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JBEF
ISSN 2146-7943

Journal of Business, Economics and Finance YEAR 2023 VOLUME 12 ISSUE 1

# ANALYSIS OF RICE FARMERS' ACCESS TO AGRICULTURAL CREDIT AND PROFITABILITY IN SOUTH TOGO

**DOI: 10.17261/Pressacademia.2023.1722**
**JBEF- V.12-ISS.1-2023(1)-p.1-14**

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**Date Received:** December 28, 2022 **Date Accepted:** March 24, 2023



**To cite this document**
Agboklou, K.E., Ozkan, B., (2022). Analysis of rice farmers' access to agricultural credit and profitability in South Togo. Journal of Business, Economics and Finance (JBEF), 12(1), 1-14.
**Permanent link to this document:** http://doi.org/10.17261/Pressacademia.2023.1722


## ABSTRACT

**Purpose-** Access to suitable production means is required for producers to improve their profitability. As a result, agricultural financing appears to be a critical tool for attaining this goal. Various programs and donors have been attempting for decades to put together initiatives that would make it easier for the most disadvantaged populations, including the primarily agricultural rural world, to access sources of financing. Due to poor performance, the majority of these programs have failed. This study aims to investigate the determinants of credit access and how loans affect rice farm profitability.

**Methodology -** Data for this study were collected from 102 producers living in the two biggest paddy production zones in southern Togo. The treatment effect model was used to examine the data collected through the survey investigation.

**Findings-** Gender, asset type, producer experience, access to credit information, primary occupation, and land ownership status of the producer are all factors in determining rice growers' access to credit. Gender, producer experience, access to credit information, and land ownership status all have a beneficial impact on credit availability. However, asset type and the producer's main occupation have a negative impact. It also demonstrates that whether rice farms have access to loans has little bearing on their profitability. On the other hand, the average treatment impact of credit access is statistically significant. It also shows that the farmer's degree of education, expertise in the field, and lastly, the size of rice field farmed are the most important elements affecting the profitability of rice fields.

**Conclusion-** The findings have policy implications, increasing the channels for disseminating credible information about funding sources, access procedures and the institutions in charge of these funding sources. Integrating the enhancement of farmers' educational levels into rural support initiatives, and the extension of major agricultural landscaping works undertaken by the government to other areas suitable for rice cultivation.

**Keywords:** Agricultural credit, rice production, Probit-2SLS model, Togo.
**JEL Codes:** C26, D14, Q14

## 1. INTRODUCTION

As for most African countries, agriculture plays a very important role in development and the fight against extreme poverty. The economy of Togo is largely based on subsistence and commercial agriculture, with the agricultural sector accounting for over 54% of employment and about 40% of national income. The main agricultural products grown are coffee, cocoa, cotton, potatoes, cassava, maize, beans, millet, rice, and sorghum. Of these products, coffee, cocoa, and cotton are the country's major export items, and agricultural products account for more than 20% of export revenues (MAEP-FAO, 2013).

In developing countries, most agricultural producers are smallholders, usually depending on small-scale family land and labor. Most farmers in developing countries are smallholders, operating on a limited scale and often relying on family land and labor. Although there is no clear data available, in Togo, agriculture is mostly subsistence agriculture, but most of the time combined with cash crops (Djagni, 2002). According to (Adessou et al., 2017) smallholder producers in Togo refer to farmers who are unable,

on their own, to attract or secure the various benefits they need to improve the productivity of their production capital, i.e., production goods, agricultural advice, marketing facilities, and, of course, credit and savings facilities. The increase in loan access to small-scale producers will boost their capacity for appropriate farmland, labor, and technology acquisition to improve production and earn more profit (Sarfo, 2018).

In Togo, Finscoop, (2016) consumer survey result on financial inclusion results show that only 27% of Togolese have access to credit and most of the financially excluded are rural populations. Some sources reveal that, in Togo, the weak access to agricultural loans for producers impedes the development of the agricultural sector. These sources indicate that just about 12% of households benefit from agricultural loans, although credit is an instrument for the development of agricultural and rural activities, as are agricultural research and extension services. Due to the lack of adequate financial services, small-scale farmers had no alternative except to rely on usurious credit to acquire their inputs. Farmers are forced to borrow at usurious rates from businesswomen due to a lack of resources and difficult access to formal credit. These loans are used to cover expenses such as the purchase of inputs at the beginning of the season; remuneration of the workforce; the purchase of cereals during the lean season; and school fees. These loans, at interest rates approaching 100% over six months, usually mature during the harvest.

The need for cash at harvest time, combined with difficult access to credit, a lack of savings, and inadequate or no storage facilities, leads producers to discount their production at harvest time. This vicious circle of selling off production and low income, in which many Togolese producers find themselves, places them in a situation of great vulnerability. In addition, this severely impedes their ability to produce, innovate and invest and consequently greatly reduces their annual income (Mackiewicz-Houngue et al., 2014) Given the importance of access to agricultural credit for producers and the very important role that formal credit sources should play in the agricultural sector, this study proposes to first investigate the determinants of agricultural loan access in two rice-producing areas in Togo and the effect of access to credit on the profitability of rice farms.

Many studies have been conducted on the determinants of access to credit for agricultural producers in many countries (Abdul-Jalil, 2015; Akpan et al., 2013; Avocevou, 2003; Baiyegunhi, 2008; Diagne, 1999). Some have also sought to assess the impact of access to credit on the profitability of producers (Mghenyi, 2015; Nzomo & Muturi, 2014; Ogunleye, 2018; Rahman et al., 2014; Sarfo, 2018). In the case of Togo, empirical studies on producers' access to agricultural credit are minor (Adessou et al., 2017; Ali & Awade, 2019; Julien et al., 2021). According to the literature, no study has been conducted in Togo on the relationship between credit availability and farm profitability. It is; therefore, appropriate to take a look at these subjects which are of capital importance. Thus, the purpose of this work is to analyze access to agricultural credit and its effect on the profitability of rice producers. This paper is organized as follows. The next section is the literature review, and section 3 provides information about the methodology. Section 4 reports the empirical results, and the conclusion is given in section 5.

## 2. LITERATURE REVIEW

### 2.1. Empirical Evidence of Credit Accessibility Determinants

A lot of research has been done in all countries on the determinants of credit access among rural populations. According to these studies, access to credit is influenced by a number of factors that are or are not related to the characteristics of the borrowers. According to Tetteh Anang et al., (2015), gender, household income, farm capital, improved technology adoption, contact with extension agents, the location of the farm, and awareness of lending institutions in the area, are the main determinants of credit access in Northern Ghana. Mashile, (2014) finds that low levels of education, main occupation, group membership, and household income are significant and have encouraging effects on access to credit and financial services in Gauteng province (South Africa).

According to Kodjo et al., (2003) and Avocevou, (2003) diversification of activities and livestock ownership positively influence access to credit. Being a woman, being a member of a farmer's organization or structure, or having a material guarantee facilitates access to credit. Finally, the interest rate positively affects access to credit. For Phan, (2012) in the Mekong River Delta, Vietnam, the positive determinants of formal microcredit accessibility are: being a local government employee, having credit group membership and a poor certificate, educational attainment, working skills, and village road access. In their research on livestock farmers' credit access in Ebonyi State, Nigeria, Ume et al., (2018) find that off-farm income, level of education, farming experience, and membership in an organization are the determinants of producers' credit accessibility. According to Baiyegunhi, (2008) credit is supplied by lenders; in other words, credit access by households is largely determined by gender, monthly income, asset value, savings, dependency ratio, repayment capacity, and social capital, among other things. In Togo, Julien et al., (2021) found that gender, membership in a financial solidarity group, sown area, marital status, type of association, and interest rate are the determinants of agricultural credit demand. On their side, Ali & Awade, (2019) showed that farmers' age, membership in a

soybean organization, selling the soybeans to a recognized NGO or a private organization, and growing cotton or cashew are the main determinants of access to the full amount of credit.

### 2.2. Effect Of Credit Use on Farmers' Profitability

Credit is a very important input for any entrepreneurial activity. Therefore, like any business, agricultural activity also needs money. In farming, the importance of credit extends from soil preparation operations to harvesting and marketing (Sarfo, 2018). The capital shortage is one of the main problems impeding smallholder producers' activities. This situation prevents farmers from adopting new technologies and improving the efficiency of the agricultural sector. A well-structured credit market helps producers increase their consumption and input use, which in turn contributes to the improvement of their living conditions (Feder et al., 1990; Ayaz & Hussain, 2011).

According to Zeller, (2000) credit is a means of increasing income and consumption, future investment, and asset accumulation. Credit is naturally an instrument and a creator of value and growth. Investment and productivity cannot be developed without credit. The latter can be an instrument of equity if it is used in favor of the poor to "break down the walls of money" and reduce economic dualism and democracy (Bomda, 1998). According (Zeller et al., 1997), the availability of credit can significantly improve the ability of poor households lacking significant personal capital to purchase production inputs. According to Nzomo & Muturi, (2014), the efficient use of agricultural credit can increase income. Credit in terms of size serves a dual purpose: it expands economies of scale while also improving farm productivity from available resources.

## 3. METHOD

### 3.1. Source of Data

This study, as specified in its title, covers the southern Togo area. More specifically, it concerns two rice production areas, namely the Kovié and Agomé-Glozou areas located respectively in the Zio and Mono valleys, about 35 and 100 km from Lomé. These areas represent the two largest irrigated rice production zones in Togo (MAEP-FAO, 2013). Thus, only producers in the Kovié and Agomé-Glozou rice-producing areas were reached for data collection.

A multi-stage sampling method was used. In the first stage, the two largest paddy-producing regions in southern Togo were selected as research areas. Therefore, the Zio and Mono valleys have been selected. In the second stage, depending on the extent of the rice production area, the Kovié and Agomé-Glozou zones were targeted. Finally, producers were randomly selected for data collection. Since there is no data on paddy producers in our target zones, to compute the sample size, the following formula was employed (Anderson et al., 2013).

$$n = \frac{t^2 * p(1-p)}{e^2}$$

***n***: sample size,

**t** : confidence interval (generally 1.645 for 90% confidence interval),

**p**: the probability of the unit under study occurring in the population (p-value will be taken as 0.5),

**e**: degree of freedom (10%).

Using this formula, some 70 producers should be surveyed. At the end, a total of 102 producers were surveyed, 51 of whom had access to credit and 51 of whom did not, thus serving as a control group. The survey was conducted with Kobocollect.

### 3.2. Definition of Model Variables

This study aims to investigate the determinants of rice producers' credit access and assess the influence of accessing or not accessing credit on the profitability of their farms. Thus, access to credit (1=yes, and 0= otherwise) and farm profitability are the main dependent variables in this study.

The variables employed to specify the model are taken from the literature and take into account several assumptions. To investigate the determinants of credit access, many studies (Ankrah Twumasi et al., 2021; Baiyegunhi, 2008; Phan, 2012; Sossou et al., 2017) have used producers' socio-demographic characteristics, household characteristics, farm variables, financial structure variables as well as those of their products and other factors.

Phan, (2012) and Julien et al., (2021) used individual characteristics (age, gender, education level, main occupation) and household characteristics (size, agricultural land size, land ownership) to determine factors that influence microcredit access. In addition to the above factors, Baiyegunhi, (2008) also includes the variables "credit awareness" and the "assets" and other factors as those likely to determine credit access in the Eastern Cape Province, South Africa. Sossou et al., (2017) also included group membership (Social Capital) in addition to other variables to investigate credit access determinants in Benin. Farming experience, and extension services in addition to socio-demographic characteristics, were used by Oke et al., (2019); Akpan et al., (2013); Ankrah Twumasi et al., (2021) and Ume et al., (2018) to investigate the determinants of credit access. To assess the effect of access to microcredit on technical efficiency, Tijani *et al.*, (2009) and Ekwere and Edem, (2014) used age, family size, farming experience, educational status, and farmland size as control variables. Moreover, other variables were employed by Agbodji and Johnson, (2021); Awotide et al., (2015) ; Omolade and Adepoju, (2019); and Rahman *et al.*, (2014) to assess the effect of credit access on productivity. Finally, factors like age, household size, farming experience, educational status, and farm size were used (Rugube et al., 2019) to investigate the factors that influence the profitability of vegetable farmers in the Shiselweni Region, Kingdom of Eswatini, Swaziland. Thus, for our study, we retained variables such as age, gender, level of education, household size, and type of asset, membership in a farmer's organization, experience in agriculture, rice farm size, extension service access, credit awareness, the main occupation, land ownership, and other crop production. The detailed list of variables is presented in table 1.

**Table 1: List of Variables**

| VARIABLE | SYMBOL | TYPE | A PRIORI EXPECTATION |
|---|---|---|---|
| Dependent Variable | | | |
| Credit Status: 1= Access to credit, 0= otherwise | ACCESS | Binary | |
| Profitability | PROF | Continuous | |
| Independent Variables | | | |
| Age (Age in years) | AGE | Continuous | Age is hypothesized to negatively affect the probability of having access to credit, so far that older clients may not be as active as younger ones in their enterprises. |
| Gender (Male=1,0 otherwise) | GENDER | Binary | The male is expected to have greater access to credit than the female; hence its expected sign is positive. |
| Scholar (level of education) | EDUC | Continuous | The coefficient is expected to be positive. Higher levels of education imply better technical knowledge and skills, and more information on markets and facilities provided by financial institutions. |
| Household size | HSİZE | Continuous | The coefficient of this variable is assumed to be indeterminate (+/-), insofar as, on the one hand, the size of the household could constitute a source of burden, hence the possibility of diverting the idea of using the credit and therefore difficulty in repayment. On the other hand, a large household size could be an asset in terms of labor and therefore the possibility of cultivating large areas and then having a lot of income and therefore ease of repayment. |
| Assets type | TASSET | Continuous | The type of asset that the producer has, could be a source of additional collateral and therefore could facilitate access to credit. We expect a positive sign for this variable. |
| Social Capital | APGRP | Binary | Belonging to a social network may be representative of the client's social relationships and may signal his ability to fulfill obligations. Its expected sign is positive. |

| | | | |
|---|---|---|---|
| Experience (Number of years of involvement in agriculture) | EXPER | Continuous | The number of years in agriculture is assumed to be positively correlated with access to credit. Indeed, the more the number of years increases, the more the producer is supposed to have experience and therefore has a good mastery of agricultural practices and presents less risk of failure. |
| Land size (for rice-producing) | SupRiz20 | Continuous | The area of rice regularly produced by the producer is assumed to have a positive sign. The larger the area, the more likely it is that the producer will be considered a great producer, and thus more reassuring to financial services institutions. |
| Extension | EXTEN | Binary | Having access to extension services is assumed to improve the producer's farming practices and thus the probability of farm success. We, therefore, assume a positive sign for this variable. |
| Credit information (be informed about a credit source = 1, 0 otherwise) | INFCRED | Binary | Awareness may have a strong bearing on the accessibility of credit hence its sign is expected to be positive. |
| The practice of other crops | OCROP | Binary | Involvement in other crops is assumed to provide additional sources of income and thus more insurance in terms of repayment. A positive sign is therefore expected for this variable. |
| Main occupation | OCCUP | Continuous | The main occupation is supposed to have a positive influence on access to credit: a producer whose main activity is farming would be more reassuring and able to take good care of his farm. |
| Land ownership | OWNER | Continuous | Land ownership, as opposed to rental and other forms of access to land, is expected to increase the long-run investment incentives and the collateral value of the land to lenders. Its expected sign is positive. |

Note: VARIABLE: Variables' full names; SYMBOL: Abbreviated names of variables; TYPE: The type of the variable; A PRIORI EXPECTATION: Variables explanation and its corresponding sign assumptions.

Tests of multicollinearity, heteroscedasticity, and normality analysis were performed. To identify any multicollinearity issues between variables, the variance inflation factor (VIF) is employed. According to Gujarati & Porter, (2009), the larger the value of VIF, the more "troublesome" or collinear the variable X. Generally, 10 is the threshold VIF's value, which, when exceeded shows that the variable is highly collinear. The test results indicate that the explanatory variables of our model do not suffer from any significant multicollinearity problem because none of the values exceeds 10 and the average is 1.587. To check for heteroscedasticity, the Breusch–Pagan test is used and the evidence shows no problem with heteroscedasticity (F =1.32 Prob = 0.2201). A normality test was performed, and the result indicated the residuals were normally distributed with a significance level of 5%. The Jacque Berra test was used, and the result is 2.93, which is less than 5.99, with a p-value equal to 0.231, which is more than 0.05, meaning that the null hypothesis could not be rejected. It was concluded that the residuals are normally distributed. Table 2 below presents the descriptive statistics of the study variables.

**Table 2: Descriptive Statistics of the Variables**

| Variables | Description | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Age | Age of the producer in years | 40.96 | 10.048 | 20 | 75 |
| Gender | Male=1,0 otherwise | 0.68 | 0.470 | 0 | 1 |
| Scholar | Level of education | 1.26 | 1.024 | 0 | 4 |
| Household size | The number of people in the household | 4.42 | 2.23 | 0 | 12 |
| TypeActif | The type of assets owned by the producer. | 0.73 | 0.94 | 0 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| OP | Belonging to a social network | 0.78 | 0.413 | 0 | 1 |
| AnnAgri | Number of years of involvement in agriculture | 20.03 | 10.47 | 2 | 45 |
| SupRiz20 | Sown rice area | 1.03 | 0.73 | 0 | 4 |
| Vulga | 1=access to extension service, o= otherwise | 0.93 | 0.25 | 0 | 1 |
| Infocred | 1=if access to credit information,0=otherwise | 0.84 | 0.37 | 0 | 1 |
| AutreCult | 1=if involve in other crops production, 0= otherwise | 0.85 | 0.37 | 0 | 1 |
| Occup | 1=agriculture, 2=Business, 3=Employed, 4=Artisan,5= Driver, 6=health staff, 7=Others | 1.42 | 1.06 | 1 | 7 |
| StatuFonc | 1= owner of the land, 2=rental land | 1.42 | 1.06 | 1 | 6 |

Note: Mean: Mean of the variables; Std.Dev: Standard deviation; Min: Minimum value of the variables; Max: Maximum value of the variables.

### 3.3. Model Specification

In our study, the selection equation's dependent variable is binary, and the research aims to analyze the influence of credit access or lack thereof on the profitability of rice farms. Based on the work of Hamilton & Nickerson, (2003) and Certo et al., (2016), two-stage least squares or treatment effects models would be more appropriate. Because the selection equation in our case was binary, the direct two-stage least squares regression could not be used.

As suggested by Cerulli, (2014), to exploit suitably the *binary* nature of the selection one can choose between the Probit-2SLS or the Probit-OLS model. Also, according to the same source, Probit-OLS compared to Probit-2SLS is less efficient and requires consistency that the Probit is "correctly" specified. Depending on this fact, the Probit-2SLS model will be used in this study.

In our study, access to credit will be considered as a "treatment" received by producers with access to credit. The treatment effect of accessing credit on the outcome variables (Z) represented here by the profitability of rice farmers is defined in the equation below.

$TE_i = y_{1i} - y_{0i}$

Where $y_{1i}$ is the profitability of producer i in the case where he has access to credit, and $y_{0i}$ is the profitability of producer i when he has no access to credit. According to Rosenbaum & Rubin, (1983), it's impossible to identify TEi because it refers to the same producer at the same moment. This means that only one of the two quantities is observable. The reason why one must rely on the estimation of average treatment effects (ATEs).

Average Treatment Effect = ATE = $E(y_1-y_0)$

In this study, the STATA command "ivtreatreg" developed by (Cerulli, 2014) is employed to compute the Probit-2sls model. Using the explanatory variable "X" and the instrumental variable "w" the predicted probability of getting credit is computed by the probit model.

$P_Y = E(Y|X,W) = Pr(Y=(1|X,W)$

Here, our instrument variable (w) is the variable "Credit information (INFCRED)". The structural system of (two) Equations is below:

$$y_i = \mu_0 + \boldsymbol{\omega_i} \mathrm{ATE} + x_i \boldsymbol{\beta} + \mu_{\mathbf{0i}}$$

$$\omega_i^* = \eta + q_i \delta + \varepsilon_i$$

$$\omega_i \begin{cases} 1 \text{ if } \omega_i^* \geq 0 \\ 0 \text{ if } \omega_i^* \leq 0 \end{cases}$$

$q_i = (xi, zi)$

Where equation (1) is the outcome equation, equations (2) and (3) are selection equations, and equation (4) is the exclusion restriction.

## 4. RESULTS

### 4.1. Determinants of Credit Access

Table 3 below presents the results of the probit-2sls model for the determinant of access to credit and its effect on rice farmers' profitability. The determinants of rice producers' credit access are gender (GENDER), type of assets owned by the producer (TASSET), the farmer's experience in agriculture (EXPER), access to information about credit sources (INFOCREDI), the farmer's main occupation (OCCUP), and the farmer's land ownership status (OWNER). Gender, experience, information access, and land tenure status also positively influence producers' credit access, as predicted by the study. Furthermore, asset type and main occupation negatively influence credit access, in contrast to the predicted trend.

In the process of granting credit access to the producers, the gender variable plays a positive role. The coefficient of the variable significant at 5% is positive, following its predicted sign. The reasons could be that women do not have easy access to production capital and, in addition, they rarely hold the role of household head, so they would not present sufficient collateral to financial institutions. Furthermore, since men are the natural owners of the land and the heads of the families in the community, they would have more credibility with the financial organizations. This result is consistent with those of Baiyegunhi, (2008); Sarfo, (2018); Zeller et al., (1994); Abdallah *et al.*, (2019); Siaw et al., (2021) and Agbodji and Johnson, (2021) according to whom this fact could mean the existence of discrimination against women. It can therefore be said that men are more privileged than women during credit access in the research zones. The result, on the other hand, contradicts those of Oke et al., (2019); Akpan et al., (2013), and Abdul-Jalil, (2015) according to whom being male negatively affects producers' chances to get access to credit.

The type of asset owned by the producer is negatively correlated with the probability of accessing credit, with a significant coefficient of 5%. Owing more non-productive assets than productive assets impede the chance of being granted credit. This result is consistent with that of Sekyi et al., (2017) who also found household asset type as one of the credit constraint factors. The result contrasts with that of Diagne, (1999), according to whom a household's asset composition influences more than the total value of the assets and the probability of accessing formal credit.

The experience of the producers in the agricultural field is likely to positively contribute to credit access. This finding is in line with those of Ume et al., (2018); Sarfo, (2018); Agyemang et al., (2020); and Ullah et al., (2020). According to Nwaru, (2004), more experienced producers are efficient in resource use and are likely to seek credit to increase their income by improving productivity. We can also assume that by being more experienced in the agricultural field, the producer would be more capable of exercising vigorously and would master the risks related to the profession, thus being more reassuring to financial institutions.

The easy accessibility of credit sources' information, according to its significant coefficient at 5%, positively contributes to the producers assess to credit. This finding is in line with those of (Chenaa et al., 2018; Lakhan et al., 2020; Rasheed et al., 2016; Ullah et al., 2020), who also came across the benefit of information access on credit accessibility. The probable explanation for this fact could be that a farmer with easy access to information on credit sources and procedures would be more likely to apply for credit and be granted it if possible. But a farmer without access to information will be less likely to apply.

The producer's main occupation is revealed to not be a credit accessibility support factor. With a negative coefficient significant at 10%, this variable negatively affects farmers' access to credit. Thus, a producer whose main activity is farming without any other activity would be less favored in terms of access to credit. This result conforms with Kiplimo et al., (2015); Ojo, (2003); Agbodji & Johnson, (2021); and Sekyi, (2017) who find that a farmer with extra income-generating activity has a greater chance of being granted a loan. Also, according to Zeller et al., (1998), this finding could be justified by the fact that many financial structures tend to give more credibility to business activities and therefore lend more easily to traders than to farmers. Farming is considered a high-risk activity. Commercial activity is considered more profitable in some respects and generates more frequent cash flows.

Farmers' land ownership status is found to be a supportive factor for credit access. It is what one can understand through its positive and significant coefficient. Working on your own farm area or having a legal right to it is likely to increase credit access. This finding is supported by Galang, (2020); and Knox *et al.*, (2021) who also found the beneficial importance of land ownership status on credit access. This result can be explained by the fact that many financial organizations employ land as collateral in their credit schemes, Hernando., (2000). The result is in contrast with Field & Torero, (2006) for whom property title is not significant in determining credit accessibility.

**Table 3: Probit-2SLS Model Results**

**Step 1. Probit Regression** **Number of obs = 102**
**LR chi2 (13) = 36.63**
**Prob > chi² = 0.0005**
**Log-likelihood = -52.37** **Pseudo R² = 0.2590**

| **AccesCredi** | Coef. | Std.Err. | z | P>z | [95%Conf.] | Interval] |
|---|---|---|---|---|---|---|
| **Age** | -0.020 | 0.021 | -0.920 | 0.358 | -0.062 | 0.022 |
| **Gender** | **0.889** | 0.391 | 2.280 | **0.023** | 0.123 | 1.655 |
| **scholar** | -0.046 | 0.181 | -0.260 | 0.798 | -0.401 | 0.308 |
| **Taillemen** | -0.057 | 0.085 | -0.660 | 0.508 | -0.224 | 0.111 |
| **TypeActif** | **-0.394** | 0.174 | -2.270 | **0.023** | -0.735 | -0.054 |
| **OP** | 0.214 | 0.459 | 0.470 | 0.642 | -0.687 | 1.114 |
| **AnnAgri** | **0.060** | 0.022 | 2.730 | **0.006** | 0.017 | 0.104 |
| **SupRiz20** | -0.375 | 0.287 | -1.310 | 0.190 | -0.937 | 0.186 |
| **Vulga** | 0.533 | 0.820 | 0.650 | 0.515 | -1.073 | 2.140 |
| **InfoCredi** | **0.915** | 0.458 | 2.000 | **0.046** | 0.016 | 1.813 |
| **AutreCult** | 0.257 | 0.413 | 0.620 | 0.534 | -0.553 | 1.066 |
| **Occup** | **-0.291** | 0.163 | -1.780 | **0.074** | -0.611 | 0.029 |
| **StatuFonc** | **0.268** | 0.140 | 1.910 | **0.057** | -0.008 | 0.543 |
| **cons** | **-1.885** | 1.093 | -1.720 | **0.085** | -4.028 | 0.258 |

**Step 2. Instrumental variables (2SLS) regression**

| Source | SS | df | MS |
|---|---|---|---|
| Model | 8.97e+06 | 13 | 6.90e+05 |
| Residual | 8.87e+06 | 88 | 1.01e+05 |
| Total | 1.78e+07 | 101 | 1.77e+05 |

Number of obs =102
Prob > F = 0.000
R-squared = 0.540
Root MSE = 307.020

| | Without Heterogeneous Effect | | | With Heterogeneous Effect | | |
|---|---|---|---|---|---|---|
| **RENTA5103** | Coef. | Std.Err. | P>t | Coef. | Std.Err. | P>t |
| **AccesCredi** | -88.718 | 293.638 | 0.763 | -228.624 | 295.043 | 0.441 |
| **_Ws_SupRiz20** | | | | **716.113** | **148.829** | **0.000**$^{***}$ |
| **Age** | -3.907 | 5.236 | 0.458 | -4.483 | 5.080 | 0.380 |
| **Gender** | -167.062 | 110.595 | 0.134 | -134.206 | 108.685 | 0.220 |
| **scholar** | 57.658 | 38.335 | 0.136 | **83.748** | **37.224** | **0.027**$^{**}$ |
| **Taillemen** | -21.901 | 19.529 | 0.265 | -17.424 | 18.815 | 0.357 |
| **TypeActif** | -39.602 | 48.494 | 0.416 | -73.944 | 48.874 | 0.134 |
| **OP** | 33.416 | 99.788 | 0.739 | 85.485 | 98.066 | 0.386 |
| **AnnAgri** | 8.982 | 6.693 | 0.183 | **11.223** | **6.599** | **0.093**$^{*}$ |
| **SupRiz20** | **471.182** | **64.819** | **0.000**$^{***}$ | **172.634** | **93.457** | **0.068**$^{*}$ |
| **Vulga** | 161.856 | 173.478 | 0.353 | 65.214 | 166.173 | 0.696 |
| **AutreCult** | 131.211 | 96.417 | 0.177 | 70.392 | 93.141 | 0.452 |
| **Occup** | -24.580 | 36.058 | 0.497 | -37.942 | 35.430 | 0.287 |
| **StatuFonc** | 55.628 | 41.912 | 0.188 | 47.804 | 40.203 | 0.238 |
| **Cons** | -462.984 | 210.867 | **0.031** | -14.302 | 227.795 | 0.950 |

Instrumented: AccesCredi _ws_SupRiz20
Instruments : Age Genre scholar Taillemen TypeActif OP AnnAgri SupRiz20 Vulga AutreCult Occup StatuFonc G_fv _z_SupRiz20

Note: Number of obs: Number of observations; LR chi2: Likelihood ratio chi-square test value; Prob > chi2: Probability of obtaining the chi-square statistic value; Pseudo R2: Pseudo R-squared; AccesCredi: The dependent variable credit accessibility; RENTA5103: The dependent variable profitability of Rice farmers. Coef.: Coefficients; Std.Err.: Standard error; SS: Sum of Squares; df: Degrees of freedom; MS: Mean Squared Errors; R-squared; Root MSE: Root Mean Squared Errors.
***: 1% significance; **: 5% significance; *: 10% significance.

The marginal effects of variables were computed and presented in Table 4 below. The analysis of the results indicates that the gender variable is affected by a positive coefficient. Being a man in the research zone increases by almost 25.9% the probability of being granted a loan. Also with positive coefficients, the "experience of the producer", "information access," and "land ownership status" variables showed a positive marginal effect on credit access. The chances of accessing credit increase respectively by around 1.8%, 26.6%, and 8% if the producer has been practicing agriculture for a long time, has easy access to information on credit sources and credit procedures, and is working on his land. Affected by negative coefficients, the variables "asset type" and "main occupation" have negative marginal effects on the probability of getting credit in the research area. In effect, according to the coefficient, the probability of accessing credit decreases by 11.5% as the producer owns more non-productive assets and by 8.5% as the producer has farming as the only occupation.

**Table 4: Marginal Effects of the Variables**

| Variables | Coefficients | Std.Err. | z | P>z | [95%Conf. | Interval] |
|---|---|---|---|---|---|---|
| Age | -0.006 | 0.006 | -0.930 | 0.351 | -0.018 | 0.006 |
| Gender | **0.259**** | 0.105 | 2.470 | **0.014** | 0.053 | 0.464 |
| scholar | -0.013 | 0.053 | -0.260 | 0.798 | -0.117 | 0.090 |
| Taillemen | -0.016 | 0.025 | -0.670 | 0.506 | -0.065 | 0.032 |
| TypeActif | **-0.115**** | 0.047 | -2.430 | **0.015** | -0.207 | -0.022 |
| OP | 0.062 | 0.133 | 0.470 | 0.641 | -0.199 | 0.323 |
| AnnAgri | **0.018*** | 0.006 | 3.080 | **0.002** | 0.006 | 0.029 |
| SupRiz20 | -0.109 | 0.082 | -1.340 | 0.181 | -0.269 | 0.051 |
| Vulga | 0.155 | 0.237 | 0.650 | 0.513 | -0.310 | 0.620 |
| InfoCredi | **0.266**** | 0.126 | 2.120 | **0.034** | 0.020 | 0.512 |
| AutreCult | 0.075 | 0.119 | 0.630 | 0.531 | -0.159 | 0.308 |
| Occup | **-0.085***** | 0.045 | -1.870 | **0.062** | -0.174 | 0.004 |
| StatuFonc | **0.078**** | 0.039 | 2.010 | **0.044** | 0.002 | 0.154 |

Note: Std.Err: Standart errors; Z: Z statistic value; P>z: Computed P value; 95% conf. Interval: 95% confidence interval
****: 1% significance; **: 5% significance; *: 10% significance.*

## 4.2. Determinants of Profitability

The 2SLS regression results show that access to credit is not a significant factor for rice farm profitability (neither without or with heterogeneous effect). Without a heterogeneous effect, the variation in farmers' profitability is explained by only the land size. With a heterogeneous effect, the variation in farmers' profitability is then explained by idiosyncratic factors such as the level of education, experience in the agricultural field, and land size (see table 2). The influence of the area cultivated can be explained by the fact that the yields and selling prices of rice in these production areas are generally acceptable so that as the area of land cultivated increases, the yield tends to increase, and therefore the profitability of the producer moves in the same direction. This result confirms that of Mwambi et al., (2014); Pradhan & Ranjan, (2016) and Rugube et al., (2019).

Ceteris paribus, the producer's level of education positively influences the producer's profitability. This can be explained by the fact that a well-educated producer tends to better understand and respect technical itineraries, has a better grasp of farm management techniques and risks, and is therefore likely to have a good yield and, in turn, be more profitable. This result is consistent with (Dong et al., 2010) and (Rahman et al., 2014). This result is contrasted with those of (Ogunleye, 2018) and (Rugube et al., 2019).

A producer with many years of experience in the agricultural field would be better able to master the different parameters of his operation and know-how to better use the resources available to him and thus be more profitable. This result is in line with that of Ogunleye, (2018) who finds that producer experience positively influences the level of technical efficiency and hence productivity of cassava producers with access to credit in Osun State, Nigeria. This finding contrasts with Rugube *et al.*, (2019)

who discovered a negative impact of producer experience on profitability in the Shiselweni Region, Kingdom of Eswatini (Swaziland).

### 4.3. The Average Treatment Effect of Access to Credit

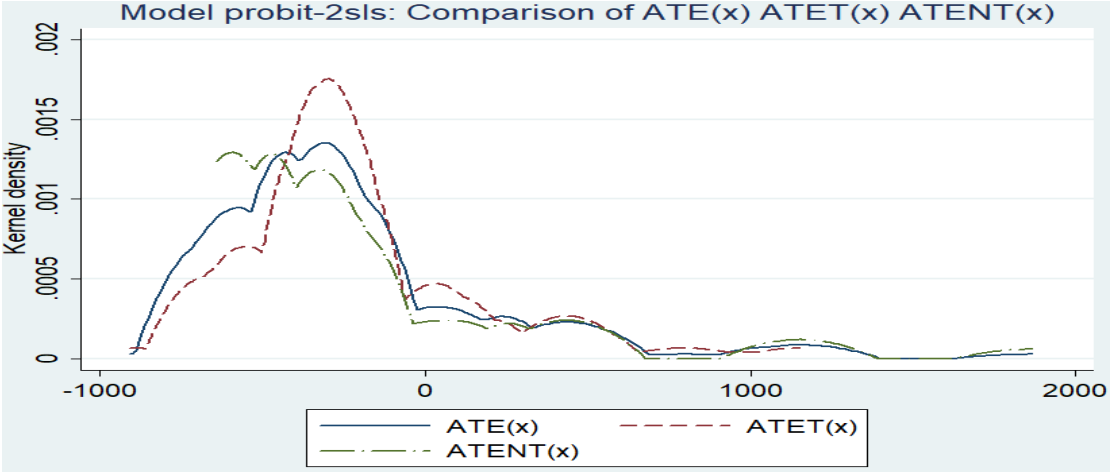
The results from the instrumental variables (2SLS) regression indicate that the ATET (average treatment effect on treated) of accessing credit is positive and statistically significant at 1% for the profitability of rice farmers (see table 5). Also, a comparison of the ATE, ATET, and ATENT was shown in Figure 1. The ATET values obtained without and with heterogeneous effects are the same and, are about $3.36. It means that farmers who have access to credit would have earned less profitability by $ 3.36 if they had not had access to credit. Between the two variables used to estimate the heterogeneous effects, only the coefficient of land size is positive and statistically significant at 1%. This means that farmers with a large area of rice would be more profitable. Thus, it can be argued that more than the variable access to credit, the area of rice cultivated has a greater impact on the profitability of rice farmers.

**Table 5: Average Treatment Effects**

| | Without Heterogeneous Effect | | | | With Heterogeneous Effect | | | |
|---|---|---|---|---|---|---|---|---|
| | Coef. | Bootstrap Std. Err. | z | P>\|z\| | Coef. | Bootstrap Std. Err. | z | P>\|z\| |
| **ATET** | 1866.531 | 687.229 | 2.72 | **0.007***** | 1866.531 | 644.477 | 2.90 | **0.004***** |
| **ATENT** | -639.863 | 396.846 | -1.61 | 0.107 | -639.863 | 311.480 | -205 | 0.040** |

Note: Coef: Coefficients; Bootstrap std.Err: computed standard error using bootstrapping.
***: 1% significance; **: 5% significance; *: 10% significance.

**Figure 1: Probit 2SLS Model ATE, ATET, and ATENT Comparison**




Note: ATE: Average Treatment effect; ATET: Average Treatment effect on Treated ATENT: Average Treatment effect on Non Treated.

### 5. CONCLUSION

The majorities of farmers in the Kovié and Agoméglozou zones are under 50 years old, have an average level of education, cultivate on government-developed land that they rent, own non-productive assets, are men, are members of farmers' organizations, practice mixed farming, have access to credit information, and have access to extension services, according to all these results.

Concerning the determinants of access to credit, demographic factors, and farm factors such as gender, asset type, producer' experience, access to credit information, principal occupation, and land ownership status of the producer are correlated with access to credit by rice farmers. Finally, only the results of the 2SLS model provided consistent estimators for the determinants of the profitability of producers with access to credit. Thus, the factor of interest, access to credit, taken exclusively, was found to

be insignificant for the profitability of farms, but its average effect on the treated group was statistically significant. Other factors, such as the amount of rice grown, the level of education, and the producer's experience, have been discovered to be determinants of credit-accessible producers' profitability.

Although access to credit is a very important factor for farming activities, according to the results of this study, it is not the only factor influencing farm profitability. Its effect appears to be less than that of the area of rice cultivated. This may imply the inadaptability of the credits made available to producers. Thus, as confirmed by the majority of producers, in addition to the fact that credit from formal and semi-formal sources is somewhat rare, it is also not adapted to agricultural activities. Either these credits are granted late compared to the agricultural calendar or they have high-interest rates with very restrictive repayment schedules.

Thus, the following recommendations could be made: (i) Financial institutions need to improve their agricultural financial services offerings to adapt them to the needs of rural populations. As a result, it is necessary to put on the market products that are better suited to the needs of producers, as well as more flexible terms that allow producers to feel secure. (ii) These institutions must also increase the number of channels for disseminating information on financial service offers to allow the rural world to obtain regular information from credible sources. (iii) The improvement of the education level of producers must be included in rural aid programs to significantly raise the literacy level of agricultural producers. (iv) This study, given the remarkable importance of the area of rice cultivated on the profitability of producers, strongly encourages policymakers to emphasize the development of large areas of rice in all areas suitable for rice production. This could allow more producers to have access to land and those who can plant larger areas could acquire them.

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