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# Access to finance and difference in family farm productivity in Benin: Evidence from small farms



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## ABSTRACT

In most of developing countries, agricultural finance is weak and there is a great constraint for family farmers to access credit. In that context, this article aims to analyze the effect of access to finance on the productivity of smallholders family farmers. Using a rich national representative survey data covering the 2016–2017 agricultural season, we estimated an Endogenous Switching Regression (ESR) model. The results show that access to credit has a positive impact on the productivity of smallholder farmers, with a gain of 15%. Small farmers manage to achieve a 13% increase in productivity, which is a very significant performance. These findings suggest the establishment of a policy to support small farms, so that they are more productive and more favorable to agricultural growth.

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## Introduction

Family farming and smallholder farming have really attracted interest in recent years, due to the weight and importance of the agricultural sector itself in economic growth, poverty reduction and development [1,7,11,12,37,52,53,56].

Family farming is a questionable concept, taking into account preconceptions such as the size of farms, the logic of rationality, the purpose pursued, etc. [13]. Taking this consideration into account, in Benin, family farming can be defined as an operation under the control of a family, with a permanent family workforce, and able to recruit external workers; the capital belongs to the family and the land is often inherited; the farm mainly cultivates food or cash crops but food production dominates; it mainly sells or consumes its production. Smallholder family farming have the same characteristics,

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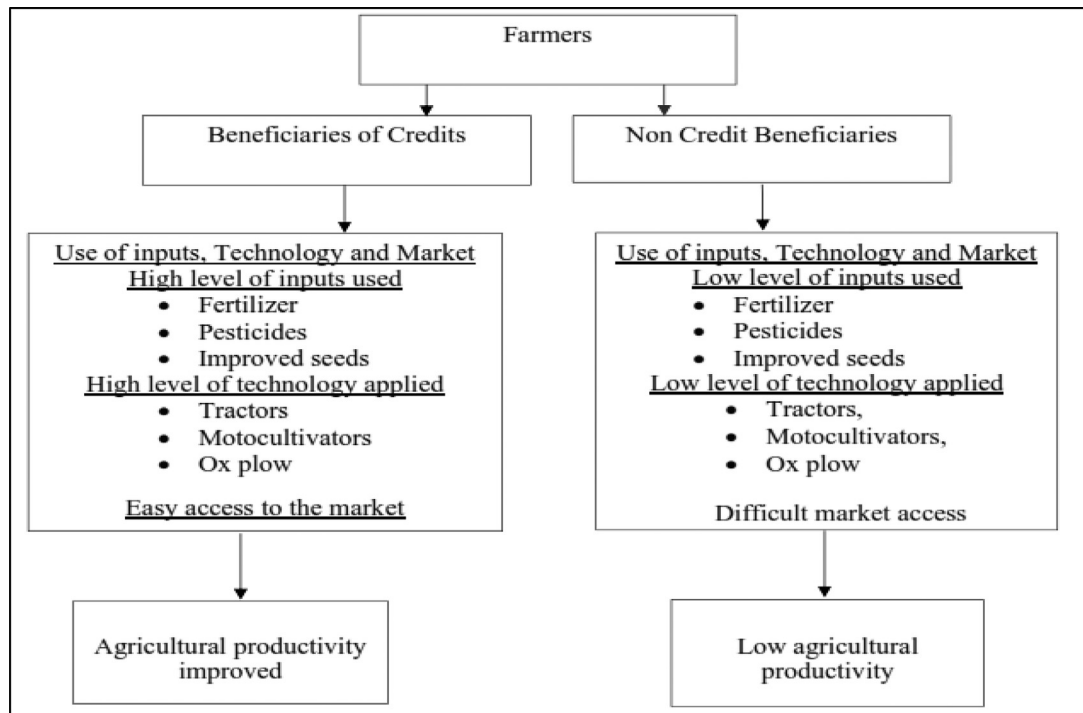
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except that the cultivated area is small. In the literature, the threshold for small farms is two hectares. However, it is recommended that the farm size threshold be adapted to national and regional contexts [19]. According to UNDP [54], a small farm has at most 01 ha; medium-sized farms have between 01 ha and 2 ha, and large farms have more than 2 ha. However, in West Africa, 95% of farms managed by an individual are smaller than two hectares. In this article, the UNDP definition of smallholder farming is used to reflect this information. A small family farm therefore has an area strictly less than one hectare, an average family farm has between one and two hectares, and a large farm has an area of more than two hectares. As much as family farming, access to finance and the productivity of family farming is also a subject of controversy, because of the controversies over the development of the two major types of agriculture existing in an economy: family farming and agribusiness. Two approaches coexist for this purpose: the pro agribusiness approach which relates the obstacles relating to the development of family farming and small-scale agriculture and the pro-family farming approach which traces the assets linked to this development [24].

For the proponents of the pro-agribusiness approach, including financial economists [34,45], there are several obstacles that block the growth and access to finance for family farming and small farms. One of the main arguments put forward is that these types of farms are unable to meet the challenges of globalization [14,22,33]. Thus, the intervention of international firms in developing countries crowds out small producers from agricultural markets [16]; the internationalization of the agri-food sector requires standards quality for agricultural products and therefore high production costs that small producers cannot bear [21,41,46]. In addition, the use of imports in political strategies affects the importance of agricultural products, lowering their price and the income of small producers and their jobs. The risks faced by smallholder farms namely production, market, and domestic risks are better managed by agricultural enterprises than small family farmers [40]. These facts modify the evolution of the aspirations of rural youth for whom the family environment is no longer necessarily the ideal reference [50,24]. In addition, they prevent small producers from having easy credit in the market unlike large farms [6,41]. The result is a low productivity of family farms in developing countries which remains far from that of the rest of the world, and which would be difficult or even very expensive to bring to a level that enables it to face international competition [24]. Smallholders farming are unable to generate a sufficient profit to allow the repayment of credit which they could benefit through the payment of the interest rates. This blocks them for future credit applications.

With regard to the pro-agribusiness approach, it appears that access to finance is challenging or even impossible for family farms and small farms. Ultimately, it leads to low productivity. These theoretical results have been evidenced in Benin, where there is indeed a low access to finance for family farming, mainly composed of small and medium-sized farms [48,54]. Indeed, interest rates have always been high and constitute a strong constraint to credit. Yet, for Microfinance Institutions (MFIs) which are closer to farmers, it has been shown that they could not finance income-generating activities at a rate lower than 36% [2]. More recently, it has been reported that the private sector grants only 10% of its credits to agriculture, and only 2% of these credits go to family farming [43]. Similarly, the public sector, does not sufficiently meet its commitments to the agricultural sector [43]. Thus, in Benin, the Maputo objectives would not always have been possible to achieve if all the resources invested by the State in rural areas had not been taken into account [3]. Access to finance prevents farmers from adopting cost-effective technologies by reducing them to rudimentary equipment and tools, which negatively affects their agricultural productivity [54]. For instance, the agricultural value added per agricultural economically active population, as well as the value added per sown area have only multiplied by two, in twenty years representing a fifth of the performance in Asia [54].

These empirical facts account for low access to finance for small farms as an inevitable phenomenon, and result in low productivity. On the contrary, the pro-family farming approach tries to show that access to finance for small farms is possible and that it can positively impact their agricultural productivity. The authors of these arguments show the importance of investing in small farms and consider that an investment in small agriculture would be a relevant way to increase production and reduce poverty [19]. Indeed, Johnston and Mellor [26] show that in rural areas the promotion of smallholder agriculture has a multiplier effect in terms of the use of labor and income distribution. Drawing on a historical perspective, Lipton [30] shows that there are no examples of agricultural development leading to poverty reduction without a large increase in productivity in smallholder agriculture. Improving their productivity should be a priority, because of their experiences. An increased productivity boosts the incomes of millions of smallholders and raises their standard of living [54]. This pro-family farming argument is based on a theoretical and empirical corpus that analyzes the consequences of access, low access or non-access to finance on agricultural productivity and socioeconomic indicators. Schultz [44] argues that small farmers can resist to modernization and that the problems they face would be resolved if cultivation techniques and the functioning of the credit market are improved. It shows that financing plays an important role for small producers. In the absence of agricultural credit, farmers would have great difficulties in carrying out their activities and making them profitable. These difficulties are linked to the limited quantity of inputs used by the farmer due to credit constraints. Feder et al. [18], beyond this role of credit, point out that credit not only increases the purchase and use of inputs but also increases the welfare of farmers. Indeed, if the farmer had an infinite supply of liquidity. But in practice, asymmetric information predominate in credit markets, leading financial institutions to adopt credit rationing [51]. Credit rationing negatively affects agricultural productivity and results in low incomes, with negative effects on household well-being and food security, compared to those of farmers without financial constraints [4,25,38]. A similar problem is raised by other authors who have shown that access to credit and other financial services by small farmers is a means of improving productivity, standard of living, reduction of poverty and the shift from subsistence agriculture to market oriented agriculture [9,18,47]. As credit rationing negatively



**Fig. 1.** Impact of finance on agricultural productivity  
Source: Authors, adapted from Girabi and Mwakaje, 2013.

affects income and food security, improving access to finance can increase farmers' investment choices and provide them with effective risk management tools [8,27,29].

The results of this study show that if family farms and smallholder farming access finance, their productivity is improved. In Benin, studies on the analysis of access to agricultural finance exist [48,49] and show that family farms can effectively access finance. However, these studies do not lead to an assessment of the impact of access to finance on agricultural productivity. It is therefore questionable whether family farms that access finance in Benin improve their productivity. This concern justifies the research questions addressed in this article: What is the effect of access to finance on the productivity of family farms? How does access to finance affect the agricultural productivity of small farms compared to medium and large family farms?

The article is structured as follows. Section 2 presents the literature review. Section 3 presents the methodology and data used. Section 4 presents the results and discussions and Section 5 concludes the study with some recommendations.

## Literature review

The theoretical analysis of the effect of access to finance on agricultural productivity presented in this article is a causal analysis and shows that farmers with limited access to credit risk underinvesting in productivity-enhancing inputs relative to their unconstrained peers, which would have significant consequences on their income and livelihoods [4,25,36,38]. The synthesis of these relationships is presented in Fig. 1. This figure captures the positive causality between access to finance and productivity through demand for and use of inputs, adoption of improved technology, and market access.

Empirically, several studies have focused on the effect of finance and socio economic variables on agricultural productivity. Feder et al. [18] analyzed using an Endogenous Switching Regression Model (ESR) the relationship between credit and productivity for Chinese agriculture, and find that farmer's access to capital has a significant positive effect on their productivity. Using the ESR model, the study by Guirkingner and Boucher [20] on credit constraints and agricultural productivity in Peru shows that credit constraints lower the value of agricultural production in the region by 26%. Reyes et al. [42], meanwhile, analyzed the factors that determine the productivity of fruit and vegetable farmers in Chile, and find that short-term credit has no impact on agricultural productivity, because of the constraints linked to it. In Nigeria, the effects of the agricultural credit facility on agricultural production and rural development were examined by Ekwere and Edem [17] using a stratified method reveals that the amount of the loan, the size of the farm and the inputs explain the variation in the total value of farmers' production. The work by Mukasa et al. [36] analyzed the nature, extent and impacts of credit constraints on Ethiopian agriculture. Using an ESR model, their findings show the determinants of credit constraints and their impact on farm's productivity are specific to the type of constraints imposed on farmers. These findings support the work of

Chandio et al. [10] on the effects of agricultural credit on wheat productivity of smallholder farms in Sindh, Pakistan. Using an instrumental variable model, these authors conclude that agricultural credit has a significant positive effect on wheat productivity, with a greater effect of short-term credit than that of long-term credit.

It appears that access to finance has a positive impact on agricultural productivity, but this effect can be amplified by the presence of socio-demographic variables. In fact, the way in which economic and financial variables influence agricultural productivity may depend on credit conditions but also on the socio-demographic characteristics of the farmer. For example, the lack of education or training among farmers can contribute to technical inefficiency which is a source of underperformance [15,28]. Likewise, education and the type of activity positively impact agricultural productivity in a non-binding credit environment [18,42].

## Methodology

The challenge in this study is to estimate the causal effect of access to finance on smallholder productivity. Several techniques have been used in recent studies. They include the Linear Probability Model; Probit and bivariate probit regressions, Heckman selection model, the Propensity Score matching methods, the linear regression model with endogenous treatment effect the Endogenous Switching Regression [18,36]. In this study we employ the Endogenous Switching Regression (ESR) instead of other impact evaluation technics, in particular the linear regression model with endogenous treatment effect, because of its ability to minimize the various biases of impact evaluation [18,36]. However, there are two main biases from impact evaluation models. The first bias is linked to the heterogeneity between individuals receiving treatment and those who do not, due to factors other than treatment. In this case, nothing proves that the result would be induced by the single treatment variable. The second bias, called endogenous selection bias, is linked to the problem of finding a comparison group if the effect of the treatment on the outcome of the beneficiaries is sought, instead of the outcome in the entire population of treated and not treated individuals. This comparison group has the same characteristics as the control group and selected so that the two groups are differentiated only by the treatment variable.

### Estimation strategy: endogenous switching regression

The ESR model estimation is made in two steps. In the first step, a probit model is used to estimate the determinants of the treatment variable. The second step produces two types of outcome: an outcome for treated individuals and for untreated individuals.

Access to credit a proxy for access to finance in this study can be analyzed in the context of utility maximization theory. Let  $U_{i1}$  be the utility derived from the access to credit and  $U_{i0}$  be the utility derived from not having access to credit. Let's denote  $U_i$ , the difference in utility between access and non-access to finance. The farmer  $i$  decided to request credit when it gave him more utility than in the case of non-access. Mathematically, we will have.

$$U_i = U_{i1} - U_{i0} > 0. \quad (1)$$

Since  $U_i$  is not observable, the preference of choice of the farmer can be represented by the latent variable  $Access_i^*$  for the access to credit:

$$\begin{aligned} Access_i^* &= \partial Z_i + \mu_i \\ Access_i &= \begin{cases} 1 & \text{if } Access_i^* > 0 \\ 0 & \text{if } Access_i^* \leq 0 \end{cases} \end{aligned} \quad (2)$$

Where  $Z_i$  is a vector of farmers' characteristics that are supposed to influence the access to credit and  $\mu_i$  the error term. The impact model of access to credit on farmer's productivity is presented as follows:

$$y_i = \alpha_i X_i + \beta_i Access_i + v_i \quad (3)$$

With  $y_i$  denoting the productivity of farmers,  $\alpha$  and  $\beta$  the parameters to be estimated and  $v_i$  the error term. Following Eq. (2), productivities are observed for the two groups [5,32].

$$\text{Regime 1 : } Y_{1i} = \alpha_1 X_{1i} + v_{1i} \text{ Access credit} \quad (4)$$

$$\text{Regime 2 : } Y_{2i} = \alpha_2 X_{2i} + v_{2i} \text{ Non - Access to credit} \quad (5)$$

Where  $y_{1i}$  and  $y_{0i}$  refer respectively to the outcome of a treated individual and that of an untreated individual;  $X_{1i}$  and  $X_{2i}$  are vectors of weakly exogenous covariates and  $v_i$  the error term. The error term in the Eq. (2) and the error terms in Eqs. (4) and (5) may be correlated. To address this problem, Eqs. (2), (4) and (5) will be simultaneously estimated using the Full information maximum likelihood method which appear as the most effective approach used with the "movestay" command under Stata [31].

Following previous studies [5,9], the ESR model is used to compare the productivity of farmers that had access to credit to the productivity of famers who did not have access to credit and to estimate the productivity gain in the case of counterfactuals where the beneficiary farmers have not accessed credit and those who did not access credit had access. The effect

of access to credit on farmers' productivity is expressed by Eq. (6). It is the "treatment effect on treaties" [23,5].

$$TT = E(y_{1i}|Access_i = 1) - E(y_{2i}|Access_i = 1) \quad (6)$$

Similarly, the effect of the treatment on non-treated (TU):

$$TT = E(y_{1i}|Access_i = 0) - E(y_{2i}|Access_i = 0) \quad (7)$$

Apart from access to credit which measures agricultural finance, the variables used in the specifications above are defined in Table SM1.

Most of these variables have been used in the literature. Agricultural productivity was used by Mukasa et al. [36], Guirkinger and Boucher [20]. Mukasa et al. [36] employ variables including household size, farming size, fertilizer use and improved seeds; but in the database used in this article, it is rather the cost of the fertilizer and its availability that were measured. An indicator to measure the use of agricultural mechanization was used by Muhammad and Farzand [35], it is the cost of purchasing machinery, while in this article, it is a qualitative variable measuring whether or not machines are used on the farm.

### The data used and collection procedure

The data used come from a national survey entitled "optimal conditions for increasing cotton and maize production"; this survey was carried out for the 2016–2017 agricultural season by the "Agricultural Policy Analysis Program [*Programme d'analyse des Politiques Agricoles (PAPA)*]" in agro ecological zones of Benin. The sampling method used has two stages: the selection of the villages and then that of the farmers to be studied.

The minimum size of the villages surveyed is given by  $n_0$  which is as follows:

$$n_0 = \frac{\left(U_{1-\frac{\alpha}{2}}^2\right) \times [p(1-p)]}{d^2} \quad (8)$$

$U_{1-\frac{\alpha}{2}} = 1,96$ ,  $p$  the proportion of representative villages in each study area,  $d$  is the margin of error set at 5% and  $U$  the reduced normal distribution. This formula is determined by the variable  $p$  which is calculated by the ratio: number of representative villages of the agro ecological zone divided by the total number<sup>1</sup> of villages in the area. The application of this formula gives a minimum size of 391 villages surveyed. Farmers were selected from these 391 villages.

The heads of agricultural were sampled by a stratified random selection according to the type of crop (cotton, maize, rice, and vegetable crops), the type of soil cultivated and their sex (woman or man). The minimum sample size is determined by the formula of Yamane [57] which is as follows:

$$n_0 = \frac{N}{1 + Nd^2} \quad (9)$$

$n_0$  is the minimum size of producers to be surveyed;  $N$ , the total number of producers identified in the study area (village);  $d$ , the desired level of precision. As in most studies, 5% was retained. This formula made it possible to obtain a minimum sample size of 1875 producers for all 391 villages distributed in respect to the number of farms listed per village.

In total, 1875 heads of small farm spread across all agro ecological zones and study departments were effectively interviewed on their production conditions and demographic characteristics. The following section is devoted to the analysis of the results and discussions.

## Results and discussions

Seven variables have been identified as determinants of agricultural productivity: cultivated area (Supcul), type of seed (Seed), cost of fertilizer (Fertilizer), availability of fertilizer (Engdispo), agricultural mechanization (PRODMEC), household size (Tmenag), and access to credit (ACCECREDIT). Descriptive statistics for these variables are summarized in Table 1 and partial correlation in Table SM2:

The cultivated area by producer is on average 2.18 Ha. Some producers use very small areas (0.08 Ha); they are part of the farmers working on a land of less than one (01) Ha; small farms represent 30% of the sample. Farms of more than one (01) hectare and less than two (02) represent 36%; they represent medium farms. Large farms exploiting more than two (02) hectares make 34%. Statistics show that farms have a strong preference for local seeds (71.78%). For 77.77% of farmers, fertilizer is expensive; but it remains available on the market for 74.96%. Table 3 shows two relationships. The first relation relating to the type of seed shows that the use of improved seeds, despite a great preference of farmers for local seeds, is positively linked to the improvement of productivity. As for the second, it indicates that the mechanization of production is also positively linked to an improvement in productivity. These relationships give rise to presumption of causality which is better refined by the estimation of the ESR model.

<sup>1</sup> This number was determined by the RGPH 3 database

**Table 1**  
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Access to credit	1871	0.230	0.421	0	1
Cultivated area	1867	2.177	3.118	0.08	61.30
Improved Seed	1871	0.282	0.450	0	1
Cheaper fertilizer	1795	0.222	0.415	0	1
Fertilizer available	1809	0.749	0.433	0	1
Mechanized production	1871	0.235	0.424	0	1
Household size	1871	11.08	5.392	1	43

**Source:** Authors, from the PAPA 2016–2017 database.

**Table 2**  
Estimation results of the ESR model.

VARIABLES	ln(Prodvtag <sub>1</sub> )	ln(Prodvtag <sub>0</sub> )	ACCECREDIT
Cultivated area	−0.0750***	−0.147***	0.0254**
Improved Seed	0.532***	0.518***	−0.0300
Expensive fertilizer	−0.522***	−0.239*	0.256***
Availability of fertilizer	0.272	0.138	−0.129
Saving			0.413***
Membership of a takeover bid			0.345***
Training received in agriculture			0.0141
Mechanized production	0.200	0.592***	−0.0551
Road in good condition and accessible			0.0650
Self-consumption (Sale)			−0.197**
Pledge as a mode of land acquisition			1.618**
Number of years of CE experience			−0.00802***
Food crops (Cotton)			−0.416***
CE age			0.00302
Man			0.531
Average age of household members			−0.00677
Average household size	−0.0190	−0.0203**	0.00633
Instruction rate			0.330**
Literacy rate			0.717*
Constant	8.850***	7.192***	−1.327**
Observations 1720	1720	1720	1720
lns1	lns2	r1	r2
0.588***	0.605***	−0.774***	−0.376***

LR test of indep.eqns:  $\chi^2(1) = 149.27$  Prob >  $\chi^2 = 0.0000$ .

(\*) (\*\*) (\*\*\*): Significance threshold 1%, 5% et 10% respectively.

From this result, the estimated linear equation of the ESR can then be written in the form:

The results of the estimation of the agricultural productivity analysis model are presented and then analyzed. Two types of analysis are performed. The first uses the direct determinants of productivity such as fertilizer, type of seed, cultivated area, mechanization and household size. In the second type, the impact of access to credit on productivity is studied, which makes it possible to assess and analyze the productivity gain, in particular that of small farmers relative to medium and large farmers. This paragraph is also the subject of an analysis of the robustness of the estimated model.

### Analysis of driving factors of productivity

The ESR model is employed to evaluate the impact of access to credit on the productivity of family farmers. Table 2 presents the Full Information Modified Likelihood (FIML) estimates of the ESR model. The model has a good fit with explanatory variables as shown by the significance of the likelihood ratio test of independence between the equations (p-value < 0.01). The estimated coefficient of correlation between access to finance and productivity is positive and significantly different from zero suggesting that self-selection occurred in access to finance.

**Table 3**

Impact of access to credit on agricultural productivity according to each type of farmer.

Type of family farm	Agricultural productivity with access to credit	Productivity counterfactual with access to credit	Impact of access to credit on agricultural productivity	Agricultural productivity gain
Small farms	1734.33	1502.84	231.49***	13.34%
Medium farms	1857.63	1598.96	258.67***	13.92%
Large farms	1786.12	1442.89	343.23***	19.21%

Significance level \*10% \*\*5% \*\*\*1%.

**Source:** Author, estimation results, from the PAPA 2016–2017 database.



To analyze the effect of variables on agricultural productivity, we use the elasticity which is equal to:

$$\begin{aligned} \frac{\frac{\partial \text{Prodvtag}}{\partial X_i}}{\frac{\text{Prodvtag}}{X_i}} &= \frac{\partial \text{Prodvtag}}{\text{Prodvtag}} \times \frac{X_i}{\partial X_i} \\ \frac{\frac{\partial \text{Prodvtag}}{\partial X_i}}{\frac{\text{Prodvtag}}{X_i}} &= \frac{\partial \text{Prodvtag}}{\partial X_i} \times \frac{X_i}{\text{Prodvtag}}, \\ \text{Prodvtag} &= e^{\sum_i \beta_i X_i} : \\ \frac{\partial \text{Prodvtag}}{\partial X_i} &= \beta_i \text{Prodvtag} \text{ and :} \\ \frac{\frac{\partial \text{Prodvtag}}{\partial X_i}}{\frac{\text{Prodvtag}}{X_i}} &= \beta_i \text{Prodvtag} \times \frac{X_i}{\text{Prodvtag}} \end{aligned} \quad (11)$$

The elasticity gives:

$$\frac{\frac{\partial \text{Prodvtag}}{\partial X_i}}{\frac{\text{Prodvtag}}{X_i}} = \beta_i X_i$$

To properly interpret this relation, each member of the equality is multiplied by 100, which gives:

$$\begin{aligned} 100 \times \beta_i &= \frac{100 \times \frac{\partial \text{Prodvtag}}{\partial X_i}}{\frac{\text{Prodvtag}}{X_i}} \text{ Finally :} \\ (100 \times \beta_i) \partial X_i &= \% \partial \text{Prodvtag} \end{aligned} \quad (12)$$

This relationship means that a one percent increase of  $X_i$  induces an increase in productivity by  $100 \times \beta_i$ , ceteris paribus [55]; this coefficient is a semi elasticity. The interpretation is valid for continuous  $X_i$  variables. If  $X_i$  is a dummy variable as is the case here for most variables, then:

$[\exp(\beta_i) - 1]\%$  is expressed as the average differential productivity between the expressed category and the reference category. For instance,  $\beta_i = -0,297$ , if  $X_i$  is a gender variable and the male category is a reference.  $[\exp(-0,297) - 1]\% = -25,7\%$ , then a woman would be, on average, 25.7% less productive than a man.

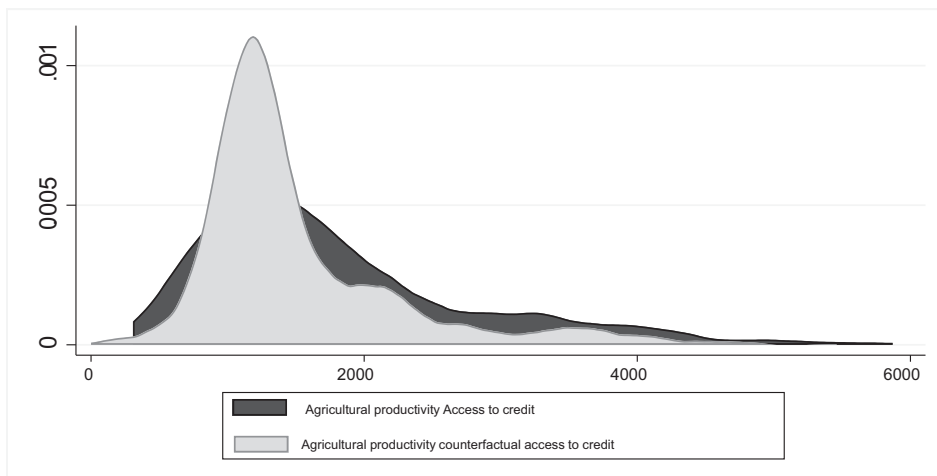
The increase in cultivated area negatively and significantly affects productivity in both groups of producers but much less among beneficiaries than among non-beneficiaries of credit. For non-beneficiaries, the decrease in productivity is 15 Kg / Ha, while it is 7.5 Kg / Ha for beneficiaries of credit. This poor performance in the two groups can be explained by the fact that more sown area requires financial means and that if these are lacking, they would have a negative impact on production. This would justify why the beneficiaries of credit feel less the negative effect of the increase in the cultivated area. The negative effect of the increase in cultivated area has been demonstrated by Piette [39], Mukasa et al. [36] and could therefore support the choice to prioritize the financing of small farms. In addition, the search for productivity should go through the productivity of production factors and that of producers and not through an increase in areas [39].

The adoption of improved seeds has a positive and significant effect on agricultural productivity in both groups of producers than that of local seeds; but the effect is slightly higher among beneficiaries. Indeed among beneficiary farmers, those who adopt improved seeds are on average 70.23% more productive than those using local seeds. With non-beneficiaries, this indicator is 67.86%. In the study by Mukasa et al. [36], only farmers with access to credit were able to improve their productivity with improved seeds, which can be justified by the fact that those who have access to finance buy the inputs to increase their productivity. However, most of farmers (71.78%) use local seeds.

Besides, the perception that fertilizer costs less significantly, decreases the productivity in both groups than if it were expensive; but the effect is more pronounced among beneficiaries than non-beneficiaries of credit. Among beneficiaries, farmers who consider fertilizer to be expensive are on average 40.66% less productive than those who find fertilizer cheaper, while among non-beneficiaries, this indicator is 21.25%. This situation is due to the fact that 77.77% of the farmers in the sample find the fertilizer expensive; even among the beneficiaries, farmers who find the fertilizer expensive constitute 72.01%. The theoretical positive effect of fertilizer on increasing production per hectare is irrefutable since it brings nutrients to the soil which passes them on to the crops. However, a perception of the high cost of inputs can lead farmers to abstain from them or reduce their use; this is particularly the case for those who have the means and the habit of taking it, like the beneficiaries of credit who could resort to organic fertilizers.

The availability of fertilizer has an insignificant positive effect on productivity regardless of the farmer; this result can be understood simply by the importance of its cost rather than its existence. This variable positively but not significantly affects the productivity of beneficiaries. On the other hand, it has a positive and significant effect on that of non-beneficiary producers. Thus, among non-beneficiaries, farmers who try to mechanize their production would be on average 80.76% more productive than their counterparts who only use rudimentary means such as hoe, cutter, etc. The non-significant result noted among the beneficiaries can be explained by the fact that the users of mechanization are more numerous among the beneficiaries than among the non-beneficiaries. Indeed, among beneficiaries of finance, they represent 31.48% while among non-beneficiaries they are in a proportion of 21.13% (Table 2).

The average number of household members has a negative effect on the productivity of beneficiaries and non-beneficiaries; this effect is insignificant among beneficiaries and significant among non-beneficiaries. Among non-beneficiaries, the increase in the size of households with additional labor decreases productivity by 02 Kg / Ha. In the study by Mukasa et al. [36], on the other hand, it is among the beneficiaries that the negative effect of household size on



**Fig. 2.** Difference in productivity with counterfactual  
Source: Authors, from the PAPA 2016–2017 database.

agricultural productivity is observed. This result can be explained by the fact that an increase in the size of the household is not enough to be productive; the quantity of production factors is important, but these factors must be of good quality in the sense of Schultz and they must be productive [39]. Those who have access to credit would respect this principle a little bit, by acquiring at least small machines that are useful and more efficient than man, so that they are indifferent to the increase in the workforce. Non-beneficiaries, for lack of means, would adopt the opposite behavior, which could be the basis of a significant decrease in their productivity.

In total, the direct factors that significantly influence agricultural productivity are: cultivated area, seeds, cost of fertilizer, agricultural mechanization and household size. Improved seeds and agricultural mechanization, relative to local seeds and the use of rudimentary means, increase agricultural productivity, while the decrease in the cost of fertilizer relative to its increase in price, the increase in cultivated area and household size decreases agricultural productivity. However, the following clarifications should be made. The positive effect of improved seeds is significantly higher among beneficiaries than non-beneficiaries; that of agricultural mechanization is significant among non-beneficiaries while it is not among beneficiaries. Regarding the fall in the cost of fertilizer compared to its increase, its negative effect is stronger among the beneficiaries; the negative effect of the increase in area is less weak among beneficiaries, while that of the increase in household size is only significant among non-beneficiaries.

The analysis carried out makes it possible to know globally the influence of the variables that affect productivity in the model, but these details which are provided do not lead to a decision on the impact of access to credit on agricultural productivity and the gain in agricultural productivity due to access to credit.

*Impact of access to credit on productivity for all farmers: productivity gain*

From the estimation of Endogenous Switching Regression, it is possible to know the estimated value of agricultural productivity in the group of beneficiary farmers from that of non-beneficiaries of credit. The analysis of this predicted value is nothing other than the impact analysis which can be plotted, as it can be taken by a Student test of difference in average productivity conditional on access to credit to confirm graphical analysis. As for the gain in agricultural productivity, the formula of Guirkingner and Boucher [20] is used. This is the mathematical expectation of the difference between the predicted value of the productivity of beneficiaries and that of their counterfactuals. The higher the expected value of this differential, the greater the productivity gain due to access to credit, and the more important it is to work to minimize credit constraints to improve access to non-beneficiary farmers. By noting GP the productivity gain, and referring to Guirkingner and Boucher [20], and Mukasa et al. [36], the productivity gain is deduced by the formula:

$$GP = \frac{E(\widehat{Prodvtag}_1 / ACCECREDIT = 1) - E(\widehat{Prodvtag}_0 / ACCECREDIT = 1)}{E(\widehat{Prodvtag}_1 / ACCECREDIT = 1)} \tag{13}$$

To analyze the impact, an estimate using the Stata software makes it possible to generate the agricultural productivity of farmers with access to credit and that of their counterfactuals (Fig. 2).

By examining these two probability density curves, a clear difference emerges between the productivity of the farmers who have access to credit and that of their counterfactuals. Indeed, they clearly indicate that in general, the producers with the highest productivity represented by the field in green, are those who have access to credit. This difference corresponds

to the effect of credit on producers who have access to it. According to the Student test, this is a positive and significant effect at the 1% level. This difference is nothing more than the effect of the treatment on the treaties. On average, both of the two groups of farmers have positive productivity. The productivity of counterfactual beneficiaries is 1519.16 Kg / Ha while that of treated farmers or those having access to credit is 1797.33 Kg / Ha. It follows that the beneficiaries of credit have a much greater productivity and that the difference is equal to 278.17 Kg / Ha. The productivity gain would then be 15%. This result is much lower than that found by Mukasa et al. [36] in their work on the relationship between credit constraints and the productivity of small farmers in Ethiopia, which is 60.03%. This means that Ethiopian farmers are relatively four times more productive than Beninese producers. It is also lower than those found by Guirking and Boucher [20] on "credit constraints and agricultural productivity in Peru", which vary between 49% and 59%. In other words, compared to Benin, agricultural productivity would be at least three (03) times greater. This 15% productivity gain obtained in Benin suggests, in fact, that the agricultural productivity of non-beneficiary farmers would increase by 15% compared to their current level of productivity if they obtained credit. The productivity gain due to access to credit is therefore relatively high but above all significant. Thus, facilitating access to credit for non-beneficiary farmers would increase their productivity. Ultimately, access to credit significantly and positively improves the agricultural productivity of agricultural credit beneficiaries.

In short, the model made it possible to realize the importance of agricultural credit for farmers. Agricultural credit is relatively very profitable in Benin, especially with regard to the 2016–2017 agricultural season. This makes it possible to guarantee any financial support to Beninese family farmers and in particular to small farmers.

#### *The impact of access to credit on the agricultural productivity of smallholders*

After assessing the impact of access to credit on agricultural productivity for all agricultural producers, that of smallholders is just a matter of deduction. Thus, from the previous estimates of the ESR model, in order to know the agricultural productivity of smallholders, it was necessary to impose the surface conditions in the different graphic and algebraic syntaxes allowing to have the desired impact. This way of proceeding makes it possible to assess the impact not only for small farms but also for medium and large farms. The different results are summarized as follows:

These results reveal that access to credit has a positive impact on the agricultural productivity of small farmers who manage to achieve productivity gains close to those of medium and large farms. This is an evidence that if smallholders have access to credit, their productivity would be positively affected. This constitutes a justification for the support to be provided to this type of farmers. In general, the results obtained are based on a model whose estimation is very significant with regard to the various estimation indicators obtained such as the probability of chi-2.

#### **Concluding remarks**

This article aimed to analyze the productivity of Beninese family farmers. The analysis is carried out in two parts. In the first part, the direct driving factors of productivity such as fertilizer, type of seed, cultivated area, mechanization and household size are analyzed. In the second, the impact of access to credit on productivity is evaluated in order to identify the productivity gain. Finally, the article was also interested in examining the robustness of the model.

The following are identified as significant determinants of productivity: cultivated area, seeds, the cost of fertilizer, agricultural mechanization and household size. Among these variables, improved seeds and agricultural mechanization increase agricultural productivity, while the drop in the cost of fertilizer, the increase in cultivated area and the size of households decrease the productivity.

Regarding the impact of access to credit on agricultural productivity, the analysis carried out revealed that access to credit has a positive impact on the productivity of the beneficiaries of credit. This, therefore results in a gain in productivity following Guirking and Boucher [20] and show that the agricultural productivity of non-beneficiary farmers would increase by 15% compared to their current level of productivity if all the credit constraints they encounter could be removed. These different conclusions do not change significantly, even in the presence of new variables.

Several economic policy measures in favor of family farmers emerge from our results. Already, "the promotion of suitable financing instruments for small family farmers represents one of the major challenges of the PSDSA 2017–2021". The results obtained in this study support such an orientation of the PSDSA, and it would be important for this strategy to be well operationalized to allow farmers to have better access to credit and to make optimal choices in terms of purchasing inputs and adoption of better technological packages. The negative and significant effect of the increase in cultivated area on the productivity of beneficiaries and non-beneficiaries of credit albeit much less among beneficiaries than non-beneficiaries, is indicative of the great resources required for large areas. For this reason, state support to producers must also target medium and large farms, with emphasis on both the effectiveness and efficiency of production factors such as machines. Large-area farming can only be profitable with the help of agricultural machinery. It is important that public agricultural machinery programs restart with new, more profitable management strategies where farmers and the state are all winners. With an emphasis on both the effectiveness and efficiency of factors of production such as machinery. To improve agricultural productivity, the State must also support producers, by subsidizing improved seeds and fertilizers, which would allow them to buy these intrants at a lower cost on the market.

Considering the importance and the remarkable effort of family farmers in the agricultural production system of Benin, it would not be superfluous for the State to set up a "national program for the development of family farming in Benin".

The main objective would be to promote, guarantee and ensure agricultural financing, all actions that would allow it to transform, to modernize, and to be more attractive in the eyes of young people, with a view to achieving double economic growth.

### Declaration of Competing Interest

There is no conflict of interest to declare

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