Journal of Economics and Development Studies
December 2020, Vol. 8, No. 4, pp. 68-82
ISSN: 2334-2382 (Print), 2334-2390 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jeds.v8n4a6
URL: https://doi.org/10.15640/jeds.v8n4a6

Determining the Magnitude of the Impact of Agricultural Credit on Productivity

Steffie Raynica MBOULOU[1]

Abstract

The objective of this study was to assess the extent of the impact of credit on agricultural productivity in Congo. Data from the 2011 agricultural sector survey (AS), an endogenous switching regression (ESR), and a multiple linear regression (MLR) were used. The results obtained showed that in the Congolese context, access to credit depended on farmers' working conditions, but above all, the results showed that access to credit among farmers had a negative impact on their productivity. These results have made it possible to propose policy implications, such as the establishment of a financing system adapted to the Congolese agricultural sector, the creation of specialized agricultural banks, and the promotion of an increase in the availability of skilled labor.

Keywords: Agricultural credit, agricultural productivity

Classification JEL: N5, O13, O47, E51

Introduction

Access to credit is important for agricultural development (African Union, 2003; World Bank, 2007; G8, 2009). In this regard, Ahma (2010) argued that access to credit in the agricultural sector plays an important role in the development of a more productive and efficient sector. However, although credit is the most common means of financing in developed countries, in developing countries, it is sometimes difficult to access credit (Fouquet, 2014). This difficulty in accessing credit can be explained either on the supply side or the demand side. On the supply side, banks may find it very risky and costly to provide credit to small rural farmers and might ration the supply of credit or set up contracts that are too costly or too demanding in terms of collateral (Awotide and Al, 2015). On the demand side, farmers may not have sufficient collateral and may find it too risky to borrow (Boucher et al, 2008).

In addition, the lack of credit availability or the capital constraint faced by farmers is one of the major barriers to adopting modern technologies and improving efficiency and productivity. In addition, the financial constraints illustrated by high interest rates are changing the efficient allocation of savings to investment. These rates also thwart lending incentives by reducing access to credit for producers who break even below the interest rate (Acclassato, 2008). Guirkinger and Boucher (2008) found that credit constraints led to a decline in the value of agricultural production.

In the economic literature, the relationship between access to agricultural credit and agricultural productivity has been the subject of several controversial studies. To this end, two opposing points of view stand out: the first perspective involves studies highlighting the positive link between agricultural credit and agricultural productivity (Carter, 2003; Guirkinger and Boucher, 2008; ...), while the second perspective includes studies emphasizing a negative link between agricultural credit and agricultural productivity (Garcia, 1975; Texeira 1976; Taylor and Al 1986; ...). Thus, to date, the debate on the relationship between access to agricultural credit and agricultural productivity is not yet over. Moreover, the place of access to agricultural credit in the explanation of agricultural productivity remains a topical issue in Congo.

The following research question flows directly from the above: What is the magnitude of the impact of agricultural credit on productivity?

[1] Laboratoire de Recherche et d'études Économiques et Sociales (LARES), Faculty of Economics, University Marien, N'GOUABI of Brazzaville

The objective of this article is to assess the magnitude of the impact of credit on agricultural productivity. In this paper, the hypothesis is that the magnitude of the impact of agricultural credit on productivity is small. Indeed, similar to any sector, the agricultural sector needs financing to develop.

This article, in addition to the introduction (first section), is structured in five (5) sections. The second section is devoted to a review of theoretical and empirical work. The third section addresses the methodology for analyzing the magnitude of the impact of agricultural credit on productivity. The fourth section is devoted to the presentation and interpretation of the results. Finally, we conclude this article with the fifth section, which is devoted to the conclusion and policy implications.

1. Literature review of the relationship between credit and agricultural productivity

The debate on the impact of agricultural credit on productivity is examined in the theoretical and empirical literature.

1.1. The relationship between credit and agricultural productivity: a theoretical argument

At the theoretical level, access to finance would allow farmers to obtain insurance to mitigate potential production and marketing risks. This would encourage more people to engage in agricultural production at a commercial level and improve their productivity. Theoretically, Ricardo (1815) noted that agriculture can achieve great improvements with the increasing application of capital to fixed factors of production. However, capital accumulation is influenced by development within a country's financial system. Access to financial services is important for activities in the agricultural sector, particularly with the diversification of agricultural exports, where efforts are being made to increase exports of agricultural products. In fact, these farmers need credit for their activities, as most of these activities are capital intensive. Moreover, because of the cyclical nature of production, an optimal mix of productive resources is important to achieve productivity growth.

The main problem for potential lenders, such as commercial banks, is the problem of information asymmetry (Stiglitz and Weiss 1981). Indeed, lenders are at a disadvantage and are unable to perfectly identify "good borrowers" since the farmer has superior knowledge of the type of project they intend to produce, and only once the loan is secured will it be clear if the farmer will abide by the rules of the contract, leading to the problem of moral hazard. Because of this information asymmetry, we therefore assume that potential lenders demand that their loans be fully secured.

This breaks the assumption of separability between production and consumption decisions and changes in household preferences. Thus, the shadow price of the credit constraint will affect farmers' outputs (Stiglitz and Weiss, 1981; Singh, Squire and Strauss, 1986; De Janvry, Fafchamps and Sadoulet, 1991). Indeed, for a fixed cost of variable input X, a farmer could make higher profits by increasing the quantities used by X, but they are limited by the credit available (Ciaian & Swinnen, 2008). As a result, a farmer who is constrained by credit may use varying levels of suboptimal inputs and may not be able to achieve the maximum possible profit. Relaxing the credit constraint can therefore help the farmer increase their input use (Onumahand, 2011; Hussein & Thapa, 2012; Ololade & Olagunju, 2013) and thus improve their production level and hence their profit by keeping the cost of inputs variable. In other words, a constraining credit constraint will lead to suboptimal use of variable inputs: the higher the fictitious price of the credit constraint is, the lower the farmer's optimal level of demand for inputs. Thus, farmers under credit constraints are likely to invest in productivity-enhancing inputs relative to their unconstrained peers, with important consequences for their incomes and livelihoods.

1.2. The relationship between credit and agricultural productivity: empirical studies

The relationship between credit and agricultural productivity has been the subject of several empirical studies. The results of these studies have highlighted two opposing points of view. On the one hand, there is literature on the beneficial nature of agricultural credit on agricultural productivity (Awotide, 2015; Akudugu, 2016), and on the other hand, there is literature on the adverse, if not marginal, impact of credit on agricultural productivity (Wang and Liao, 2013; Baffoe et al., 2015).

By increasing a farmer's capital, credit promotes technical progress and enables the modernization of agriculture, which has a positive impact on productivity (Diagne, 2002). Modern agriculture consists of high-yield seeds, fertilizers and plant protection measures; the majority of modern inputs are purchased through intermediaries or on credit. Therefore, an efficient credit market enables farmers to meet the requirements for consumption and use of balanced inputs, leading to improved productivity (Feder et al, 1990; Iqbal et al, 2003). The availability of and access to credit (access to credit facilities) provides producers with the capacity to diversify the agricultural sector through new investments and allows for an increase in the intensity of use of fixed resources, such as land, labor and management. With regard to the work the first point of view, Nzomo and Muturi (2014) studied the relationship between participation in the agricultural credit market and productivity in Kenya. Analysis of data collected from 123 randomly selected smallholder farmers using cross-sectional data revealed that agricultural credit could increase farmers' incomes and productivity. Similarly, Nosiru (2010) studied the relationship between participation in a microcredit program and smallholder productivity.

The results of this study revealed a significant difference between the productivity of participating farmers and nonparticipating farmers. Thus, the author concluded that the participation of smallholder farmers in microcredit programs could improve their incomes. In addition, Kinkingninhoun et al. (2010) conducted a study to determine the effect of participation in agricultural credit on farmers' productivity. The authors showed that farm credit had a significant positive effect on rice yield. In analyzing access to credit and its effect on the productivity of young rice farmers in Nigeria, Adesiji et al. (2012) showed that despite the difficulties of access to credit encountered by farmers, there was an increase in their production when they had access to credit. In Tanzania, Girabi and Mwakaje (2013) studied the impact of participation in the microcredit program on the agricultural productivity of smallholders and concluded that participants in the microcredit program recorded higher agricultural productivity than nonparticipants. Rahman et al. (2014) concluded that providing loans to farmers is useful for improving agricultural productivity, as loans allow farmers to purchase a variety of high-yield seeds, fertilizers and pesticides.

Awotide (2015) examined the impact of access to credit on agricultural productivity in Nigeria using an endogenous switching regression (ESR).Following his analysis, based on the results obtained, the author concluded that access to credit had a positive and significant impact on cassava productivity, as there was a large difference between the farm households with access to credit and those without access. In addition, one year later, Akudugu (2016) studied the relationship between agricultural productivity, access to credit and farm size in Africa using the case of Ghana. He showed that there was a positive and significant relationship between certain sources of credit, both formal and informal, and agricultural productivity. Similar to Akudugu (2016), Seck (2019) found a positive relationship between access to credit and productivity in his paper entitled "Heterogeneous credit constraints and productivity of smallholder farmers in the Senegal River Valley". Then, he found that access to credit tended to be more advantageous for farmers with no ties to organizations than for affiliated farmers. Credit tends to improve the performance of farmers growing crops other than rice.

With regard to the work of the second point of view, several empirical studies have shown that in rural areas of some developing countries, credit constraints have a significant negative impact on agricultural production (Feder et al., 1990; and Carter, 1996), agricultural investment (Carter and Olinto, 2003) and agricultural profit (Carter, 1989). Indeed, several studies (Garcia, 1975; Texeira 1976; Taylor and Al 1986 and Steitich 1971) show that increased investment in production factors, such as mechanization equipment and fertilizers is not enough to increase production. An effective management and information system for farms would have to be put in place. In other words, they have access to credit and can buy modern factors for production, but this does not always guarantee the proper use of these factors. In this regard, Boucher, Guirkinger and Trivelli (2006) assessed the impact of credit constraints on agricultural productivity using a linear fixed-effect model and semiparametric techniques to control for unobserved heterogeneity at the household level. The results showed that credit constraints had a negative impact on agricultural productivity and that the performance of the agricultural sector depends on the strengthening of formal financial institutions.

Reyes et al. (2012) analyzed the factors that determine crop productivity in central Chile using a panel data model. They found that short-term credit had no effect on farmers' productivity. Moreover, loans obtained in the informal sector were used for consumption, which means that in the long run, informal loans cannot be used for productive activities (Nasir, 2007). Thus, it is difficult to establish a causal relationship between agricultural credit and production because of the existence of serious endogeneity problems, as increases in the supply and price of credit support are subcomponents of total investment in agriculture. The sources of borrowing can be formal or informal (Sriram, 2007). Thus, the absence of data at the informal level makes it impossible to rule out this relationship in any case.

Furthermore, Wang and Liao (2013), using a two-sector general equilibrium model that required data on consumption and financial frictions, showed that credit constraints decreased the use of intermediate inputs, which increased the use of labor input in provinces in China. As a result, workers were forced to stay in the agricultural sector, and labor productivity was low. Baffoe et al. (2015), in their studies to establish the relationship between access to credit and agricultural productivity in Ghana, analyzed the responses of 109 agricultural households of borrowers and nonborrowers and concluded that the difference in productivity between borrowers and nonborrowers was statistically significant. The increase in productivity was attributed to the technical efficiency of the borrowers.

In summary, the literature reviewed in this subsection suggested that improved access for farmers is likely to increase productivity. However, the fact remains that credit to farmers comes at a cost and is fraught with risk. Therefore, improving productivity as a result of obtaining credit is not a trivial matter because it depends on several factors. Thus, under certain conditions, credit to farmers has a perverse or negative impact on productivity. Through empirical analysis, we noted that to analyze the impact of access to credit on agricultural productivity, the Cobb-Douglas function is often favored (Nosiru, 2010; Kinkingninhoum et al, 2010), as is the regime change model with endogeneity (Ali et al, 2014; Awotide, 2015; Seck, 2017; Diamoutene, 2018; Seck, 2019).

2. Modeling the relationship between credit and productivity

This methodological section is divided into two parts. The first part is devoted to the specification of the model, and the second part is dedicated to the presentation of the data sources and the description of the data that will be used for the estimation of the model.

2.1. Presentation of the theoretical model and model estimation process

The objective of this paper is to assess the extent of the impact of credit on agricultural productivity in Congo. Following the lessons of the empirical literature review presented above, much of this work has focused on the limited dependent variable models (logit, probit) consisting of analyzing the determinants of the probability of access to agricultural credit and the nonexperimental impact assessment method, which does not take determinants into account. In this study, going beyond these models and methods, we adopted an impact assessment method that went beyond the identification of the impact and took into account the analysis of the determinants.

2.1.1. Presentation of the theoretical model

The model for assessing the impact of access to agricultural credit on agricultural productivity (regime change model with endogeneity) adopted in this study involves a two-stage process. The first stage consists of determining the probability of accessing agricultural credit on the basis of a probit model as follows:

$$P_i^* = \theta Z_i + \varepsilon_i$$

$$P_i = 1 \; if P_i^* > 0 \qquad (1)$$

$$P_i = 0 \; if P_i^* \leq 0$$

Where P is a binary variable reflecting access to agricultural credit?$P = 1$ if the farmer had access to credit, and $P = 0$if they did not have access to credit.θ is a parameter vector to be estimated. Z Is the vector that represents the characteristics of the producer and the farm. Finally, ε is the random error vector?

The second stage consists of estimating a linear regression model using ordinary least squares (OLS) while correcting for the selection problem to understand the causal link between agricultural productivity and the optimal mix of explanatory variables related to the decision to access agricultural credit. As a result, the regression equations conditional on access to credit can be written as follows:

Regime 1 (access to credit): $G_{1i} = x_{1i}\theta_1 + v_{1i} \;\; si \; P = 1$ (2a)

Regime 2 (no access to credit): $G_{2i} = x_{2i}\theta_1 + v_{2i} \;\; si \; P = 0$ (2b)

WhereG_{1i} and $G_{2i}$are the productivities of farmers in regimes 1 and 2, respectively. x_{1i} and x_{2i}represent vectors of exogenous variables assumed hypothetically to determine the agricultural productivity function, θ_1 and $\theta_2$are the parameters to be estimated, and v_1 and $v_2$are the error terms. The error terms are assumed to have a normal distribution, with a mean of zero and a non-singular covariance matrix.

2.1.2. Estimation method and presentation of variables

Previous studies have used a two-step method to estimate the endogenous switching model (Feder et al., 1990; Fuglie and Bosch, 1995). In the first step, a probit model of the criterion equation is estimated, and the predicted variables inverse $\gamma_1$andγ_2, representing the inverse of the Mills ratio are determined. In the second step, these predicted variables are used to yield the following sets of equations:

$$G_{1i} = \lambda_1 H_i + \theta_{1\varepsilon}\gamma_1 + \phi_1 P_{1i} + \eta_1 \qquad (3a)$$

$$G_{2i} = \lambda_2 H_i + \theta_{2\varepsilon}\gamma_2 + \phi_2 P_{2i} + \eta_2 \qquad (3b)$$

The coefficients of the variables $\gamma_1$and $\gamma_2$provide estimates of the terms of covariance $\theta_{1\varepsilon}$and $\theta_{2\varepsilon}$, respectively. Since the variables $\gamma_1$and $\gamma_2$have been estimated, the residuals $\eta_1$and η_2 cannot be used to calculate the standard errors for the two-stage estimates. While Lee (1978) suggested a procedure for obtaining consistent standard errors, particularly for the two-stage approach, Maddala (1983) argued that such a procedure requires a potentially cumbersome and complicated process that most studies have failed to achieve. For Lokshin and Sajaia (2004), the efficient method for estimating the ESR model in a single step is the maximum likelihood method. It is this method we choose.

The average treatment effect (ATT) on farmers without access to credit can be calculated as follows:

$$ATT = E(G_{1i} - G_{2i}|P_i = 1) = H_i(\lambda_1 - \lambda_2) + (\sigma_{1\mu} - \sigma_{2\mu})\gamma_1 \quad (4)$$

where $E(G_{1i}|P_i = 1) = H_i\lambda_1 + \sigma_{1\mu}\gamma_1$represents the expected outcome for households with access to credit if they had chosen to access credit and $E(G_{2i}|P_i = 1) = H_i\lambda_2 + \sigma_{2\mu}\gamma_1$denotes the productivity of farm households with access to credit if they had chosen not to access credit.

2.2. Data sources and descriptive analysis

2.2.1. Data sources

The data used in this thesis came from the ASS database. The choice of this database was justified in the introduction, but it should be remembered that this database contains data relating to the problem of improving agricultural productivity (financing of agricultural activities, characteristics of agricultural production systems, characteristics of holdings, etc.). In addition, these data were collected through the agriculture questionnaire and the questionnaire on the characteristics of household members. The number of households surveyed throughout the country was2, 961.

The description of the ASS database indicates that men practiced agriculture more than women (62.23%). Young people aged between 15 and 35 were in the minority (12.53%), while adults aged between 36 and 65 were in the majority (87.47%). Furthermore, with regard to groups, we noted that out of the 371 young people counted in the base, 53 belonged to a group, i.e., a total of 14.28% of young people chose to belong to a group, while 21.71% of adult farmers chose to belong to a group. With regard to credit, 2.97% of adults had obtained credit compared to 1.61% of young people. On the other hand, young people were more likely to adopt new technologies, such as fertilization, (44.20%) then adult farmers (34.5%).

Well before proceeding to estimate our impact assessment model (IAM) to correct the endogeneity problem, we had to make a choice on the optimal mix of variables concerning the selection equation and the substantial equation of our model. To this end, we drew on the empirical work of several authors (Awotide, 2015; Diamountene, 2018).

2.2.2. Study variables

The main variables retained were those we considered likely to explain access to agricultural credit and to show the impact of agricultural credit on productivity: productivity, fertilization, number of fields, labor force, age, sex, area, credit and membership of a group.

- Access to credit: Carter (1989) provided various explanations as to why credit is a determinant of agricultural productivity. We therefore expected credit to be positively correlated with agricultural production.

- Number of fields: Number of fields owned appears to guarantee repayment to the credit institution because the higher the number of fields is, the higher the income appears. A positive coefficient was expected for this variable.

- Fertilization: The use of fertilizers (natural or chemical) is intended to increase soil fertility.

- Labor: This variable specifies the use of family or paid labor within the farm household.

-Belonging to a group: Belonging to a group is positive for a farmer because the group becomes the interface between the farmer and the credit institution (Diamoutene, 2018). Furthermore, Akudugu (2012) found that the coefficient of this variable was positive. A positive coefficient was therefore expected for this variable.

-Sex: Farm households headed by men are known to be highly mobile and exposed to information (Kuwornu et al., 2012). Moreover, these men are also more likely to invest in agricultural activities by taking out credit compared to their female counterparts. We therefore expected that male-headed farm households were likely to have access to credit for agriculture. We therefore expected this variable to have a positive sign.

-Productivity: Agricultural value added per worker (a measure of agricultural productivity) is an indicator of agricultural productivity. It is the outcome variable.

The table below concerns the means and standard deviations of the variables used for the estimates.

Table 1: Statistics on key variables

Variables	Mean	SD
Productivity	1.326	3.505
Fertilization	0.357	0.479
Number of fields	2.032	1.607
Labor	0.599	0.490
Area	6938.247	13456.7
CreditA	0.028	0.1651
Belonging to a group	0.208	0.406

Source*: Author based on ASS data, 2011*

A reading of this table reveals that the average productivity of the sample was positive and equal to 1.326 and that the dispersion around the mean was concentrated. Indeed, the value of the standard deviation was not far from 0, i.e., 3.505. Moreover, it can be seen that in the whole sample, the farmers had an average of 2 fields.

3. Model estimation and interpretation of results

3.1. Presentation of results

The two-stage estimation of our regime-switching model with endogeneity using the maximum likelihood method produced two results: labor was a determinant of access to credit, and agricultural credit hada negative impact on productivity.

These results are summarized in the following two tables:

Table 2: Results of the estimation of the selection equation

Variables	Coefficients	Prob
Labor	0.311	0.042**
Age_2	3.676	0.977
Age_3	3.636	0.977
Number of fields	-0.428	0.000***
Belonging to a group	0.0456	0.769
Sex	0.008	0.963
Number of iterations	8	
LR chi2(6)	38.45	
Prob>chi2	0.000***	

***Significant at 1%, **Significant at 5%, *Significant at 10%

Source: *Author based on ASS data, 2011*

Table 3: Results of the substantial equation

Variables	Acces to credit		Non acces to credit	
	Coefficients	**Prob**	**Coefficients**	**Prob**
Fertilization	-2.254	0.169	0.428	0.361
Number of fields	-11.446	0.055*	-0.273	0.002***
Labor	6.978	0.085*	0.746	0.044**
Age_2	2.115	0.922	1.613	0.028**
Age_3	1.495	0.945	1.496	0.029
Sex	-0.563	0.445	0.053	0.870
Area	-0.000	0.872	-0.000	0.000***
_cons	-46.102	0.120	1.153	0.017
	Coefficients		**Prob**	
Mills	-10.307		0.527	
ATE	-69.456		0.065*	

***Significant at 1%, **Significant at 5%, *Significant at 10%

Source: Author based on ASS data, 2011

The results of the selection equation presented in Table 3 are of good quality. Indeed, the convergence of the model was rapid: it took place at the end of the fifth iteration. Similarly, the likelihood ratio test that allows us to assess the overall quality of the model suggestedthat the variables used to explain access to credit wererelevant because they are globally significant at the 1% threshold for a likelihood ratio with a chi2 valueof 38.45 with6 degrees of freedom, which allowedus to reject the hypothesis that all coefficients had null values; in other words, the model hadat least one nonzero coefficient.

For the substantial equation, the results obtained revealed that the inverse of the Mills ratio was negative; in other words, there wereunobserved factors that explained access to credit and hada negative impact on productivity. In the context of this work, this impact would not be significant at the 5% threshold. It is also observed that the inverse of the Mills ratio wasnot significant at the 5% threshold. This result suggestedthat the use of the ESR methodology wasnot justified since the error terms of the selection and substantial equations werenot significantly correlated. Thus, productivity is independent of access to credit, and therefore, the two equations can be estimated separately using multiple linear regressions.

The results obtained using this regression is presented in the following table:

Table 4: Multiple linear regression results

Variables	Coefficients	Prob
Number of fields	-0.046	0.000***
Credit A	-0.375	0.006***
Fertilization	0.0435	-0.665
Labor	0.226	0.000***
Sex	0.047	0.405
age		
2	-0.119	0.359
3	-0.048	0.715
cons	0.504	0.000
F (7, 1627)	4.22	
Prob > F	0.0001	
R-squared	0.0130	
Nombred'observations	1 635	

***Significant at 1%, **Significant at 5%, *Significant at 10%

Source: Author based on ESA data, 2011

The results of this regression showed that the degree of fit of the data to the model wasvery low. Only 0.06% of the total variability in productivity was explained by the variables used in the model. This result wasexplained on the one hand by the fact that the model didnot take into account all variables that are determinants in explaining productivity and on the other hand by the fact that the data are snapshot data that do not allow for structural phenomena to be taken into account in the explanation of productivity (the failure of the Food and Export Marketing Boards). On the other hand, the Fischer statistic is significant at the 1% threshold, which reassures us that the selected variables jointly contribute to the explanation of productivity. Thus, the relatively good quality of this model allows us to move on to the discussion of our results.

3.2. Interpretation of the results

Our results allowedus to draw two conclusions. The first is that labor and the number of fields were significant determinants of whether a farmer had access to credit. The second was that credit had an adverse effect on agricultural productivity.

3.2.1. Labor and number of fields: two determinants of access to credit

An important lesson to be learned from the results obtained was that access to credit depended on the working and organizational conditions of farmers. In this respect, the results obtained suggested that the coefficient associated with the number of fields or farms was negative and significant at the 1% threshold and that the coefficient associated with labor was positive and significant at the 5% threshold. Thus, the more fields the farmer has, the less access they will have to credit, or the fewer fields they have, the more access they will have to credit. These results also showed that farmers who use labor were much more likely to have access to credit than farmers who do not use labor.

These results can be explained by the fact that the organization and working conditions pose the problem of information asymmetry between the farmer and the worker. This asymmetry is likely to limit agricultural production. According to Feder (1985), employees on small farms are more motivated since most of them are family members. When they employ outside labor, family members play the role of supervisors. Conversely, owners of many farms need to hire supervisors to ensure that the work is carried out according to the terms of their contract. These supervisors represent a cost to the owner and thus reduce their profit (Assunçao and Ghatak, 2003). For these reasons, owners of several farms will tend to hire less labor to avoid the costs associated with supervision. Thus, labor on some farms is less intensive, and consequently, production is lower. However, access to credit takes into account the financial profitability of the farm, which depends on production. It is for all these reasons that it is easier for a holder of a few fields to access credit than a holder of several fields.

It should be noted that the use of labor, which is generally family labor for both work and supervision, is a sign of the good organization of the farm household, which can thus have easier access to credit than an individual farmer. This result aligns with that obtained by Ijioma et Osondu (2015), who showed that the larger the size of the household was, the greater the probability of the farmer having access to agricultural credit. Moreover, this result was reinforced by the results obtained by Duy (2012), who carried out work on the determinants of access to formal credit in rural areas in the Mekong Delta in Vietnam. Indeed, this author, based on a survey of 325 rural households, showed that apart from other factors (household capital endowment, marital status, distance to markets, location), access to credit was also explained by household size.

For farmers who own several fields, the different fields make it possible to diversify the crops and thus produce throughout the year. Indeed, diversifying production solves the cash flow problems and financing needs that farmers specializing in a single variety may encounter. This justifies the fact that having several fields implies a lack of access to credit.

3.2.2. Agricultural credit: an obstacle to productivity

The results in Table 3 provide at least one key lesson, which is that access to credit among farmers has a negative impact on their productivity. Indeed, the coefficient associated with ETA is negative and significant at the 10% threshold. In other words, on average, credit to farmers leads to a decrease in productivity of 59.2%.

This result reflected the situation of the credit market insofar as agricultural credit makes up less than 12% of total credit regardless of the time horizon (short term: 4.53%, medium term: 5.71%, long term: 11.45%). This situation suggested the existence of credit rationing in the agricultural sector. Indeed, as Guirkenger and Boucher (2008) have shown in Peru, the guarantee requirements imposed by lenders in response to asymmetric information lead not only to quantitative rationing but also to a rationing of transaction costs and risks. According to both authors, quantitative rationing as well as the other two types of nonprice rationing had negative effects on resource allocation and productivity.

In the Congolese context, the negative impact of access to credit on productivity can be explained using two arguments. The first, which is structural, relates to the conditions under which agricultural activities are carried out in Congo. The second relates to the functioning of the credit market.

With regard to the conditions under which agricultural activities are carried out in Congo, it should be noted first that agriculture is essentially based on small mixed subsistence farms: crop production is generally associated with small-scale livestock farming. It remains dominated by food crops (cassava tubers, maize, groundnuts, plantains, potatoes), which occupy 80% of the arable land. State farms cover approximately 10,000 hectares, and peri-urban agriculture covers 5,000 hectares. The average size of family farms is between 0.5 and 1 ha. Average yields are low, at less than one ton per hectare according to most estimates, apart from cassava, which has been estimated to yield approximately 7 T/ha/year. Cash crops (coffee, cocoa, oil palms, etc.) have declined sharply following the disorganization of the marketing system resulting from the liquidation of state-owned companies (food crop, coffee, cocoa and oil offices). In general, agricultural production is currently low and covers less than 30% of the country's food needs (African Development Bank, 2008). This poorly developed agricultural system faces other difficulties related to storage and product disposal infrastructure. In this regard, the survey conducted by the PDARP (2013), a summary of which is presented in the following table, gives us an overview of transport costs and waiting times for the evacuation of products.

Table 5: Evolution of transport costs and waiting time between 2010 and 2013

	2010	2013
Average transportation cost	2,870	2,750
Waiting time	6.5 days	4 days

***Source**: PDARP, 2013*

The table shows that despite the efforts made by the public authorities to pave national roads and rehabilitate certain agricultural roads, the evacuation of products from production basins to marketing centers remains a major concern. Indeed, the average cost of transporting agricultural products fell from 2,870 CFA francs in 2010 to 2,750 CFA francs in 2013, i.e., a drop of 120 CFA francs. This 4.18% decrease remains small in that it only improves the profit margins of commercial intermediaries while prices to producers remain unchanged or fall due to difficulties in transportation. This table also shows that the time taken by producers to find a transport vehicle decreased slightly, from 6.5 days to 4 days.

These 4-day waiting times require infrastructure to store agricultural products before they leave for the marketing centers. However, the country's logistical performance in this regard is still weak, as shown in the following table.

Table 6: Logistics performance indicators in 2018

Performance Indicators	Cameroun	Congo	Kenya	Côte d'Ivoire
Logistics performance index: quality of trade and transport infrastructure (1= low to 5 = high)	2.57248	2.066116	2.553886	2.886806
Logistics performance index: frequency with which consignments reach the recipient within the planned or scheduled time frame (1 = low to 5 = high)	2.565542	2.949395	3.176152	3.227109
Logistics performance index: competence and quality of logistics services (1 = low to 5 = high)	2.596936	2.281405	2.810438	3.227109
Logistics performance index: overall (1 = low to 5 = high)	2.595547	2.485858	2.814935	3.082253

***Source**: Excerpt from World Development Indicators, World Bank, 2019*

This table gives us the values of the logistics performance index, which is an indicator that takes into account the quality of trade and related transport infrastructure, the quality of infrastructure services, and the frequency with which shipments arrive at the consignee on time. The index ranges from 1 to 5. It is equal to 1 when the logistics performance is very poor and is equal to 5 when the logistics performance is very good. Thus, when comparing Congo's logistics performance with that of agricultural countries (Cameroon, Kenya, Côte d'Ivoire), it emerged that Congo had the lowest index compared to other countries in terms of the overall logistics performance. With the exception of the logistics performance index relating to the frequency with which shipments arrive on time, where Congo performs better than Cameroon, in the other aspects of logistics performance (logistics performance index - competence and quality of logistics services and logistics performance index - quality of trade and transport infrastructure), Congo remains below the other countries, such as Côte d'Ivoire, Kenya and Cameroon, which are agricultural countries.

The difficult conditions of agricultural activity that have just been briefly highlighted here suggest that the granting of credit to farmers to increase production and thus their productivity will come up against the problem of storage and disposal. A rational response by agricultural actors would therefore be to use credit for other purposes to meet their obligations to the bank rather than to increase productivity. This "rational" behavior poses the problem of adverse selection and moral hazard relating to the functioning of the credit market.

The adverse selection problem, referred to as an ex ante problem, occurs before the contract between the bank and the farmer is signed, particularly when the bank fears that it does not have enough information to decide whether to grant the loan. This problem results in the bank having difficulty or being inability to gather comprehensive information to select a credible farmer. In Congo, the problem of adverse selection is a real challenge, as the quantity and reliability of the information collected does not always allow confirmation of the creditworthiness of farmers applying for a loan, nor the regularity of their income (income that will be used to repay the requested loan). The bank will therefore fall victim to adverse selection due to pseudo farmers, who will present quality signals to the detriment of credible farmers. This problem is therefore the first reason why the loan granted by the bank might not granted be to the right farmer, and in this case, we cannot expect an increase in production and therefore an increase in productivity.

After the loan is granted, the bank may face a problematic situation related to the behavior of the pseudo farmer or even the credible farmer. This problem of ex post information, called moral hazard, results from a change in behavior or from a breach of the association between the bank and the farmer. This post contractual opportunism may result in the transmission of incorrect information or in ineffective actions undertaken by the farmer to satisfy their own interest at the expense of those of others. Moral hazards can be observed with two types of farmers: pseudo farmers and farmers. In the first case (the pseudo farmer), the objective is to capture the bank's resources for private use, sometimes unrelated to agriculture. Under these conditions, the credit granted by the bank has no link with agricultural production and, beyond that, with the productivity of the agents working in this sector. In the second case, the credible farmer will try to increase their production and will quickly realize that they can neither store nor transport the production in a timely manner.

Faced with the obligation to meet these commitments to the bank, the farmer develops a parallel commercial activity to meet the repayment of the credit but finds themselves traddling two activities, hence the drop-in productivity in the agricultural sector, which partly explains the result obtained in our work.

Conclusion

In Congo, as in most sub-Saharan African countries, low productivity is a major challenge, unlike in other regions of the world. To overcome this disadvantage, many solutions have been proposed, including access to agricultural credit. Thus, the objective of this second paper was to assess the impact of credit on agricultural productivity. First, we conducted a descriptive analysis of certain variables in the ESA survey database. Then, we conducted an econometric analysis. The methodology used, an endogenous switching regression (ESR), allowed us first to highlight the determinants of access to credit and then to see the impact of credit on agricultural productivity.

The results obtained on the determinants of access to credit highlighted an important lesson: whether access to credit depends on the working and organizational conditions of farmers. In fact, access to credit was explained by the number of fields worked, the labor force and the age of the head of household, while lack of access was explained by the number of fields worked, the area and the age of the head of household.

From these estimates, it appeared that access to credit among farmers had a negative effect on their productivity, which is contrary to the prevailing theory. This negative effect was justified by the high cost of credit, the little credit granted, and the cost of the credit granted. Indeed, only 4.58% of the individuals surveyed had obtained credit.

The value of the credits was not provided in the database, but as we have shown, the credits allocated to agriculture were mostly short-term credits with rates obliging farmers to carry out a second activity enabling them to finance the credit obtained. At the end of our work, the results obtained allowed us to propose economic policy implications, the first of which was to increase the availability of skilled labor, and the second was to set up a financing system adapted to the Congolese agricultural sector.

The Congolese government should invest in the training of human capital, as labor in the agricultural sector remains very inefficient but is necessary for the development of agricultural activities. Indeed, a skilled workforce is better able to integrate innovations in the agricultural sector. Efforts must be made so that the population can reach a level of education enabling them to accept innovation and thus improve the sector's yields. In addition, to overcome the difficulties of access to agricultural credit and to access credit that would allow investment in physical capital and increase productivity, it would be interesting to develop new financing systems adapted to farmers. These new systems must take into account the promotion of mutual and joint forms and several guarantees as alternatives to traditional bank guarantees.

References

Acclassato, D. (2008) Les plafonnements de taux d'intérêt en microfinance servent-ils réellement les pauvres et petits opérateurs économiques ? Mondes en développement, vol. 36, n°141, 93-109.

Adesiji, G.B. & Dada, S.O. &Komolafe, S.E. (2012). Problems Faced by Rural People in Accessing Health Care Facilities in Akure North and Akure South Local Government Areas of Ondo State, Nigeria. Journal of Applied Sciences Research. 8. 2260-2266.

African Union. (2003). Second Ordinary Session Maputo, MOZAMBIQUE. Assembly Declarations.

Ahma, W. (2010). Meeting the financial needs of smallholder farmers in Ethiopia. African small holders. Food Crops, Markets and Policy, 156.

Akudugu, M., Guo, E., Dadzie, S. (2012). Adoption of Modern Agricultural Production Technologies by Farm Households in Ghana: What Factors Influence their Decisions? Journal of Biology, Agriculture and Healthcare 2(3).

Akudugu, M.A. (2016). "Agricultural productivity, credit and farm size nexus in Africa: a case study of Ghana," Agricultural Finance Review, Emerald Group Publishing, vol. 76(2), pages 288-308, July.

Awotide, B.A. , A. Tahirou, A. Arega , V.M. Manyong. (2015) Impact of Access to Credit on Agricultural Productivity: Evidence from Smallholder Cassava Farmers in Nigeria. Conference, August 9-14, 2015, Milan, Italy 210969, International Association of Agricultural Economists.

Baffoe, G., Matsuda, H., Masafunii, N. And Akiyama, T. (2015). The dynamics of rural credit and its impact on agricultural productivity: an empirical study in Rural Ghana. OIDA International Journal of Sustainable Development, 7(5): 19–34.

Banque Mondiale. (2007). World Development Report 2008. Agriculture for Development. Washington, DC.

Boucher, S., Guirkinger, C., and Trivelli, C. (2006). Direct elicitation of credit constraints: Conceptual and practical issues with an empirical application to Peruvian agriculture. mimeo, University of California - Davis.

Boucher, S.R., Carter, M.R., Guirkinger, C., (2008). Risk rationing and wealth effects in credit markets: Theory and implications for agricultural development. Am. J. Agric. Econ. 90(2), 409–423.

Brave, S., Walstrum, T., (2014). "Estimating marginal treatment effects using parametric and semiparametric methods," Stata Journal, StataCorp LP, vol. 14(1), pages 191-217, March.

Carter, M. R. (1989). The Impact of Credit on Peasant Productivity and Differentiation in Nicaragua. Journal of Development Economics. 31: 13-36.

Carter, M. R. and P. Olinto (2003). Getting Institutions 'Right' for Whom? Credit Constraints and the Impact of Property Rights on the Quantity and Composition of Investment. American Journal of Agricultural Economics, Vol. 85 :73-186.

Carter, M. R., Fletschner, D. K., and Olinto, P. (1996). Does land titling activate a productivity-promoting land market? Econometric evidence from rural Paraguay. University of Wisconsin-Madison.

Ciaian, P., & Swinnen, J. (2008). Credit market imperfections and the distribution of political rents. 12th Congress of the European Association of Agricultural Economics. Ghent.

De Janvry, A., Fafchamps, M., &Sadoulet, E. (1991). Peasant household behaviour with missing markets: Some paradoxes explained. The Economic Journal, 101 (409), 1400-1417.

Diagne, A. (2002). Impact of Access to Credit on Maize and Tobacco Productivity in Malawi. In Manfred Zeller & Richard L. Meyer (eds.) The triangle of Finance: Financial Sustainability Outreach and Impact. John Hopkins University Press, Baltimore and London.

Diamoutene, A.K., (2018). Accès au credit Agricole et performance agricole dans la zone Office du Niger : Cas de la culture du riz.

Duy, V.Q. (2012). The role of access to credit in rice production efficiency of rural households in the mekong delta, Vietnam. CAS discussionpaper.84.

Feder, G. (1985). The relation between farm size and farm productivity: The role of family labor, supervision and credit constraints, Journal of Development Economics, 18, (2-3), 297-313

Feder, G., Lau, L. J., Lin, J. Y., and Luo, X. (1990). The Relationship between Credit and Productivity in Chinese Agriculture - a Microeconomic Model of Disequilibrium. American Journal of Agricultural Economics, 72(5) : 1151-1157.

Fouquet, B. (2014). Pour un développement du crédit à l'agriculture : l'option du mutualisme, FARM

G8. (2009). G8 leaders declaration: Responsible leadership for a sustainable future. 35th G8 summit, L'Aquila, Italy, 8-10 July 2009.

Garcia, J-C. (1975). Analise de Alocacao de Recursos porproprietarios e Parceiros en Areas de Agricultura de Substencia. Thesis, Universidade Federal de Vicosa

Girabi, F. et Mwakaje, A. (2013). Impact of microfinance on smallholder farm productivity In Tanzania: The case of Iramba district.

Guirkinger,C. ,Boucher, S. (2008). Credit constraints and productivity in the Peruvian agriculture. Agricultural Economics, 39 (3), 295-308.

Hussain, A. (2012) Small holder access to agricultural credit and its effects on farm productivity, income and household food security in Pakistan. Ph.D. Thesis. Asian Institute of Technology, Thailand.

Ijioma, J. &Osondu, K. (2015). Agricultural Credit Sources and Determinants of Credit Acquisition by Farmers in Idemili Local Government Area of Anambra State. Journal of Agricultural Science and Technology B. 5. 10.17265/2161-6264/2015.01B.004

Kinkingninhoun, F.M., Diagne, A., Simtowe, F., Agboh-Noameshie, A.R., Adégbola, P.Y.(2010). Gender discrimination and its impact on income, productivity, and technical efficiency: evidence from Benin. Agric Hum Values 27, 57–69 (2010).

Kuwornu, J. (2012). Agricultural Credit Allocation and Constraint Analyses of Selected Maize Farmers in Ghana. British Journal of Economics, Management & Trade. 2. 353-374. 10.9734/BJEMT/2012/2270.

Nasir, J. (2007). Downside of Informal Agricultural Credit.

Nosiru, M.O. (2010). Microcredit and agricultural productivity in Ogun State, Nigeria. World Journal of Agricultural Sciences, 6 (3), 290-296.

Nzomo M, Muturi, W. (2014). The effect of types of agricultural credit programmes on productivity of small-scale farming businesses in Kenya: A survey of Kimilili Bungoma Sub County. Journal of Economics and Sustainable Development, 5(23): ISSN 2222- 1700 (Paper).

Ololade, R.A., Olagunju, F.I. (2013). Determinants of access to credit among rural farmers in Oyo State, Nigeria. Global Journal of Science Frontier Research Agriculture and Veterinary Sciences. 13(2):17-22.

Onumah, G. and Meijerink, G. (2011). Innovative Agricultural Financing Models, Policy Brief, AGRINATURA.

Rahman, S.U., A. Hussain and M. Taqi (2014). "Impact of Agricultural Credit on Agricultural Productivity in Pakistan: An Empirical Analysis." International Journal of Advanced Research in Management and Social Sciences.Vol.3.No.4.

Reyes et al (2012) Impact of Access to Credit on Farm Productivity of Fruit and Vegetable Growers in Chile. Selected Poster prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

Ricardo, D. (1815). An Essay on the Influence of a Low Price of Corn on the Profits of Stock.

Seck, A. (2019). Heterogeneous credit constraints and smallholder farming productivity in the Senegal River Valley, Emerging Markets Finance and Trade.

Singh, I., Squire, L., & Strauss, J. (1986). Agricultural household models: extensions, applications, and policy. Baltimore: The John Hopkkins University Press.

Sriram, M.S. (2007), "Productivity of Rural Credit: A Review of Issues and Some Recent Literature", International Journal of Rural Management, Vol. 3, No.2, pp. 245-246.

Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. The American Economic Review , 71 (3), 393-410.

Taylor, T.G., Drummond, H.E., Gomes, A.T. (1986), Agricultural Credit Programs and Production Efficiency: An analysis of Traditional Farming in South-esatern Minas Gerais, Brasil. American Agricultural Economics Association, Washington

Texeira, T.D. (1976). Resource Efficiency and the Market for Family Labour: Small Farms in the Sertao of Nord-East Brazil. PHD Thesis, Perdue University

Wang, W. Liao, J. (2013) Financial Frictions and Agricultural Productivity Differences.

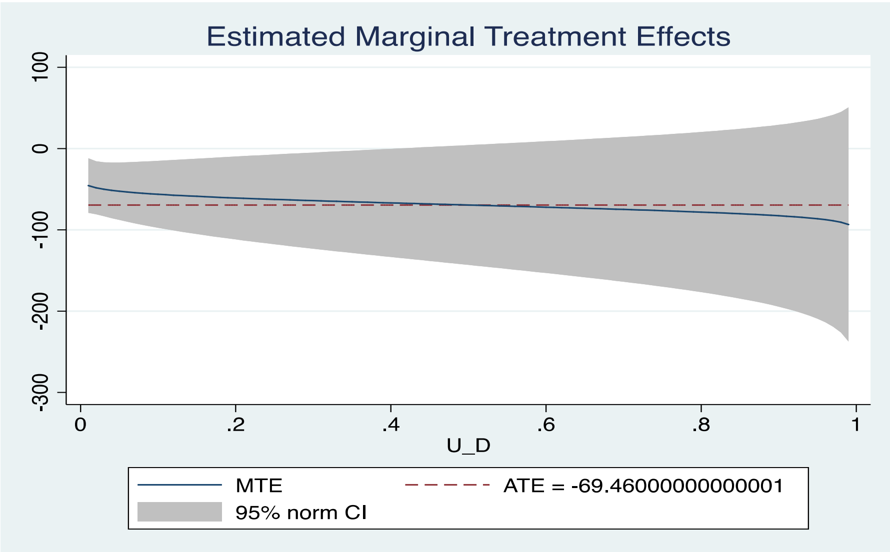
Appendix

```
.  xi:margte  (productiviteFertinombrechamps    i.MO  i.Age  i.SEXE_01_1  superficie  ),
treatment(creditA
>  i.MO i.Agenombrechamps i.APPA_GPT_01_1 i.SEXE_01_1 )first
i.MO              _IMO_0-1            (naturally coded; _IMO_0 omitted)
i.Age             _IAge_1-3           (naturally coded; _IAge_1 omitted)
i.SEXE_01_1       _ISEXE_01_1_0-1     (naturally coded; _ISEXE_01_1_0 omitted)
i.APPA_GPT_01_1   _IAPPA_GPT__0-1     (naturally coded; _IAPPA_GPT__0 omitted)

Iteration 0:   log likelihood = -213.13267
Iteration 1:   log likelihood = -197.96059
Iteration 2:   log likelihood = -194.14422
Iteration 3:   log likelihood = -193.92456
Iteration 4:   log likelihood = -193.90866
Iteration 5:   log likelihood = -193.90593
Iteration 6:   log likelihood = -193.90542
Iteration 7:   log likelihood = -193.90535
Iteration 8:   log likelihood = -193.90534

Probit regression                               Number of obs     =      1,635
                                               LR chi2(6)        =      38.45
                                                Prob > chi2       =     0.0000
Log likelihood = -193.90534                     Pseudo R2         =     0.0902
------------------------------------------------------------------------------
CreditA |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _IMO_1 |   .3117683    .153006     2.04   0.042     .0118821    .6116546
      _IAge_2 |   3.676871   128.1492     0.03   0.977     -247.491    254.8447
      _IAge_3 |   3.636767   128.1492     0.03   0.977    -247.5311    254.8046
nombrechamps|  -.4280852   .1083249    -3.95   0.000    -.6403981   -.2157722
_IAPPA_GPT__1 |   .0456237    .155662     0.29   0.769    -.2594682    .3507156
_ISEXE_01_1_1 |   .0081382   .1768632     0.05   0.963    -.3385073    .3547838
        _cons |  -5.077338   128.1494    -0.04   0.968    -256.2456    246.0909
------------------------------------------------------------------------------
Note: 7 failures and 0 successes completely determined.
(running parametric_normal on estimation sample)
Bootstrap replications (50)
----+--- 1 ---+--- 2 ---+--- 3 ---+--- 4 ---+--- 5
..................................................    50
Parametric Normal MTE Model                     Number of obs     =      1,635
Treatment Model: Probit                         Replications      =         50
------------------------------------------------------------------------------
             |  Observed   Bootstrap                         Normal-based
Productivite |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
Treated      |
Ferti|  -2.254982   1.640314    -1.37   0.169    -5.469939    .9599753
Nombrechamps |  -11.44664   5.965613    -1.92   0.055    -23.13903    .2457425
       _IMO_1 |   6.978525   4.048962     1.72   0.085    -.9572959    14.91435
      _IAge_2 |   2.115743   21.70952     0.10   0.922    -40.43412    44.66561
      _IAge_3 |   1.495863   21.75504     0.07   0.945    -41.14324    44.13496
_ISEXE_01_1_1 |  -.5635511   .7371606    -0.76   0.445    -2.008359    .8812571
Superficie |   -.000019   .0001178    -0.16   0.872    -.0002498    .0002119
            k |  -26.52474    14.9665    -1.77   0.076    -55.85854    2.809063
        _cons |  -46.10184   29.61459    -1.56   0.120    -104.1454    11.94169
-------------+----------------------------------------------------------------
Untreated     |
Ferti |   .4280691   .4690992     0.91   0.361    -.4913484    1.347487
Nombrechamps |  -.2737644   .0883196    -3.10   0.002    -.4468677   -.1006611
       _IMO_1 |    .746692   .3710688     2.01   0.044     .0194106    1.473973
      _IAge_2 |   1.613319   .7342292     2.20   0.028     .1742564    3.052382
      _IAge_3 |   1.495863   .6843663     2.19   0.029     .1545295    2.837196
_ISEXE_01_1_1 |   .0533424   .3265613     0.16   0.870    -.5867061    .6933908
superficie |  -.0000396   5.78e-06    -6.85   0.000    -.0000509   -.0000283
k |   -16.2176   7.018327    -2.31   0.021    -29.97327   -2.461936
        _cons |   1.153298    .484975     2.38   0.017     .2027644    2.103832
-------------+----------------------------------------------------------------
Mills        |
    rho1-rho0 |  -10.30713   16.28489    -0.63   0.527    -42.22492    21.61065
-------------+----------------------------------------------------------------
```

```
ATE              |
   E(Y1-Y0)@X |   -69.45645   37.61503     -1.85    0.065     -143.1805     4.267646
```




```
.   regressproductivitenombrechampscreditAFerti   i.MO   i.Age   i.SEXE_01_1     [pweight   =
superficie],r
>obust
(sum of wgt is 14,712,504)

Linear regression                               Number of obs     =      1,635
F(7, 1627)        =       4.22
                                                Prob > F          =     0.0001
                                                R-squared         =     0.0130
                                                Root MSE          =     1.1346

------------------------------------------------------------------------------
             |               Robust
productivite |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
nombrechamps |  -.0455717   .0129591    -3.52   0.000    -.0709899   -.0201535
creditA |  -.3750159   .1353272    -2.77   0.006    -.6404498    -.109582
Ferti |   .0435258   .1003753     0.43   0.665    -.1533527    .2404043
        1.MO |   .2263496   .0522149     4.33   0.000     .1239342     .328765
             |
         Age |
          2  |  -.1193606   .1300758    -0.92   0.359    -.3744943    .1357731
          3  |  -.0485539   .1327048    -0.37   0.715    -.3088442    .2117364
             |
 1.SEXE_01_1 |   .0473065   .0568153     0.83   0.405    -.0641323    .1587453
       _cons |   .5039997   .1411571     3.57   0.000     .2271309    .7808685
```