improved productivity and strengthen food security since maize is mainly consumed in this part of the country. It is also important that the public authorities strengthen technical supervision mechanisms of farmers through extension sessions. To this end, the territorial agricultural development agencies (ATDA) could conveniently be called upon to support the training of farmers.

Finally, due to the existence of a large proportion of farmers who do not have access to finance, the state actors involved in the promotion of agricultural financing in Benin can make the financial support granted to the agricultural sector more effective. The support intended for microfinance institutions (MFIs) should be operationalized through a relaxation of the refinancing mechanism set up with the FNDA. Periodic evaluation of such a device is necessary to ensure its effectiveness.
References


Gupta, K., & Gupta, A. S. (2020). Enhancing Productivity for Poverty Reduction in India.


Appendix

![Figure A1: Average yield by region and access to credit](image-url)

**Figure A1:** Average yield by region and access to credit