Land Tenure Security, Credit Access and Agricultural Productivity in Cameroon

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Abstract

Cameroonian farmers face two tenure systems: a modern regime and a customary regime. These two regimes are perpetually confronting each other, putting farmers in a total uncertainty as to the regime to adopt to ensure the sustainability of their ventures. This study aims to assess the influence of land tenure security on agricultural productivity through credit access. To achieve this goal, a two-stage sampling technique was applied to data from the third Cameroon Household Survey (ECAM 3). The number of farmers selected for the analysis was 602. These data were analysed using descriptive and three-step recursive regression models. The results of the analysis reveal that land tenure security improves agricultural productivity through the credit access it allows. A proof of the robustness of this result has been provided through discussion of the effects of land tenure security in different agro-ecological zones and through a distinction between cash crops and food crops. The overall results confirm that land tenure security positively and significantly influences agricultural productivity. The regression has also shown that the size of the farm defined in one way or another, the perception of farmers on their level of land tenure security and therefore indicates the intensity with which land tenure security influences agricultural productivity. The recorded productivity differential indicates that smallholder farmers, because they keep small farms, feel safer and produce more than those who keep medium-sized farms. The results also show that land tenure security significantly improves the value of production per hectare of food products that are globally imported into Cameroon. Therefore, we recommend that the public authorities promote land tenure security by reinforcing the unassailable and irrevocable nature of land title, but also by easing the conditions of access to it.

Keywords: Land tenure security, credit access, agricultural productivity, Cameroon

1. Introduction

Agriculture is considered a lever against poverty by Cameroon and a key tool for ensuring food security. The agro-ecological conditions of this activity are favourable, allowing diversification of production. Cameroon's land potential is not negligible; the Foncier Rural[1] estimates it to be more than 7.2 million hectares. Together, these non-exhaustive attributes reinforce the idea that agriculture is a privileged instrument for economic policy. However, agriculture has so far been unable to fully achieve its objectives. Indeed, Cameroon continues to import agricultural products despite its immense potential (WTO, 2013). As a result, its imported products in 2013 are estimated at more than FCFA 1.458 billion and exports at FCFA 1.378 billion. In addition, agriculture was unable to reassure a population in distress during the last hunger riots of February 2008.

The agricultural sector in Cameroon is vulnerable due to the absence of land tenure security for farmers (Niee-Foning et al, 2015). Indeed, land tenure security, which is the set of mechanisms by which the landowner is in a situation of peaceful use of the land without fear of possible expropriation is not assured to Cameroonian farmers. The latter are constantly exposed to land grabbing by urban elites, degradation of the environment,[2] a dysfunctional legal system[3] and the clash between modern law and customary law.

The clash between modern law[4] and customary law[5] is particularly unfavourable to the development of the agricultural sector. Indeed, the presence of two opposing regimes puts farmers in a situation of uncertainty as to the decision to be made to ensure sustainability of their property. However, it should be noted that property theorists[6] predict a negative effect of customary regimes on development. It is for the sake of promoting land tenure security that Cameroon set up the 1974 land reform complemented by Decree No. 2016/1430/PM of 27 May 2016 (FAO and CEEAC, 2019), setting the modalities of organization and operation of the Advisory Committee on Land and Domain. This reform introduces a land title as the only instrument for securing land rights. Thus, land title certifies that a parcel of land belongs to you. Once established, the land title becomes intangible, unassailable and definitive. This reform does not exclude any social category from obtaining the title deed. To obtain this title, the law requires the applicant to compile a file with information on: (i) marital status, (ii) location/residence, (iii) profession, (iv) description of the land (area, nature of occupation or investment, valuation, etc). The file is deposited with the

local administrative authority, which forwards it to the department in charge of land affairs. After acknowledgment of the development and payment of fees, demarcation is carried out. The technical file thus constituted is sent to the regional delegate for registration. This step results in the transfer of the file to the land registrar[7] who is responsible for issuing title deeds in case of non-contestation of ownership. This procedure is expected to take about six months and cost about FCFA100,000 but in reality, the duration of obtaining the land title is not less than 12 months and the cost is more than FCFA500,000.

Despite the provisions in the law, which do not exclude any social category from obtaining land titles, certain social groups in certain communities are excluded from the right of private property for reasons of customary order. This is particularly the case of women and pastoralists in some nomadic areas. In the case for women, because of the custom which does not recognize their possession, they cannot use their occupation rights to obtain a land title. This is worrying as the proportion of women who regularly registered their land in 2013 was only 21.6%. This represents barely a quarter of the land officially registered by men. This marginalization of women is more prevalent in rural areas (Alden, 2011). Cameroon's rural environment is dominated by the customary regime. Data from the National Institute of Statistics (INS) reveal that in 2015, shows that only 25.58% of farmers held land titles to their property. The distribution of the percentage of individuals obtaining the title by region is very disparate (see Annex 1), with a significant dominance of the customary regime over the legal regime in the Eastern and Northern regions. The statistics reveal that only 4% of landowners own land titles to their property. This low distribution is also observed in the South, Far-North and Littoral regions with 5%, 6% and 8% of farmers, respectively, with titles to their land. The relationship between customary and legal systems is less unequal in the Western Region. In fact, 32% of landowners have land titles to cultivated plots. Thus, over 74% of Cameroonian farmers have land without land title, yet land tenure security[8] should facilitate farmers' access to credit (Das et al, 2019).

This ability of land tenure security to make credit access easy is a necessity for the rural world in general and the agricultural sector in particular, in that it is credit access that can lead to modernization of the agricultural economy (Twine et al, 2018). Indeed, when the need for credit is oriented towards agricultural investment, credit access has a positive indirect effect on agricultural productivity through adoption and acquisition of new technologies (if available) and increased capital for agricultural investment (Feder et al, 1990; Twine et al, 2018). In fact, credit access can affect agricultural productivity[9] because farmers facing capital constraints resort to low-quality inputs and traditional technology (Petrick, 2004).

Thus, credit allows farmers to meet the liquidity needs induced by the agricultural production cycle and thus to increase agricultural productivity (Feder et al, 1990). Unfortunately, the penetration rate of credit institutions and financial institutions in Cameroon is very low. It is estimated to be 19% lower compared to some developed economies that are close to 72% (MINFI[10], 2017). In addition, the functional framework

of the credit system in place does not favour more flexible access of households to credit. This credit system is subdivided into two: formal[11] and informal. The formal sector is dominated by commercial banks and microfinance institutions. Survey data from the United Nations Capital Development (UNCFD) and the INS (2017) reveal that 49% of households have access to these institutions. This rate of credit access is much lower for farmers; INS estimates it to be less than 5%. This low credit supply to farm households is explained by the fact that the formal system has not specialized in agricultural credit operations and, therefore, does not have specific conditions for granting credit to farmers. Three criteria generally dictate access to bank credit in Cameroon: (i) hold a bank account, preferably a current account, (ii) be solvent,[12] and (iii) be in possession of a bank account guarantee. Guarantees generally come in two forms: the certificate of participation in a specific development programme or membership to a registered[13] cooperative and the guarantee on farmland (mortgage[14]). In the first case, some banks provide agricultural credit to households that are members of a clearly defined programme. The difficulty with this funding strategy is that not all farmers are eligible for programmes that receive bank support in terms of funding. This is, for example, the case of PIDMA,[15] which admits into their programme only farmers who cultivate cassava, maize and sorghum. However, there are farming households that do not grow any of these three products. As a result, they cannot obtain agricultural credit from banks under the guise of a partnership agreement signed between the bank and the programme coordinators. It is for this reason that the second alternative is most often put forward. Indeed, land mortgage is a pledge of choice for banks especially when it is titled. The mortgage is established by a notarial deed and is the subject of registration and publicity according to the formalities of the land register in accordance with the provisions of the Uniform Act on Security and those governing the registration of land rights in Cameroon. Formalization of the mortgage is often time-consuming and incurs costs (land royalties, notarial fees, tax stamps, etc). However, the mortgage of agricultural land has a considerable advantage. Indeed, it is possible to apply for substantial agricultural credit by agreeing to pledge the entire agricultural operation[16] when the developed space is titled. Unfortunately, most Cameroonian farm households do not have titled land, which excludes them from the banking circuit. The absence of an agricultural bank as an intermediate solution to their difficulty in accessing credit is equally detrimental. This partly explains the emergence of the informal credit market sector (Kamgaing-Tadjuidje, 1982). In addition, UNCFD and INS[17] estimate that more than 36% of households used this market to finance their activities in 2017.This informal credit market, which is usually central to the functioning of associations, is not only a place to keep money but also a recourse in times of financial crisis for rural populations who have become very poor. The granting of credit to a member in the informal system depends on seniority, the amount of credit requested, the type of project and solvency. The informal credit system, which farmers often use to finance their activity, is still limited due to high interest rates, low amounts offered and generally very short repayment terms (Kemayou et al, 2011)

To overcome this lack of credit, Cameroon has, under the auspices of the Ministry of Agriculture and Rural Development (MINADER), developed multiple programmes. These programmes include: the Rural Microfinance Development Support Project[18] (PADMIR); the decentralized rural credit project[19] (PCRD); and the project to support development microfinance institutions. Despite these measures, credit access remains subject to many constraints, among them: (i) lack of necessary capital for the development of the agricultural sector, (ii) insufficiency of the internal capacities of technical and financial management, (iii) a pre-eminence of the misappropriation of the funds allocated to the development of the sector, (iv) a weak extension of financial services in rural areas, (v) a weak extension of credit programme, (vi) and the absence of structures responsible for the specific supervision of the promoters of agricultural activity in the rural area to improve their self-financing capacity, but also to help them access bank financing. These difficulties of access to finance prevent farmers from increasing and developing their agricultural production (Moulende-Fouda, 2003).

In light of the foregoing, it is necessary to question the role played by land tenure security on agricultural productivity through credit access. This theme is usually addressed separately in literature. Indeed, some authors analyse only the effect of land tenure security on credit access and others the effect of credit access on agricultural productivity. This study is motivated by the following question: what is the impact of land tenure security on agricultural productivity through credit access? In other words, does holding title to a parcel improve agricultural productivity through credit access?

The objective of this study is to assess the impact of land tenure security on agricultural productivity through credit access. Specifically, this study aims to:

(i) Assess the impact of land tenure security on credit access. It is a matter of assessing whether possession of the land title allows the applicant to easily credit access.

(ii) Evaluate the impact of credit access on agricultural productivity. This includes assessing whether credit access allows Cameroonian farmers to be more productive.

2. Literature review

The evolutionary theory of property rights developed by Platteau (1996) teaches that when the volume of the population increases and the need for intensification of agriculture to protect oneself from hunger and to promote integration into the market are high, land tenure insecurity increases due to the vagueness of customary tenure rights. This insecurity and the resulting problems (conflict, weak agricultural investment, etc) can be solved by an individual and private appropriation of land, guaranteed by "land titles". These allow the emergence of a land market and the use of land as collateral on the credit market (de Soto, 2000). In this context, the securitization of land is seen as a fundamental element of the land market in that it determines not only the emergence of a land market but also promotes credit access indispensable for investing in soil quality.

Many empirical lessons on the effect of land tenure security on productivity through the credit channel are inspired by this theoretical framework. Indeed, Seligson (1982) shows that extension of land titles in Costa Rica increased farmers' credit access by 18% to over 31.7%. Feder et al (1988) in their study of India, Thailand, and the Republic of Korea show that land guarantee increases the amount of credit offered by more than 43% compared to unsecured loans. Indeed, formal and informal institutions give more credit when land is used as collateral. The work of Feder and Onchan (1986) in three provinces of Thailand concludes that the issuance of land titles increases the volume of investments on farms in two of the provinces studied. In the same perspective, Hayes et al (1997) concludes through the use of a probit model on data collected in the Gambia that land tenure security has a positive effect on investments and a multiplier effect on agricultural productivity. These results are further supported by Scheweigert's (2006) work on the links between land title, tenure security and investment and agricultural production in Guatemala. This work leads to the conclusion that holding a land title increases the likelihood that a household will invest in the quality of the labour factor which leads to higher productivity. These results are also confirmed by considering the political hierarchy dimension by Goldstein and Udry (2008), which highlights the existing relationship between land tenure security and agricultural investments in Ghana. Indeed, the authors consider the hierarchical position as an essential component of land tenure security. Thus, individuals who have a comfortable position in the political hierarchy enjoy significant land tenure security and invest more to increase soil fertility. They can benefit from higher levels

of productivity. In addition, the work of Niee-Foning et al (2015) analyses the direct impact of land tenure security on agricultural productivity in Cameroon. They adopt a measure of land tenure security in terms of bundles of rights. This work leads to the result that land tenure security increases the likelihood of investing in agricultural equipment purchases. This study did not focus on agricultural credit, which is one of the channels through which land tenure security passes to increase agricultural productivity. This study addresses this approach through appropriate modeling. It should be noted that this result and the previous ones are in contradiction with those of Migot-Adholla et al (1991). Indeed, the authors demonstrate that the establishment of a system of individual rights instead of a collective rights regime in the context of Ghana, Kenya and Rwanda is detrimental because private status is a necessary but not sufficient condition to promote credit access and increase agricultural productivity. However, as the study covers only rainfed areas or investment is low and irrigation is virtually useless, farmers needing resources to finance irrigation are excluded from the study. Similar results are obtained by Place and Hazell (1993). Indeed, using data from three countries in Sub-Saharan Africa (Ghana, Kenya and Rwanda) on the relationship between land tenure security and agricultural productivity, the authors found that land tenure rights have not been achieved just as there is no significant impact on investments, land management and conservation, input use, credit access or agricultural productivity. However, the absence of effect of land tenure security on agricultural productivity would be linked to the fact that in this context, land cannot be mortgaged for agricultural credit. In addition, Place and Migot-Adholla (1998), through a study in Kenya, conclude that farm registration programmes do not improve the level of credit access for smallholders or even lead to more agricultural productivity. This can be explained by the fact that land acquisition costs are very high in Kenya and land registration does not give one the power to sell the land. However, systematic and comprehensive registration is supposed to increase land transactions through elimination of uncertainty about the identity of the landowner and the reduction of land conflicts. It should, therefore, be noted that land title is not a sufficient legal instrument to secure land tenure in the context of Kenya, as land disputes remain after the issuance of land titles. In the same perspective, Suyanto et al (2001) conclude that the establishment of individual and transferable ownership of land does not confer any efficiency in the management of agricultural holdings. But the inefficiency noted seems to come from the measurement of land tenure security. Indeed, in their study, the authors equate land tenure security with land potentially equipped with trees. However, this system of securing land does not ensure the transferability of land between actors. In addition, the land on which the trees are planted is for the most part the family property. In fact, any land transaction requires taking into account the consensus of the entire family, and this has the effect of increasing transaction costs and thus hinder the credit supply operations necessary to increase investments in the land. Subsequently, Jacoby and Minten (2007), after a cost-benefit analysis of Malagasy farm registration policies, conclude that holding a land title does not significantly affect the decision to invest by farmers. This implies a marginal effect of

land tenure security on agricultural productivity. This marginal effect can be linked to the high cost of land tenure security in Madagascar. For land tenure security to have an impact on agricultural investment, its cost should be reduced.

Most of the work cited above is based on Feder et al (1988) conceptual model which establishes the link between land tenure security and agricultural productivity. It is understood as a basic conceptual model and is based on the precepts of the evolutionary theory of property rights (Platteau, 1996). One of the fundamental relationships[20] that dictates this model is the one that links title to credit access. This relationship reflects the ability of the land to be used as collateral once titrated (de Soto, 2000). The credit thus received is subsequently used to stimulate agricultural investment (Carter and Weibe, 1990; Feder et al, 1990). Due to lack of data, these components are for the most part analysed independently. Title and credit access under review (Field and Torero, 2006; Sheuya and Burra, 2016), credit access and investment in soil quality (Petrick, 2004; Kohansal et al, 2008) being the subject of another study. Such an approach breaks the conditional link between land tenure security and agricultural productivity. Indeed, analysed independently, the link between credit access and investment in soil quality without first questioning whether credit access is induced by land tenure security does not allow us to objectively affirm that the functional link between land tenure security and agricultural productivity is verified. On the other hand, a generally neglected dimension in the description of the channels through which land tenure security affects agricultural productivity is the choice to secure land by title, as there are customary measures to secure the land. However, the decision-making function makes it possible to measure the level of perception of land tenure security according to the measure adopted to guard against future expropriation. We believe that the modeling of the relationship between land tenure security and agricultural productivity should take into account three aspects: first, the decision function, so the objective is to subjectively evaluate how households measure the alternatives available to them; in terms of land tenure security; secondly, the link between credit access and land tenure security and finally the interaction between credit access and agricultural productivity. A three-step model seems appropriate to account for these three dimensions. Indeed, drawing on the generalized model of Heckman (1976), we can not only objectively discuss the factors that encourage households to legally secure their land, but also appreciate the extent to which land tenure security allows credit access and by multiplier effect how this credit access improves agricultural productivity. As a result of all this, we adopt a three-step model to assess the indirect influence of land tenure security on agricultural productivity through the credit access channel.

3. Methodology

Model and method of analysis

This sub-section presents not only the econometric model used but also the estimation method. However, it seems useful to us to mention the possibility of certain endogenous biases or selections that could affect the analysis.

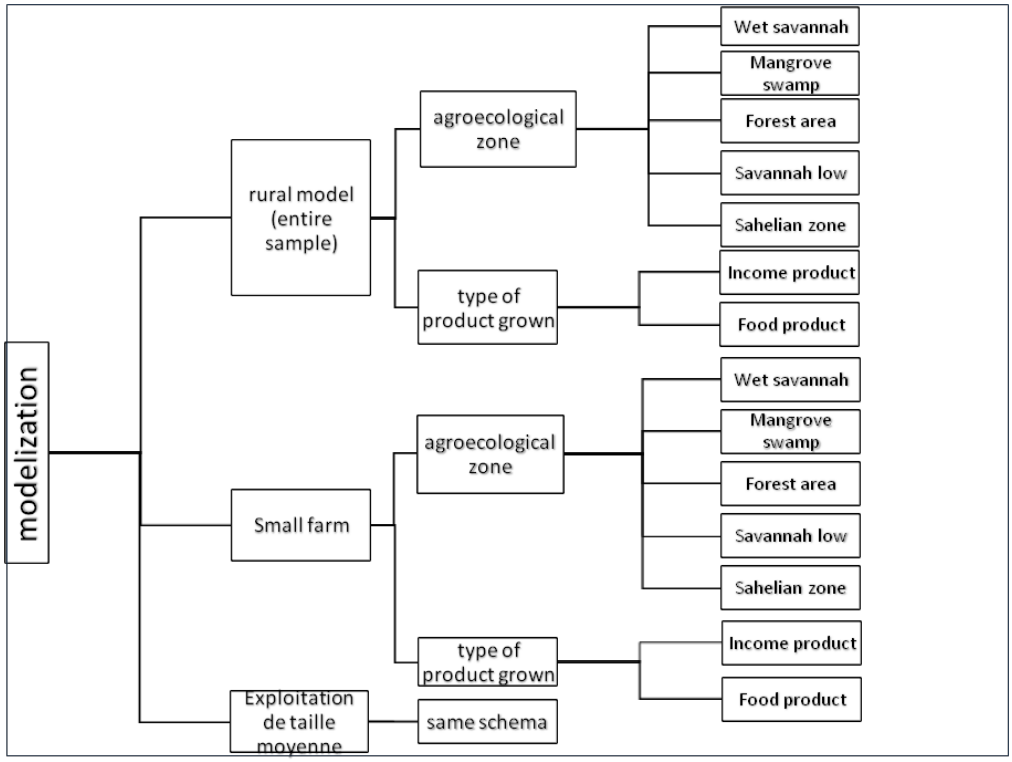
Endogeneity bias problem

This study aims to estimate the effect of land tenure security on agricultural productivity through credit access. A challenge in this estimation is the presence of selection bias. There may be selection biases because farmers with the best-tuned projects receive credit from banks rather than farmers with land titles. This may also be because it is the older farmers in a community who receive priority credit in farmers' associations than those who have a title to their land. With the expansion of the land market and the development of informal credit structures, farmers can easily access credit and use this informal credit to titrate their land, thereby increase the value of land. This can create reverse causality (bias of endogeneity) so that credit leads to access to land tenure security and vice versa. In addition, there may be a bias in the estimation that it is the most motivated farmers and those with the most fertile lands who have the best agricultural performance than those with access to land tenure security. It should be noted that apart from the unobservable variables such as the motivation of the farmer or the ability to better manage the agricultural credit received[21], certain determinants of land tenure security, such as the method of acquisition of the land, the obligations towards the transferor and the right to sell or not to sell the land received are not taken into account in the analysis due to lack of information in the database. These omitted variables are likely to bias the results, since they are potentially correlated with the explanatory variable vectors used for the analysis[22].

Thus, analysing the impact of land tenure security without taking into account these biases can lead to erroneous results. Three-step modeling and "sample" data selection, as performed here, allow for the existence of such biases. The analysis strategy is to first regress the entire sample of farmers in the rural sector, but also

to conduct micro-simulations focused on the size of the farm, on a discussion of the results according to agro ecological zone and according to the type of product grown. In concrete terms, we will initially make a regression on the entire sample (rural model), then we will perform similar replications to check whether the observed effects are identical when we perform the estimation in each agro-ecological zone (rural model in the humid savannah zone, in the mangrove, in the forest zone, in the low savannah and in the Sahelian zone) or when we distinguish farmers from cash crops and food products. We will maintain the same pattern to discuss the effect of land tenure security in the subsample of small farmers and farmers growing medium-sized farms. Figure 1 summarizes all the regressions that we will have to perform. Circles 1, 2 and 3 respectively represent the regressions in the mother sample, in the sub-sample of the agro-ecological zones and in the sub-sample of the type of crop product.

Figure 1: Estimation strategy



Econometric model

To assess the effect of land tenure security on agricultural productivity through the credit access channel, we use a multi-equation model of the generalized Heckman (1976) type. It is in fact a model with three equations. The first equation examines the

determinants of land tenure security in Cameroon. It is a binary dependent variable equation usually estimated by a probit. The second equation is also a binary response equation and thus modeled by a probit. This is the selection equation constructed on the basis of the predicted value of the first equation. The third equation that is quantitative dependent variable is constructed under the basis of the predicted value of the credit function. It highlights the effect of land tenure security on agricultural productivity. The formalization of these equations is as follows:

$$\begin{cases} \boldsymbol{Y_{1i} = X_{1i}\beta_1 + \mu_{1i}} & \textbf{(1)} \\ \boldsymbol{Y_{2i} = X_{2i}\beta_2 + Y_1^*\gamma_1 + \mu_{2i}} & \textbf{(2)} \\ \boldsymbol{Y_{3i} = X_{3i}\beta_3 + Y_2^*\gamma_2 + \mu_{3i}} & \textbf{(3)} \end{cases}$$

Y_{1i} means land tenure security, X_{1i} is the vector of variables that influences access to land tenure security.Y_{2i} represents credit access, X_{2i} is the vector of variables that dictates credit access and Y_1^* is the predicted value of land tenure security from the first equation (1). Y_{3i} means agricultural productivity, X_{3i} is the vector of variables that affects agricultural productivity.Y_2^* is the predicted value of credit from the second equation (2). $\boldsymbol{\mu_{1i}}$,$\boldsymbol{\mu_{2i}}$ and $\boldsymbol{\mu_{3i}}$ designates, respectively, the errors in each of the equations composing the system. The system is a complete model of simultaneous equations and, by order condition, the model is over-identified as defined by Koutsoyiannis (1977).

Estimation method

The system of simultaneous equations with three equations is recursive[23]. In this specific case of simultaneous equations composed of qualitative and quantitative dependent variables, we can no longer use standard estimation techniques such as least square doubles or least square triples (2SLS, 3SLS) because we obtain probabilities conditional rather than linear expressions. In the case of two equations with an endogenous input entering as exogenous in the second equation, Rivers and Vuong (1988) suggested applying a two-step estimation based on a minimum estimate of chi squared. Greene (2003) has suggested to estimate such a system of simultaneous recursive equations using a multivariate probit model. This deals with the possible correlation between each pair of equations. Roodman (2007; 2011) generalizes the two-step estimation procedure of Rivers and Vuong (1988) in the case where we have a larger number of equations with endogenous variables that are not all quantitative. In this case, the model must be recursive to allow estimation of the starting point in the simulation procedure. We are dealing with this case because the model is recursive. Thus, to take into account the biases as described above, we estimate

the system in a sequential way. In this sequential procedure, each step (except the first one) includes in the next step the regressors of the variables predicated in the previous step, correcting the standard errors. The introduction of the predicted values in the last two stages of the estimation make it possible to deal with the endogeneity problems mentioned above. However, there are still some biases resulting from the introduction of predicated variables in the last two steps. Fortunately, the techniques of Conditional Mixed Process (CMP) developed by Roodman (2007, 2011) perfectly take into account this type of bias. The CMP has the advantage of adapting to the system of apparently independent variables (SUR), instrumental variables (IV) and the system of simultaneous equations. In addition, it takes into account the cross-relationships that may exist between the different equations of a model. We use it for this analysis.

Description of the data and variables to use

The purpose here is to describe the data and variables used in the analysis.

Description of the data

To reach our goal, we use data from the ECAM 3 database that comes from the third survey of Cameroonian households. The collection of these data was carried out in 2007 by the government through the National Institute of Statistics (INS). The main objective is to produce the indicators on poverty and the living conditions of the populations. The construction of this database is to facilitate comparative analysis between households. The geographical scope of the survey is the national territory. The operation concerns all ordinary households residing throughout the national territory, excluding members of the diplomatic corps and their households. The statistical unit is the household, defined as a set of one or more persons (socio-economic unit), whether or not related by blood or marriage, living in one or more dwellings of the same concession, pooling their resources, to cover current expenses, most often eating together, and recognizing the authority of a single person as head of the household (or reference person). The observation units are at the same time the household (housing, indivisible household expenditure, etc.) and the individuals (demographic characteristics, individual expenditure, etc.). The information gathered during this survey concerns all the 10 regions constituting Cameroon. The cities of Douala and Yaoundé are two strata apart. The 10 regions are organized around three strata: urban, semi-urban and rural. The survey covers 32 strata: 10 rural, 10 semi-urban and 12 urban. The sample includes 12,609 households in 742 survey areas (EAs). This sample includes nearly 1,700 households in 82 EAs that were the subject of the pilot survey, coupled with the light survey in November-December 2006.

The multitude of indicators proposed in this database seems appropriate for us to evaluate the difference in agricultural productivity between farm households with

titled plots and those with plots without land titles. However, precautions need to be observed to build a representative sample for this analysis. In fact, the appropriate sample must be able not only to explain the differential credit access with land tenure security as the sole criterion, but also to explain how this land tenure security affects agricultural productivity through credit access. To do this, it is essential to discuss the chosen study stratum, the selection criteria for the cultivated products, to discriminate in relation to the different agro-ecological zones to avoid introducing bias in the analysis of the fact of having ignored the advantages that certain areas have over others in terms of agricultural production.

Agriculture is more prevalent in the rural stratum than in the other strata (urban, semi-urban). Moreover, it is the most practised activity in rural areas. In fact, 63.7% of households devote themselves to it. In this study, we consider only rural farmers. It should be noted that most of the cultivated land is managed under community bases (more than 87%) and the choice of these farming households is made by sampling in two stages. In the first step, retaining women, the variable access to land tenure security is used as a sampling criterion. As a result, we selected all rural farmers with a land title on their plot (154 farmers, or 25.58% of the sample). In the second stage, a simple random selection method is used to select agricultural households among those with no land title. Thus, 448 farmers are chosen from those who do not have a land title. In the end, the sample of this study includes 602 farmers. Given that agricultural production is strongly influenced by the natural environment in which it unfolds, it would be important to distribute these farmers in the different agro-ecological zones of Cameroon. To do this, we used an administrative delimitation, namely the regions. We base the definition of agro-ecological zones mainly on the map of agro-ecological zones of Cameroon and the identification variables of the ECAM 3 respondent. This allowed us to identify the five agro-ecological zones of Cameroon (Sahelian zone, lowland savanna, wet savannah zone, forest zone, mangrove zone). The specificities of agro-ecological zones are discussed in Annex 2. It should be noted that data on agricultural production were collected on 32 products. Farmers cultivate most food products. In order of importance, they mainly grow maize (42.7%), groundnuts (29.9%), cassava (28.3%), beans/cowpeas (27.8%), maize/taro (26.8%), okra (26.3%) and plantain (22.6%). In the case of cash crops, overall, only a small proportion of households cultivate: cocoa (6.6%), palm oil (5.5%), cotton (5.4%), coffee (4.9%), tobacco (1.3%) and rubber (0.1%). We do not intend to distinguish between these different crops. We therefore consider both food and cash products. However, to take into account selection biases related to the introduction of these cultures, we have three models in the analysis: a model consisting of the 32 products[24] taken as a whole, a model consisting solely of annuity products and a final model that reconciles all the food products grown. The representativeness of the targeting is as follows:

Table 1: Sample distribution according to land security and agro-ecological zones

Agro ecological zone-title	Land tenure security	Land insecurity	Total
Sahelian zone	43	110	153
Lowland savanna zone	25	113	138
Wet savannah area	72	80	152
Forest area	4	38	42
Mangrove area	10	107	117
Total	154	448	602

Variables used in the model

There are two main categories of variables: outcome variables and variables that may affect them.

Result variables

The outcome variables are credit and agricultural productivity. In this context, the main variable that can affect credit is land tenure security. The "security of tenure" is measured in this study by land title. Thus, farmers with a title to their land are considered to be in a secure land situation. This measure is generally used in economic literature to understand the notion of land tenure security (Besley, 1995; Holden and Yohannes, 2002; Kabubo-Mariara, 2007). Cameroonian law preserves the right of all individuals who have legally registered their land in the national land register. The land title therefore gives the holder the necessary security to invest because of its legal nature. Thus, in the context of Cameroon, to hold a land title is clearance of the risks of expropriation of the property except for reasons of public utility[25]. It should be noted that Cameroon's rural environment is dominated by the customary type of regime (Alden, 2011). This regime refers to unwritten rules and procedures through which a rural community regulates land relations between its members, and with neighbouring or associated communities. There is some complementarity between the customary regime and the legal regime. In fact, the registration of land in the land register involves the "abandonment of customary law". The abandonment of customary law is a document[26] signed by the village chief giving the right to the applicant to undertake all operations intended for legal recognition of the land. Individuals with land tenure security under customary land tenure generally have a lower level of land tenure security than those with land titles to their properties. In fact, unregistered lands are, according to the texts, pure and simple property of the state and do not give rise to any form of claim in the event of expropriation. Thus, land security is a binary variable that takes value one if the household has a land title on its property and 0 otherwise.

Credit: It is a binary variable that takes the value 1 if an individual has received agricultural credit and 0 if the individual self-finances his activities himself. The credits received are in cash and are granted either by formal institutions such as commercial banks, the savings and credit cooperatives, the specialized structures of MINADER; or through the informal institutions set up by farmers' associations (Tontines). Sources of formal credit are relatively low due to the absence of a farmers bank in Cameroon. Microfinance institutions and cooperatives are the most effective structures in rural areas. Farmer associations are identified as the main source of informal credit (Kamgaing-Tadjuidje, 1982). Due to lack of access to credit through the formal institutions channel (less than 2%), we cannot consider performing a comparative analysis between access to formal credit and access to informal credit, depending on whether there is a land tenure security situation. Given this fact, we consider as having access to credit in this analysis farmers who received the formal or informal credit or those who received both sources of credit simultaneously. Farmers with land titles to their properties are likely to have access to credit compared with those who have no land title (Feder et al, 1988). The credit in question is for agricultural production. We are talking about farm credit.

Agricultural productivity: Agricultural productivity refers to the relationship between agricultural production and all or part of the resources needed to achieve it (Gamache, 2005). Depending on whether we are dealing with a single factor or a set of factors of production, we are talking about partial productivity or total productivity, respectively (Kaci and Maynard, 2006). Due to data limitations, including the lack of all factors of production, we opt for partial productivity in relation to the earth factor. This index measures the efficiency with which a farmer uses the land to produce. Agricultural productivity is then formulated as follows:

$$Agricultural\ productivity = \frac{production}{cultivated\ area}$$

The data in other disposition do not give information on the quantities produced but rather on the value of the production. Given this fact, we use Total Product Value (VTP) as a proxy for production. This trick has already been used by Randrianarisoa and Minten (2001). The VTP is expressed in thousands FCFA, and the surface in hectares. The partial productivity is then understood as the value of production per hectares. We also talk about the value of agricultural yield per hectare. The value of the total production of each farmer is obtained by summing the values of the production for each product cultivated by the latter. Using the value of production instead of physical quantity can broaden the term of error when estimating because

of crop aggregation. To take account of this problem, we take care to introduce in the analysis a supplementary estimate that distinguishes between the productivity of cash products and the productivity of food products. It should be noted that 32 agricultural products were selected for analysis in the ECAM 3 survey. These products include both food[27] and cash products[28].

Control variables

We discuss here the control variables selected for the analysis:

- Sex: It is a binary variable that takes the value 1 if the farmer is a man and 0 if it is a woman. Due to traditional customs, men have priority access to land over women. As a result, they can easily have their ownership rights recognized on the plots they own. We, therefore, think that land tenure security increases with the fact that the farmer is a man. It is important to emphasize here that the gender of the household head is not only recognized as a determinant of credit access but also as a determinant of agricultural productivity (Wendy-Karamba and Winters, 2015; Wahidi and Paturel, 2016). Indeed, the literature notes that women are more discriminated against than men in the exercise of credit access. In addition, questions remain about which groups to target (men or women) to increase agricultural productivity. We, therefore, verify here the influence of the household sex on credit access and on agricultural productivity.

- Marital status: We believe that in the context of Cameroon, the marital status of the head of household can have an effect on land tenure security. This variable is used to account for the land status of widows, single persons, polygamous and monogamous families and common-law households. In the specific case of widows, it is commonplace to see the plots of land held by them taken away by the family of the deceased. Thus, being widowed negatively affects land tenure security. We will only consider the situation of widows in the analysis as we do not anticipate a clear direct link between other patterns of marital status and land tenure security. As a result, we construct a binary variable that takes the value 1 if the household is widowed and 0 otherwise. It should be noted that this variable is also taken into account in the credit function in assessing whether widowed women, because of the injustices they experience[29] in the exploitation of the land, are penalized when they wish to borrow credit.

- Age: The age group can influence the level of land tenure security. Indeed, older people are more likely to be secure because they did not leave land to younger people. In addition, land legislation stipulates that in order to obtain a land title in Cameroon, one must be born before 1974. To account for this reality, the age variable is categorized according to three age groups: young for people who belong to the interval (15-35), adults for people who belong to the interval

(35-50) and old if the farmer is over 50 years old. It should be noted that age is also recognized as a determining factor in the credit supply exercise (Zidani and Jarboui, 2011). Age is usually used as a proxy for the farmer's experience. Experienced farmers are considered the most productive (Munroe, 2001; Randrianarisoa and Minten, 2001). We will also try to appreciate the effect of age on agricultural credit and agricultural productivity.

- Level of education: An educated head of household understands with greater ease the necessity of having his property legally recognized. This is why we take this variable into account. It is a categorical variable that provides information on the highest level of education attained or followed by the farmer. This variable presents eight modalities listed as follows: no level for farmers at the kindergarten level, primary for farmers who left school after taking the second year middle school course with or without CEPE[30]/ CEP[31]; post-primary for farmers undergoing or trained in SAR/MS[32] after CEPE/CEP; general second cycle for farmers who have followed or are currently in the sixth or third year; second general cycle for farmers who have completed the second year, first or second year, second undergraduate; and second cycle and higher technology for farmers who have pursued studies after the baccalaureate. It should be noted that educational attainment is also recognized as a determinant of credit access and agricultural productivity (Randrianarisoa and Minten, 2001; Muyanga and Jayne, 2019). Indeed, the level of education is a key factor in increasing the productivity of farmers in that it promotes the adoption of intensive innovation in human capital. We also appreciate in this analysis the effect of education on agricultural productivity.

- Total number of owned lands: We believe that land tenure security decreases with the number of land possessed. That said, the less a household has land, the more it is encouraged to secure it through the use of land title more so because it involves the collection of property taxes and therefore constitutes burdens for the household. We also consider this variable in the credit function. We believe that a farmer can easily be granted credit when he has a large endowment of land resources. In addition, by having credit access, farming households can easily develop the land through access to modern farming equipment and thus increase agricultural productivity.

- Value of production: This variable is taken here as a proxy for soil fertility. We think that a farmer will have more incentive to secure a piece of land if it is fertile. In addition, the value of production can help the banker to assess the household's repayment capacity. In fact, under the basis of the income recorded by the household, credit institutions can know whether the household can or cannot repay the credit borrowed. We therefore hypothesize that the value of production positively affects the probability of credit access.

- Household size: Land insecurity arises when the population increases more than proportionally to land resources (Boserup, 1965). To ease tensions on land that has become increasingly rare as a result of population growth, it is necessary to titrate its land ownership (Platteau, 1996). In this context, we use the number of people in the household as proxy for the increase in population. It should also be noted that household size can be equated with family labour (Muyanga and Jayne, 2019). A household with many people can help reduce labour costs and thus improve agricultural productivity through investment in other variable inputs.

- Size of the farm: It is a continuous variable taking the value 1, 2, ..., 90. These values indicate the number of hectares exploited. The problem with this variable is that it may be correlated with the other variables selected for the analysis. Recent literature suggests categorizing three-dimensional: small, medium, and large-scale exploitation(Jayne et al. 2016; Muyanga and Jayne, 2019). To this end, we adopt Jayne et al (2016), which considers small holdings that are between 0 and 5 hectares in size, medium-sized farms range from 5 to 100 hectares in size and large farms range from 100 to 1000 hectares. Depending on the size of the farm, a farmer may agree to secure his or her land ownership.

- Number of homes owned: Cameroon's land legislation requires that only developed areas be titled. The texts do not clearly define the concept of development. However, individuals usually build houses to justify the development of the land. We believe that owning a home makes it easier to securitize land. The variable number of homes owned is continuous. It represents the number of dwellings held by the household. We would like to emphasize that the number of homes owned by the head of household can influence the supply of credit. Indeed, it is possible for a farmer to pledge his house against credit. As a result, we hypothesize that credit access increases with the number of homes owned by the farmer.

- Type of equipment: The type of equipment is a binary variable that takes the value 1 if the household uses modern operating tools (tractor, motor pump, etc) and 0 otherwise. Land tenure security by reducing the risk of expropriation not only facilitates credit access but also increases incentives to invest in the acquisition of modern farm equipment (Roth et al, 1994). These modern farming facilities in turn help improve agricultural productivity (Hayes et al, 1997). We test the meaning of this relationship in this analysis.

- Type of product grown: It is a binary variable. It takes the value 1 if households grow income products and 0 otherwise (food product). Annuity products are mainly for sale while food products are most often used for home consumption. As a result, we believe that credit risk is lower for households growing cash crops than for fish products.

- Level of health: It is a binary variable that takes the value 1 if the farmer's health status is good or good enough and 0 if his health condition is fair or poor. We assume that a farmer in good health is more active and therefore produces more productively than a farmer in fair or poor health.

- Value of the equipment: It is a continuous variable expressed in thousands of FCFA. This variable provides information on the costs borne by farmers to purchase production equipment. In case of default on repayment of the credit contracted by the farmer with the credit institutions, they can seize the operating equipment to recover their expenses. As a result, we believe that a farmer with high-value equipment is more likely to receive credit than a farmer with less valuable equipment.

- Production costs: These include labour costs, seed purchase costs, pesticide purchase costs, and the cost of buying fertilizer. These are continuous variables expressed in thousand FCFA.

- Type of seed used: It is a binary variable with a value of 1 if the farmer uses the improved seeds and 0 if he uses the traditional seeds. The current consensus is that adoption of improved seeds contributes nearly 30% to crop productivity (Dembélé, 2011). Depending on the quality of the seeds, one can expect to increase agricultural productivity by more than 40% (Kpedzroku and Didjeira, 2008). Following this dynamic we assume that the use of improved seeds positively affects agricultural productivity.

Table 2 below presents all the variables used in the analysis. The descriptive statistics of all the variables used in the analysis are presented in Annex 3. We have been careful to describe the various variables according to the distribution of land tenure (legal and traditional), by age group, by size of exploitation (small and medium-scale), according to the agro-ecological zone and according to the groups of cultivated products (food crops, and rents). It is observed that the average value of agricultural production for farmers in the entire sample is FCFA 255,193 with a level of agricultural productivity of FCFA 101,826. Farmers are mostly smallholders with more than 87% of the sample operating on farms of up to five hectares. They are more involved in food crops than cash crops. In fact, more than 61% of the agricultural households in the sample cultivate food products. Agricultural credit remains a rare commodity with only 22.09% of farmers having access to agricultural credit. This proportion is even lower for smallholders in forest areas, therefore less than 4% of farmers have credit access. As a result, we will not be simulating this sub-sample of smallholders. In addition, a small proportion of farmers have been identified in the low savannah area with minus 6.98% of households practicing the farmer, or only 42 farmers. This size does not allow us to perform econometric analysis in the low savanna zone. Similarly, the proportion of farmers who farm medium-sized farms does not allow

us to assess the effects of land tenure security in different agro-ecological zones or to discriminate according to the type of crop grown. Indeed, only 12.29% of farmers cultivate medium-sized farms, i.e. only 74 farmers. In fact, we will only analyse the effect of land tenure security on agricultural productivity in the sample of farmers operating medium-sized farms as a whole.

Table 2: Description of the variables used in the analysis

Group of variables	Variables	Nature of the variables	Description of the variables
Characteristic of farmers	Sex	Dummy	1 if the farmer is a man and 0 if the farmer is a woman
	Widow	Dummy	1 if the farmer is a widowed woman and 0 otherwise
	Age	Categorical variable	1 for young people (15 to 35 years old), 2 for adults (36 to 50) and 3 for old people (over 50)
	Level of study	Categorical variable	Coded from 1 to 8, respectively, according to whether the farmer is without level, primary, post-primary,.., higher
	Health level	Dummy	1 if the farmer's state of health is good or good enough and 0 if his state of health is fair or poor
	Household size	Continuous variable	Number of people in the household
	Number of houses owned	Continuous variable	Residential complex held by the head of household
	Number of land owned	Continuous variable	Land expressed in hectares
Characteristic of the exploitation	Size of the farm	Categorical variable	1 for small farms (0 to 5 hectares), 2 for medium farms (6 to 100 hectares)
	Value of equipment	Continuous variable	Expressed in thousands of FCFA
	Type of seeds	Dummy	1 if the farmer uses improved seeds and 0 if he uses traditional seeds
	Type of equipment	Dummy	1 if the farmer uses modern equipment and 0 if not
	Cost of seeds	Continuous variable	Cost of seeds in thousands of Francs per hectare

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Table 2 Continued

Group of variables	Variables	Nature of the variables	Description of the variables
	Cost of fertilizers	Continuous variable	Cost of fertilizers in thousands of Francs per hectare
	Cost of pesticides	Continuous variable	Cost of pesticides in thousands of Francs per hectare
	Cost of labour	Continuous variable	Cost of labour in thousands of Francs per hectare
	Value of production	Continuous variable	Estimated value of agricultural production in thousands of FCFA
Variables results	Land tenure security	Dummy	1 if the land is titled (land security situation) and 0 if no
	Agricultural credit	Dummy	1 if the farmer has access to credit and 0 if no
	Agricultural productivity	Continuous variable	Relationship between the total production in thousands of FCFA and the total area exploited

Source: Authors from the ECAM 3 database

4. Results and discussions

This section presents the empirical results of the impact of land tenure security on agricultural productivity through credit access. This presentation is essentially based on the application of CMP techniques on the three-equation model. A general model, that is to say the one that reconciles all rural farmers, is presented. The other micro-simulations are reported in Appendix 4.

Evidence of the relationship between land tenure security, credit access and agricultural productivity in Cameroon

Table 3 presents the results of the three-stage modeling carried out on all the rural farmers who make up the sample.

The table highlights the effect of land tenure security on agricultural productivity. Analytically, it makes it possible to identify the factors that explain land tenure security and to assess the effect of this land tenure security on credit access, and to appreciate the effect of this credit on agricultural productivity.

Table 3: Results of the three-step regression (global model)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Standard deviation	Coefficient	Standard deviation	Coefficient	Standard deviation
Land tenure security	-	-	45.64456***	16.53719	-	-
Credit			-	-	207.8816***	55.87246
Sex	-0.9604309 ***	0.3109944	43.26732***	15.86905	73.41614***	24.39109
Widow	-0.1952142	0.3561684	8.314576**	3.227922	-	-
Age						
[36-50]	-0.5126599**	0.2261361	0.23.31299***	8.510688	-31.90333	30.26851
+50	-0.3825141**	0.1790798	17.55612***	6.356375	-105.567***	27.96327
Level of study						
Primary	0.7987761***	0.2643112	-36.29345***	13.18064	-70.48861***	21.05023
Post-primary	1.195577 **	0.6192058	-55.2953***	19.85908	51.95085	57.28855
Secondary general 1st cycle	0.6782349**	0.3157433	-30.92076***	11.18083	-58.4133**	26.30581
Secondary general 2nd cycle	8465113**	0.3740369	-38.55635***	13.98194	-85.39855***	26.6099
Technical junior 1 cycle	0.8197051**	0.3850518	-36.57551***	13.15388	-120.7698***	32.57079
Technical secondary 2nd cycle	2.60914***	0.4381692	-120.1404***	43.11332	106.9599**	51.30979
Superior	1.708152 ***	0.4877837	-78.97762***	28.13046	155.0961**	66.50731
Health	-	-	-0.1112169	0.1737752	44.02799**	21.1253
Household size	-0.0014476	0.0214206	-	-	13.09118***	3.665632
Number of possessed dwelling	0.2281412**	0.0938797	-10.58291***	3.766979		
Size of the farm	0.55664***	0.2110517	-24.59625***	9.208405	-289.4776***	62.08999
Value of the equipment	-	-	-0.0059614*	0.0030572		
Number of land owned	-0.0390112	0.0359586	1.660138**	0.6498613	21.72139**	8.550597

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Table 3 Continued

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Standard deviation	Coefficient	Standard deviation	Coefficient	Standard deviation
Equipment	-	-			24.18904	25.76707
Type of seed	-	-			-3.704363	36.75679
Cost of fertilizers	-	-			0.1216308	0.2277801
Cost of pesticides	-	-			0.4775808	0.4057893
Cost of labour	-	-			0.07648	0.0890153
Cost of seeds	-	-			0.1118772	0.1414472
Value of production	-0.000445*	0.0002447	0.0208824***	0.0073728		
Constant	-1.351241***	0.441701	61.30223***	22.40774	469.3901***	72.70333
Wald chi2 (16, 18, 21)	39116.66	Obs=602	71.73	Obs=530	80.02	Obs=473
Log pseudolikelihood	0.1597		-102909.64		-1211120	

Determinants of land tenure security

The first step of the analysis reveals that the sex of the head of household, the age, the number of houses owned, the number of land owned, the size of the farm and the value of agricultural production explain the security of tenure. The influence of these variables on land tenure security varies according to whether we only take into account the farm taken as a whole, or small and medium-sized farms, but also when we take into account the different agro-ecological zones and the type of cultivated products. Overall, the analysis shows that gender, the age of the head of household and the size of the farm have a negative and significant impact on land tenure security. Indeed, in the Cameroonian context, being a woman reduces the possibility of obtaining land title compared to a man. This can be explained by the fact that men have easier access to land through customary tenure and, therefore, can easily initiate legal procedures to secure their property. The traditional chiefs generally consider the woman not only inferior[33] to the man but also as very fragile and generally unstable, who under the impulse of love can concede the lands which are given to her to a lover. Thus, depriving women of the right to land ownership is considered a means of safeguarding land assets. In addition, the negative and significant effect observed between age and land tenure security indicates that security increases with age. Indeed, young people seem less secure in terms of land tenure than the elderl. This can be explained by the fact that the elderly have not bequeathed their property to young people and can easily justify that the property belongs to them. Moreover, Cameroonian land legislation does not allow young people to carry out a direct registration of land. This prerogative is usually reserved for the elderly.

The level of education positively influences the probability of having access to land tenure security. Educated farmers understand with much greater ease the need for legal recognition of their property. Consequently, they mobilize all the necessary measures to legally secure the areas they exploit. It should be noted that apart from the Sahelian zone where the huts encountered are functionally incomplete to justify the development of land, the number of houses owned by the head of the household positively influences and significantly the probability of having access to land title. This result seems to be a direct consequence of Cameroon's land legislation. Indeed, one of the conditions for a space to be registered is that the latter must have the object of an actual development. The physical materialization (presence of a house for example) is admitted in this sense as a palpable proof that the space one wishes to titrate is really highlighted.

The value of agricultural production[34] has a mitigated effect on land tenure security. Indeed, the value of agricultural production negatively and significantly influences the probability of securing the land when we consider the sub-sample of cash crop farmers and medium-sized farms, but the effect is positive for the other sub-samples.

We believe this result is due to the level of investment that cash crop and large-scale growers make on the land. Indeed, if the land is fertile, for example, farmers will invest less or virtually no land to promote the development of annuity products[35]. In such a context, they will have less incentive to secure their land because they spend less money. Conversely, when the land is less fertile, it is necessary to invest in considerable soil quality to hope for a good harvest. Given its level of rationality, the farmer will be more encouraged to secure the space he uses to secure the investments he has made in the context of his agricultural activity.

Effect of land tenure security on credit access

The second stage of the analysis highlights the effect of land tenure security on credit access. We took into account a set of control variables. This analysis shows that land tenure security positively and significantly influences the probability of accessing agricultural credit. This result is consistent with the lessons of property rights theory, which predict a direct positive effect of land tenure security on credit access. For example, farmers who hold a title to the land they use have more credit than farmers who do not. The influence of land tenure security on agricultural credit remains positive when we take into account the different criteria used in the econometric analysis (size of farm, agro-ecological zone and type of crop). This helps to reinforce the conclusions. Moreover, the results corroborate the findings of Feder et al (1988) that in India, Thailand and the Republic of Korea, there is a positive and significant relationship between land tenure security and credit access. Titled land is therefore a collateral of choice, with credit institutions that can in the event of failure repay or resell the land of the debtor on the land market[36] to recover its costs (Dorner and Saliba, 1981). It should be added that the value of agricultural production and age also positively and significantly influence the probability of having access to agricultural credit. This result shows that the elderly, because of their higher level of land tenure security than young people, receive agricultural credit as a priority. On the other hand, when the value of agricultural production increases, farmers also benefit from credit facilities as credit institutions can use crop revenues to write off credits granted in the event of default by farmers. The value of the equipment and the number of dwellings possessed, however, have a negative influence and the probability of credit access. We believe that this result is explained by the fact that the operating equipment considered is for the most part of less value that cannot be used to amortize the credit granted to farmers. Moreover, most of the homes proposed as mortgage against credit are generally established on untitled land. As a result, it is difficult to associate the applicant with the land on which the building is built. Thus, the difficulty of proving full ownership of the land on which the house is built generates a mistrust of banking institutions towards the farmer, which militates against easy credit access by the latter.

Effect of credit access on agricultural productivity

Our analysis resulted in an appreciation of the effect of credit access on agricultural productivity. Other variables were taken into account. The strategy for verifying the robustness of the results relies as before on micro-simulation focused on the size of the farm (small-scale, medium-sized farm) with a discussion of the results according to the different agro-ecological zones but also according to the type of product grown (cash and food).

Effect of credit access on agricultural productivity of all farms

Overall, the results support the hypothesis of a positive effect of credit access on agricultural productivity. Indeed, the global model, i.e. the one that reconciles all rural farmers, reveals that credit access makes it possible to increase agricultural productivity to more than FCFA 207,881 per hectare. In other words, farmers who have access to land tenure security can reuse it to enhance these secure spaces. On average, they improve their agricultural yield by more than FCFA 207,881 for each hectare cultivated. This effect is statistically significant at the 1% level. For example, credit access increases agricultural productivity. Here, we find the effect that could be expected, which is widely shared in the literature, namely: credit access positively influences agricultural productivity (Carter 1989; Yazdani and Gunjal, 1998; Nyemeck et al, 2008; Martey et al, 2015). However, this effect needs to be qualified. Indeed, by considering all farmers in rural areas without taking into account ecological zones or cultivated products, we mask in one way or another the real influence of land tenure security on agricultural productivity.

Results according to agro ecological zones

The analysis of the entire sample according to ecological zone reveals that credit access positively and significantly influences agricultural productivity. However, this effect varies from one agro-ecological zone to another. Indeed, in the humid savannah zone, the agricultural productivity of farmers is of the order of FCFA 667,340.2 per hectare; in the Sahelian zone, it is about FCFA 201,588 per hectare, in the mangrove it is of FCFA 44,054.88 and in the forest area it is FCFA 15,319.26 per hectare. Thus, access to agricultural credit has a significantly greater effect on agricultural yields in the humid savanna zone than in other agro-ecological zones. We believe that this result is a direct consequence of the effects of land tenure security, but also of the quality of the soil deemed to be conducive to agricultural development in the area. Indeed, once protected against any expropriation pre-sale of the farm, farmers are more motivated to value the land through credit facilities that land security allows. This is reflected in a significant improvement in productivity gains compared to a situation of land insecurity[37]. The differential effect is thus FCFA 667,340.2 per hectare compared to the reference situation; that is to say for households that have no title deed on their farm.

Although agricultural productivity gains are lower than in other agro-ecological zones, farmers in forest areas nevertheless achieve significant productivity gains despite the quality of the so-called poor soil. Forest lands are characterized by low nutrient retention capacity. In fact, the achievement of good harvest resides on a large mobilization of inputs. We can therefore emphasize that the observed positive effect results from the multiplier effects of land tenure security. Indeed, land tenure security by facilitating credit access enables farmers to acquire the necessary production resources to improve agricultural productivity.

Results by type of product grown

Econometric analysis reveals that credit access affects the agricultural productivity of both cash crop and food crop producers. However, the observed effect varies from one group of products to another. In fact, producers of cash products produce a value of FCFA 72,343 per hectare while those of food products produce more than FCFA 135,209 per hectare. Thus, land tenure security by facilitating access to agricultural credit and preserving farmers from early expropriation encourages them to value the land. This is reflected in a significant improvement in agricultural productivity among cash crop farmers but especially in food producers. This effect is very important given that Cameroon is considered a major importer of food products (OMC, 2013). Thus, tenure security by improving agricultural productivity could limit or even cancel food imports. Similarly, by improving the productivity of cash products, security of tenure makes it possible to increase the stock of products to put on the market of agricultural products, and thus to increase the productivity gains related to agricultural activity.

Effect of credit access on agricultural productivity of small farms

By discriminating the analysis against the size of the farm, we observe the same effects. In fact, credit access makes it possible to increase agricultural productivity to more than FCFA 358,388 per hectare. This effect is statistically significant at the 1% level. For example, land tenure security by facilitating credit access improves the agricultural productivity of small farms. This effect is reinforced even when we take into account agro-ecological zones and types of cultivated products. Indeed, land tenure security improves the value of agricultural productivity per hectare, respectively, in the humid savanna zone (FCFA 328,334), in the mangrove zone (FCFA 53,043), and in the Sahelian zone (FCFA 25,526). The effect remains greater in the humid savanna zone. In addition, similar effects are observed when we take into account the type of product grown with a more pronounced effect among producers of food products (FCFA 505,425 per hectare) than income products (FCFA 75,642 per hectare).

Effect of credit access on agricultural productivity of medium-sized farms

The data presented did not allow us to assess the effect of credit access on agricultural productivity in all the dimensions mentioned above (agro-ecological zone and type of products grown). However, it should be emphasized that credit access positively and significantly affects the value of production per hectare of all farmers who grow medium-sized farms. Indeed, credit access makes it possible to increase the value of agricultural production to more than FCFA 4,880 per hectare. This effect is statistically significant at the 1% level. Thus, land tenure security improves the value of production per hectare through the credit access it allows.

Interpretation and discussion of results

The results of the analysis confirm the hypothesis that land tenure security positively and significantly influences agricultural productivity through the credit access it allows. Overall, the results show that land tenure security by facilitating credit access improves the value of agricultural production per hectare by more than FCFA 207,880.

Other interesting results need to be commented on. These include the effect of sex on agricultural productivity. In fact, analysis reveals that the average productivity of men is estimated at more than FCFA 73,416 per hectare. This result shows that men produce, on average, more than women. We think, however, that this result is associated with the different constraints that women face in this activity (Wendy-Karamba and Winters, 2015). The main constraint encountered in the context is the difficulty of access to land ownership. Indeed, customary law does not grant the woman any control over the land except for a simple right of use. In fact, they cannot initiate a legal procedure for recognition of land for own account. The exclusion of the exercise of full ownership of the land through the estate[38] channel, if not in an exceptional way, prevents them from using land as a mortgage against agricultural credit. Lack of credit access in turn diminishes their ability to invest in soil quality. Thus, the difference in land tenure security between men and women explains the difference in agricultural productivity between them.

The age of the head of household, the level of education, and the size of the farm, negatively and significantly affect agricultural productivity. The results indicate that young people are more productive than older people. Thus, the ageing of the labour force is a drag on the growth of agricultural productivity. In addition, the fact that the lessons received by households are not geared specifically to the agricultural sector does not favour the adoption of intensive human capital innovation by farmers. This result highlights the need to diversify school education to allow better adoption of intensive human capital innovations by farmers. It should be added that the negative interaction between farm size and agricultural productivity refers to the traditional inverse relationship between farm size and productivity. This negative effect is due to

imperfections in the labour market (Sen, 1966). In fact, small farms use labour more intensively than large farms. This generally familial workforce does not involve high supervision costs, so that moral hazard behaviours in the level of effort provided are reduced. The situation is more delicate in the case of large farms, and this explains the negative effect between the size of the farm and agricultural productivity. An indepth analysis was provided to verify this negative relationship between farm sizes and agricultural productivity. Indeed, we carried out an analysis distinguishing small farm and average exploitation. The results predict that farmers in small farms are actually more productive than farmers in medium-sized farms.

This result also teaches us that the relative size of farms actually influences households' perception of their land tenure security (Alemu, 1999). In fact, farmers with an average farm size (between six and 99 hectares) feel less secure than those with small holdings (less than six hectares). Feeling more secure than others in other categories, smallholders are more motivated to spend on labour and money on the land. This translates into an increase in the value of agricultural production per hectare of FCFA 358,388, while the value of production per hectare of farmers of medium-sized farms is FCFA 4,880. Thus, the smaller the size of the farm, the more farmers who have titled their land feel safe and invest accordingly to improve agricultural yields. An analysis of the effect of credit access on agricultural productivity in the humid savanna zone characterized by farm sizes ranging from 0.5 to 2 hectares confirms this conclusion. Indeed, because of their small size (compared to farms in other agro-ecological zones), the farmers in this area feel particularly secure. As a result, they realize a level of agricultural production estimated at more than FCFA 667,340 per hectare. This level of agricultural productivity is indeed higher than that observed in all the samples analysed. Thus, the relative size of farms influences farmers' perception of their level of land tenure security, and the multiplier effect defines the intensity of the effect of land tenure security on agricultural productivity.

5. Conclusion and recommendations

This study analyses the effect of land tenure security on agricultural productivity through credit access. To this end, we rely on data from the third Cameroon Household Survey (ECAM 3). The main implications of this analysis through three-step modeling are summarized below.

Land tenure security is an important determinant of access to agricultural credit. Indeed, the results of the econometric regression reveal that land tenure security positively and significantly influences the probability of access to agricultural credit for all farmers in rural areas. A check of the robustness of this result has been provided. In particular, we carried out micro-simulations centred on the size of the farm (small-scale farm and medium-sized farm), on the types of products grown (cash crops and food crops), but also through discussion of the results in the different agro ecological zones. The overall results show a positive and significant effect of land tenure security on agricultural productivity.

Credit access improves agricultural productivity. The sequential estimation of the model through the techniques of the "CMP" shows that credit access positively and significantly influences agricultural productivity of all farmers in the rural world. Indeed, it has been shown that credit access makes it possible to increase the value of production per hectare to more than FCFA 207,880. This effect is statistically significant at the 1% level. An analysis of the robustness of this result was provided. Micro-simulations identical to those made in the analysis of the empirical link between land tenure security and access to agricultural credit were carried out. All the stimuli carried out support the argument that credit access improves agricultural productivity.

Thus, land tenure security by facilitating access to agricultural credit and preserving the farmer from any early expropriation of the farm helps to improve agricultural productivity. It should be added that the level of perception of land tenure security, one way or another, defines the intensity with which land tenure security affects agricultural productivity. When the size of the farm is small, the farmer feels safer and produces more than the farmers who grow the farms of medium or large size. Empirical evidence has been provided on the issue with a greater impact of land tenure security on agricultural productivity of small farmers (FCFA 358,388 per hectare) compared to those exploiting medium-sized farms (FCFA 4,880 per hectare).

Our results provide evidence of a positive and significant effect of land tenure security on agricultural productivity. We can therefore say that land tenure security is fundamental for emergence of policies in the context of Cameroon, in the sense that land tenure security directly affects agricultural productivity through access to agricultural credit it allows. In this dynamic, we recommend that public authorities promote land tenure security by reinforcing the unassailable and irrevocable nature of land title, but also by easing the conditions of access to it.

Notes

1. https://docplayer.fr/42540796-On-le-pressentait-la-crise-financiere.html: page 14

2. In so far as some farmers save their resources, they most often direct torrents of water into neighbouring fields and vice versa.

3. Injustices particularly concern irregularities in the distribution of land titles, which most often lead to duplication of land titles and the expropriation of the parties involved, pending the identification of the real owner.

4. The modern regime is based on written law. It is supported by land title.

5. Customary law or regime refers to the (unwritten) rules and procedures through which a rural community regulates land relations between its members, and with neighbouring or associated communities.

6. These include Hardin (1968), Boserup (1965), Demsetz (1967), and Coase (1960).

7. Responsible for ascertaining the real land rights on an immovable, for entering them in the land register and for issuing a land title accordingly.

8. Holding a title deed on the cultivated plot.

9. In this context, agricultural productivity refers to the ratio of production in value to the area exploited, or agricultural yield per hectare. It is therefore a question of evaluating the marginal efficiency of production in relation to the earth factor. We still talk about partial productivity in relation to the earth.

10. Ministry of Finance.

11. The formal sector consists of commercial banks, specialized financial institutions, the Caisse d'Epargne Postale, postal checks, insurance companies, microfinance institutions and the money market.

12. The solvency of individuals is best appreciated through the earning of a salary.

13. In accordance with the law of cooperative societies, entered into force in January 2016

14. Provision of a land title.

15. Agricultural Market Investment and Development Project.

16. This includes the farmland guarantee, the farm product guarantee and the farm equipment guarantee.

17. https://www.cameroon-tribune.cm/article.html/19929/en.html/services-financiers-63-

18. This project aims to improve the institutional environment of microfinance, to facilitate access of rural populations to financial services and products adapted to their needs.

19. Its objective is to offer rural poor people, who do not have access to the services of traditional banks, a source of local financing enabling them to develop economic activities and thus contribute to the lasting improvement of their living conditions.

20. This model included three relations: that which links the title of property to the credit access; that reflecting the ability to use one's own means to invest in soil quality by being in a secure tenure situation; and lastly, that reflecting the emergence of the land market due to a better definition of property rights.

21. For example, the ability to better distribute credit in the different phases of production.

22. The omitted variables are included in the error term; because of the correlation between the omitted variables and the explanatory variables used for the analysis, there is a violation of the hypothesis of the independence between the error term and the explanatory variables, which has the effect of biasing our econometric analysis.

23. Indeed, each endogenous variable appears as explanatory in an equation only if it is explained by a previous equation.

24. Plantain, banana, tomato, cassava, Macabo/Taro, yam, palms, potato, maize, millet / sorghum, pineapple, onion, bean/cowpea garlic, citrus fruit, plum, avocado, mango, ginger, cabbage, carrots, okra, chilli and pistachio.

25. This is done with a fair and prior compensation paid by the party asking the owner to abandon his property.

26. This certificate issued by the village chief does not constitute a title deed.

27. These include plantain, bananas, tomatoes, cassava, macabo/taro, yams, palms, potatoes, maize, millet/sorghum, pineapples, onion, bean/cowpea, garlic, citrus, plum, avocado, mango, ginger, cabbage, carrots, okra, chili and pistachio.

28. These include coffee, cocoa, cotton, tobacco, oil palm, and rubber.

29. Expropriation of arable land upon the death of their husbands, for example.

30. Elementary Primary School Certificate.

31. Certificate of primary study.

32. Rural Craft Section and Housewife Section.

33. Given this consideration, it should not therefore enjoy the same privileges as men.

34. Taken here as a proxy for soil fertility.

35. Who are by ease characterized by these requirements in investment in soil quality.

36. The land title makes it possible to ensure the mobility of land exchanges and facilitates sales on the land market since this asset makes it possible to remove the ambiguity on the ownership of the property.

37. Land tenure insecurity is used here to refer to farmers who do not have land titles on the plots they farm.

38. Succession is one of the channels by which access to land takes place in the traditional context.

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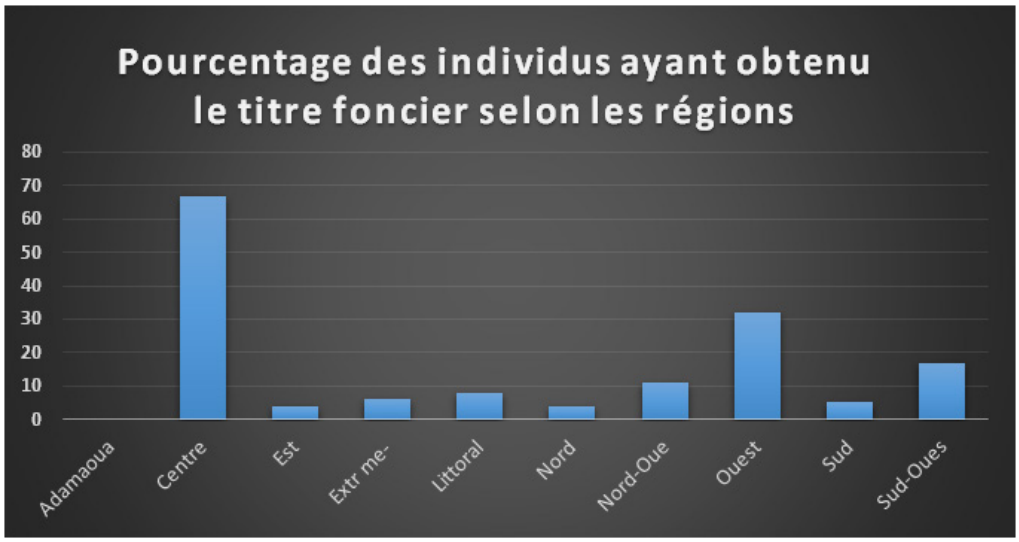
Annex 1: Distribution of individuals obtaining title (by region)



Annex 2: Characteristic of agro-ecological zones of Cameroon

The wet savanna zone: It is composed of the western and northwestern region and covers an area of 31,192 km^2. The relief here is very diverse and conducive to agricultural activities. Its "Cameroonian altitude" climate is marked by two seasons of unequal length: the dry season that runs from mid-November to mid-March and the rainy season from mid-March to mid-November. The rains are abundant, varying between 1,500 to 2,000 mm. Farms are generally small between 0.5-2 hectares under cultivation. Most farmers practise more or less intensive traditional production systems, combining food crops and cash crops. Thus, all kinds of crops are grown: maize, rice, tuber and root crops, vegetable crops, oil palm, citrus, coffee arabica and robusta, tea, cocoa tree, peanut, etc.

Mangrove area: It covers the coastal and southwestern regions, and the coastal border of the South region. It occupies an area of 45,658 km^2. The relief is flat overall. Soils are most often very fertile nitosols. The "Cameroonian" type of climate is characterized by a monomodal rainfall regime with a very weak dry season. The average rainfall is between 2,500 and 4,000 mm, with the exception of the town of Debundsha which is considered one of the most rainy regions in the world with 11,000 mm of rainfall per year. Agricultural activity is dominant everywhere in the area; it concerns more than 78% of the active population, which is involved in both cash crop and food crop development. Food crops, however, are difficult to quantify. There are more cash crops such as cocoa, banana, coffee, plantain, palm oil, ginger, pepper, etc.

Forest zone: It extends over most of the south Cameroon plateau between 500 and 1.000 m altitude. It covers the central, southern and eastern regions over an area of 165,770 km^2. Soils are characterized by low nutrient retention capacity. Warm and humid, the climate is of "Guinean" type with a rainfall of 1,500-2,000 mm per year, divided into two wet seasons allowing two crop cycles and a spread agricultural calendar with sowing and staggered harvests. The vegetation consists of dense forests and generally traditional agricultural practices with shifting cultivation followed by fallow land for the restoration of soil quality. The main food crops in the area are: sugar cane, plantain, palm oil, peanuts, dessert bananas, macabo, yams, exotic and local fruits, leafy vegetables and condiments. The cash crops are: cocoa, robusta coffee and tobacco.

Low-lying savannah zone: It mainly covers the Adamaoua region and the northern part of the Mbam and Kim department in the Central region, and the Lom-et-Djerem

region in the Eastern region. It covers an area of 123,077km^2. Soils are permeable with an average water retention capacity. The climate is wet tropical Sudanian type at two seasons per year. The average annual rainfall is about 1,500 mm. Most farmers in the area also breed. Thus, agriculture and livestock maintain complex relationships of complementarity and competition both at the level of the production system and at regional level. Maize is the main crop observed in the area. They also grow millet, sorghum, cotton, potatoes, yams, onions and peanuts.

Sahelian zone: It covers approximately the northern and far-northern regions. It covers an area of 100,353 km^2. Soils are very diverse. The climate is characterized by a monomodal type rainfall of variable duration and intensity (from 400-1,200 mm per year from north to south). The main products from agriculture are sorghum, millet, cotton, corn, rice, peanut, and cowpea. The use of fertilizer in the area remains low. There is also a complementarity between agriculture and livestock. In fact, crop residues remain in the field and serve as a forage supplement for animals in the field. The production of "local" vegetables (okra, groundnut, onion, peppers, corchorus, olitorus, hibiscus, etc) and "exotic" (lettuce, cabbage, tomatoes, carrots, eggplant, peppers, etc) does not benefit, as a rule, from any management at the peasant level.

Annex 3: Descriptive statistics

Descriptive statistics by land situation
Descriptive statistics by age group

Variables	[15-35]			[36-50]			+50		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Land tenure security	145	0.214	.411	250	0.348	0.477	207	0.174	0.38
Credit	145	0.248	.434	250	0.144	0.352	207	0.295	0.457
Agricultural productivity	140	129.297	139.094	240	92.384	147.855	199	93.887	108.518
Sex	145	0.903	.296	250	0.844	0.364	207	0.787	0.41
Widow	145	0.028	.164	250	0.08	0.272	207	0.145	0.353
Level of study									
Primary	145	0.4413793	0.4982729	250	0.34	0.474659	207	0.4251208	0.4955598
Post-primary	145	0.0068966	0.0830455	250	0.024	0.153356	207	0.0144928	0.1198
Secondary general 1st cycle	145	0.2206897	0.4161491	250	0.108	0.311003	207	0.0724638	0.2598828
Secondary general 2nd cycle	145	0.0827586	0.276472	250	0.08	0.2718374	207	0.0338164	0.1811946
Technical junior 1 cycle	145	0.0965517	0.2963701	250	0.032	0.1763531	207	0.0096618	0.0980558
Technical secondary 2nd cycle	145	0.0206897	0.1428366	250	0.244	0.4303543			
Superior	145	0.0206897	0.1428366	250	0.028	0.1653037	207	0.0386473	0.1932203
Health	145	0.869	.339	250	.84	0.367	207	0.662	0.474
Household size	145	4.51	2.706	250	7.28	3.856	207	6.053	3.686
Number of possessed dwelling	145	0.738	.54	250	1.056	0.819	207	1.106	0.934
Size of the farm	145	1.117	.323	250	1.108	0.311	207	1.145	0.353
Value of the equipment	123	27.146	38.691	224	15.656	25.361	183	18.754	24.191

continued next page

Descriptive statistics by age group (continued)

Variables	[15-35]			[36-50]			+50		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Number of land owned	145	2.028	1.384	250	2.164	1.815	207	2.319	1.876
Equipment	129	0.14	.348	248	0.129	0.336	202	0.243	0.43
Type of seed	134	0.201	.403	243	0.119	0.325	205	0.093	0.291
Cost of fertilizers	143	44.573	138.044	249	29.884	91.625	207	32.42	118.713
Cost of pesticides	143	17.084	26.651	249	19.116	38.301	207	29.58	59.033
Cost of labour	143	52.329	148.648	249	48.386	94.187	207	43.87	70.42
Cost of seeds	143	14.643	27.647	249	19.771	65.4	206	18.146	44.941
Type of product grown	145	0.372	.485	250	0.44	0.497	207	0.338	0.474
Value of production	145	276.814	261.802	250	236.072	227.291	207	263.14	358.981

Descriptive statistics by size of operation

Variables	Small operation			Medium size operation		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Land tenure security	528	0.25	0.433	74	0.297	0.46
Credit	528	0.199	0.4	74	0.378	0.488
Agricultural productivity	505	111.169	139.709	74	38.068	52.747
Sex	528	0.83	0.376	74	0.905	0.295
Widow	528	0.093	0.29	74	0.068	0.253
Age				74	2.176	0.783
[36-50]	528	0.4223485	0.4944018	74	0.3648649	0.4846782
50	528	0.3352273	0.4725175	74	0.4054054	0.4943217
Level of study				74	2.973	1.972
Primary	528	0.3787879	0.4855452	74	0.5	0.503413
Post-primary	528	0.0151515	0.1222713	74	0.027027	0.1632691
Secondary general 1st cycle	528	0.1268939	0.3331698	74	0.0945946	0.2946518
Secondary general 2nd cycle	528	0.0625	0.242291	74	0.0810811	0.2748228
Technical junior 1 cycle	528	0.0378788	0.1910841	74	0.0540541	0.2276679
Technical secondary 2nd cycle	528	0.1174242	0.3222304	74	0.027027	0.1632691
Superior	528	0.0265152	0.1608138	74	0.0540541	0.2276679
Health	528	0.788	0.409	74	0.77	0.424
Household size	528	6.17	3.635	74	6.338	4.221
Number of possessed dwelling	528	0.985	0.747	74	1.081	1.214
Value of the equipment	461	19.267	28.618	69	20.232	31.241

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Descriptive statistics by size of operation (continued)

Variables	Small operation			Medium size operation		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Number of land owned	528	2.015	1.321	74	3.392	3.281
Equipment	515	0.159	0.366	64	0.266	0.445
Type of seed	520	0.133	0.34	62	0.097	0.298
Cost of fertilizers	525	26.733	70.943	74	87.716	257.313
Cost of pesticides	525	18.884	40.211	74	46.108	64.593
Cost of labour	525	38.091	74.167	74	116.405	205.582
Cost of seeds	524	16.094	49.439	74	31.378	63.266
Type of product grown	528	0.392	0.489	74	0.365	0.485
Value of production	528	240.326	243.69	74	361.27	485.506

Descriptive statistics by agro-ecological zone

Variables	Wet savanna zone			Mangrove area			Forest area		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Land tenure security	153	0.281	0.451	138	0.181	0.387	152	0.474	0.501
Credit	153	0.281	0.451	138	0.391	0.49	152	0.092	0.29
Agricultural productivity	148	118.485	200.069	135	124.42	137.466	145	68.803	66.409
Sex	153	0.752	0.433	138	0.775	0.419	152	0.875	0.332
Widow	153	0.118	0.323	138	0.13	0.338	152	0.092	0.29
Age						0.779			
[36-50]	153	0. 3529412	0. 479454	138	0. 3405797	0. 4756306	152	0. 6118421	0. 4889419
50	153	0. 4771242	0. 5011167	138	0. 4492754	0. 4992325	152	0. 2039474	0. 4042623
Level of study									
Primary	153	0. 4183007	0. 4949	138	0. 6014493	0. 4913835	152	0. 2894737	0. 4550173
Post-primary	153	0. 0261438	0. 1600868				152	0. 0197368	0. 1395544
Secondary general 1st cycle	153	0. 1503268	0. 3585652	138	0. 1014493	0. 3030226	152	0. 1315789	0. 3391499
Secondary general 2nd cycle	153	0. 0718954	0. 259163	138	0. 0434783	0. 204674	152	0. 0723684	0. 2599535
Technical junior 1 cycle	153	0. 0392157	0. 1947452	138	0. 0144928	0. 1199457	152	0. 0592105	0. 2367985
Technical secondary 2nd cycle	153	0. 0392157	0. 1391037	138	0. 0507246	0. 2202342	152	0. 3552632	0. 4801751
Superior	153	0. 0457516	0. 2096322	138	0. 0144928	0. 1199457	152	0. 0263158	0. 1606019
Health	153	0.791	0.408	138	0.623	0.486	152	0.816	0.389
Household size	153	5.843	3.133	138	4.964	3.2	152	6.842	3.437
Number of possessed dwelling	153	1.386	1.231	138	0.783	0.563	152	0.842	0.71
Size of the farm	153	1.078	0.27	138	1.174	0.38	152	1.132	0.339
Value of the equipment	152	14.901	7.209	138	13.138	4.418	150	6.68	2.214
Number of land owned	153	2.222	1.718	138	1.964	1.525	152	2.395	1.94

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Descriptive statistics by agro-ecological zone (continued)

Variables	Wet savanna zone			Mangrove area			Forest area		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Equipment	150	0.16	0.368	131	0.305	0.462	141	0.121	0.327
Type of seed	150	0.127	0.334	134	0.119	0.325	142	0.049	0.217
Cost of fertilizers	153	67.255	169.164	138	16.007	32.544	149	3.477	12.377
Cost of pesticides	153	14.641	32.413	138	49.543	71.608	149	11.228	15.259
Cost of labour	153	75.085	140.943	138	37.732	46.982	149	22.859	34.29
Cost of seeds	152	42.099	91.488	138	15.848	30.233	149	7.235	17.959
Type of product grown	153	0.229	0.421	138	0.601	0.491	152	0.553	0.499
Value of production	153	267.928	336.973	138	308.964	316.608	152	221.066	203.146

Variables	Low Savannah Area			Sahelian zone		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Land tenure security	42	0.095	0.297	117	0.085	0.281
Credit	42	0.19	0.397	117	0.12	0.326
Agricultural productivity	36	124.176	113.792	115	88.505	70.979
Sex	42	0.833	0.377	117	0.983	0.13
Widow	42	0.095	0.297	117	0	0
Age						
[36-50]	42	0. 452381	0. 5037605	117	0. 3162393	0. 4670076
50	42	0. 1190476	0. 3277701	117	0. 3076923	0. 4635236
Level of study						
Primary	42	0. 3095238	0. 4679011	117	0. 2820513	0. 4519337
Post-primary				117	0. 025641	0. 1587417
Secondary general 1st cycle	42	0. 1428571	0. 3541688	117	0. 0940171	0. 2931078
Secondary general 2nd cycle	42	0. 1190476	0. 3277701	117	0. 0512821	0. 2215211
Technical junior 1 cycle	42	0. 1428571	0. 3541688	117	0. 008547	0. 09245
Technical secondary 2nd cycle						
Superior	42	0. 047619	0. 2155403	117	0. 025641	0. 1587417
Health	42	0.905	0.297	117	0.889	0.316
Household size	42	6.262	4.418	117	7.222	4.52
Number of possessed dwelling	42	1.048	0.309	117	0.923	0.351
Size of the farm	42	1.143	0.354	117	1.103	0.305
Value of the equipment	42	2.071	0.463	48	106.479	21.911

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(continued)

Variables	Low Savannah Area			Sahelian zone		
	Obs	Means	Std. Dev.	Obs	Means	Std. Dev.
Number of land owned	42	1.881	1.041	117	2.231	1.927
Equipment	42	0.048	0.216	115	0.139	0.348
Type of seed	41	0.024	0.156	115	0.278	0.45
Cost of fertilizers	42	0.238	1.543	117	64.094	152.216
Cost of pesticides	42	10.095	24.825	117	18.393	34.779
Cost of labour	42	67.571	170.074	117	48.487	111.673
Cost of seeds	42	7.5	9.595	117	6.632	12.848
Type of product grown	42	0.167	0.377	117	0.214	0.412
Value of production	42	264.81	231.342	117	216	282.375

Descriptive statistics by type of crop

Variables	Food products			Annuity products		
	Obs	Means	Std. Dev.	Obs	Std. Dev.	Std. Dev.
Land tenure security	368	0.196	0.397	234	0.35	0.478
Credit access	368	0.22	0.415	234	0.222	0.417
Agricultural productivity	347	101.235	146.728	232	102.71	112.738
Sex	368	0.796	0.403	234	0.906	0.292
Widow	368	0.106	0.308	234	0.064	0.245
Age						
[36-50]	368	0. 3804348	0. 4861547	234	0. 4700855	0. 5001742
50	368	0. 3722826	0. 4840713	234	0. 2991453	0. 4588651
Level of study						
Primary	368	0. 4130435	0. 4930509	234	0. 3632479	0. 4819663
Post-primary	368	0. 0190217	0. 1367873	234	0. 0128205	0. 1127407
Secondary general 1st cycle	368	0. 1141304	0. 3184025	234	0. 1367521	0. 344322
Secondary general 2nd cycle	368	0. 0733696	0. 2610971	234	0. 0512821	0. 2210453
Technical junior 1 cycle	368	0. 0461957	0. 2101944	234	0. 0299145	0. 1707167
Technical secondary 2nd cycle	368	0. 0163043	0. 1268157	234	0. 2478632	0. 4326976
Superior	368	0. 0353261	0. 184854	234	0. 0213675	0. 1449162
Health	368	0.813	0.391	234	0.744	0.438
Household size	368	6.152	3.832	234	6.252	3.512
Number of possessed dwelling	368	1.03	0.911	234	0.944	0.643
Size of the farm	368	1.128	0.334	234	1.115	0.32

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Descriptive statistics by type of crop (continued)

Variables	Food products			Annuity products		
	Obs	Means	Std. Dev.	Obs	Std. Dev.	Std. Dev.
Value of the equipment	307	20.964	30.952	223	17.229	25.839
Number of land owned	368	2.326	2.06	234	1.962	1.041
Equipment	351	0.157	0.364	228	0.193	0.396
Type of seed	356	0.104	0.306	226	0.168	0.375
Cost of fertilizers	365	44.11	129.866	234	18.915	79.762
Cost of pesticides	365	17.512	38.745	234	29.632	52.105
Cost of labour	365	48.148	97.321	234	47.171	111.905
Cost of seeds	365	23.381	61.291	233	9.532	28.695
Value of production	368	227.633	281.944	234	298.534	289.735

Annex 4: Econometric results

Result of the three-step regression (rural model in the humid savannah)

Variable	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	1.97104**	0.8399051	-	-
Credit	-	-	-	-	667.3402***	188.2819
Sex	-0.9744575***	0.3724493	1.289142	0.8330523	528.3167***	144.018
Widow	-0.045577	0.4768868	0.2393359	0.4598916	-	-
Age						
[36-50]	-0.9679461**	0.4837074	2.038014***	0.7554139	-46.54916	54.39523
50	-0.1039844	0.3490873	0.775192**	0.3848031	-415.807***	104.6747
Level of study						
Primary	0.9696482**	0.4126318	-1.746037**	0.8773386	-167.8291***	51.98301
Post-primary	1.925444**	0.8744973	-3.251212**	1.697867	-559.5448***	162.96
Secondary general 1st cycle	1.109316**	0.4869962	-1.860023*	1.05643	-308.4464***	76.52947
Secondary general 2nd cycle	1.656194***	0.5698368	-3.146529**	1.542573	-221.6338***	65.00061
Technical junior 1 cycle	2.178165***	0.7038476	-4.706708**	2.013658	42.5132	104.5196
Technical secondary 2nd cycle	2.03967**	0.8569964	-	-	-2806.778***	767.4536
Superior	1.2456	0.7750763	-	-	-1759.817***	498.6066
Health	-	-	0.4676127	0.3219667	-232.5048***	66.40573

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Result of the three-step regression (rural model in the humid savannah) (continued)

Variable	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Household size	0.0515902	0.047097	-	-	-74.10981***	24.15612
Number of possessed dwelling	0.1434514	1354273	-0.3339919**	0.1558455	-	-
Size of the farm	0.6782497	6558662	-0.-1.62376*	0.8406396	130.3674	83.53399
Value of the equipment			0.0178651	0.0204807	-	-
Number of land owned	0.2567165***	0.0935401	-0.510265**	0.238539	8.267488	9.267797
Equipment	-	-	-	-	-41.63397	35.07212
Type of seed	-	-	-	-	53.29098	70.50453
Cost of fertilizers	-	-	-	-	0.2462232	0.224927
Cost of pesticides	-	-	-	-	-0.8040744	0.6496641
Cost of labour	-	-	-	-	-0.3140034	0.265453
Cost of seeds	-	-	-	-	0.2536525	0.1794523
Value of production	-0.0010426*	0.0005902	0.002722***	0.000947	-	-
Constant	-2.099974**	0.8559048	2.569561	2.004724	929.6373***	221.6651
Wald chi2 (16, 16, 21)	31.02	Obs=153	19.26	Obs=142	37.18	Obs=141
Log pseudolikelihood	-22397.664		-77.288169		-317989.61	

Result of the three-step regression (rural model in the mangrove)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	1.486969**	0.6524159	-	-
Credit	-	-	-	-	44.05488***	15.21731
Sex	-0.2962011	0.5079065	0.4046284	0.5966336	33.44559	32.24972
Widow	0.105661	0.6395823	0.1.37907*	0.7612958	-	-
Age						
[36-50]	0.3837732	0.4062983	0.6845724	0.4970508	-196.5333***	46.13197
50	-0.8058734	0.5034953	1.93033	0.7397629***	-141.0149***	40.05585
Level of study						
Primary	-0.4582266	0.7366835	0.7027731	0.4850659	-15.07968	27.40465
Post-primary	-	-	-	-	-	-
Secondary general 1st cycle	0.9905377	0.9758037	-1.088245	1.039275	158.8347**	78.45657
Secondary general 2nd cycle	-0.4432701	9120647	-1.083702	0.8193777	112.4124**	56.06245
Technical junior 1 cycle	0.3361044	1.044169	-	-	-34.77869	95.25112
Technical secondary 2nd cycle	-	-	-0.7422394	0.9906769	230.3842**	118.9987
Superior	0.2858183	0.9575252	-	-	30.51402	85.77663
Health	-	-	-0.4713004	0.3080726	82.61493***	29.26458
Household size	0.0931611	0.0623249	-0.1269535	0.0853142	1.993892	4.632529
Number of possessed dwelling	0.6533281***	0.2369947	-1.542784***	0.4992693	-	-
Size of the farm	0.73604	0.4682327	-	-	-239.2711***	43.22682
Value of the equipment	-	-	-0.202988	0.0625732	-	-

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Result of the three-step regression (rural model in the mangrove) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Number of land owned	-0.6550746**	0.2591467	1.014127***	0.3841674	6.519	9.140923
Equipment	-	-	-	-	51.24099	32.42066
Type of seed	-	-	-	-	-86.60664	54.64476
Cost of fertilizers	-	-	-	-	-0.2180107	0.4780237
Cost of pesticides	-	-	-	-	0.5282154	0.4032827
Cost of labour	-	-	-	-	0.8116753**	3235016
Cost of seeds	-	-	-	-	-0.6174546	0.5749339
Value of production	-0.0021635***	0007986	0.0048958***	0014845	-	-
Constant	-0.772477	1.027905	1.330628	0.9954359	391.9214***	75.13238
Wald chi2 (14, 15, 20)	50.66	Obs=131	39.81	Obs=134	132.81	Obs=124
Log pseudolikelihood	-12333.633		-25193.325		-302238.32	

Result of the three-step regression (rural model in the forest area)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	3.810571***	0.6578832	-	-
Credit	-	-	-	-	15.31926***	4.343811
Sex	-1.082836	1.017263	10.99019***	2.525001	-63.01677***	16.28178
Widow	-0.8897968	1.334621	9.772217***	2.373544	-	-
Age						
[36-50]	-1.261245*	0.6736337	-	-	83.79738**	29.92372
50	-2.894872***	0.7216375	-	-	159.2923***	47.73009
Level of study						
Primary	-	-	0.7423178	0.9717011	128.1719***	47.7904
Post-primary	-2.767512***	0.7508084	-	-	-167.7618***	34.34547
Secondary general 1st cycle	-5.481377***	0.8412105	10.97499***	2.337677	117.151***	44.8651
Secondary general 2nd cycle	-3.394852***	0.802498	1.808128	1.299364	133.4801**	55.14499
Technical junior 1 cycle	-4.185461***	1.018761	-	-	252.2279***	71.2384
Technical secondary 2nd cycle	-	-	-	-	-48.74116*	29.19054
Superior	-	-	-6.937056***	2.100707	55.36175	96.02474
Health	-	-	-4.577386***	1.216613	52.64738*	29.47485
Household size	0.0545853	0.072178	-0.3144383*	0.1815106	1.732253	2.498305
Number of possessed dwelling	0.5940503	0.4415691	-3.967364***	1.121233	-	-
Size of the farm	0.808275	0.5881757	-	-	-125.8861***	23.10057
Value of the equipment	-	-	0.5266989**	0.2168497	-	-

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Result of the three-step regression (rural model in the forest area) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Number of land owned	-0.1048994*	0.0587333	-0.5977085	0.4329419	19.79331***	4.329028
Equipment	-	-	-	-	19.50249	13.84538
Type of seed	-	-	-	-	18.05968	37.82709
Cost of fertilizers	-	-	-	-	-2.80279***	0.5846994
Cost of pesticides	-	-	-	-	2.205533***	0.5405676
Cost of labour	-	-	-	-	-0.1596357	0.2841333
Cost of seeds	-	-	-	-	1.405333	1.395875
Value of production	0.0002626	0.0007417	0.0049158**	0.0022555	-	-
Constant	2.697808*	1.476087	-9.674123**	4.586885	57.76352	44.19344
Wald chi2 (13, 11, 20)	113.43	Obs=138	172.47	Obs=86	316.10	Obs=128
Log pseudolikelihood	-12647.893		-3811.3337		-240672.31	

Result of the three-step regression (rural model in the Sahelian zone)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	0.6583427**	0.2604864	-	-
Credit	-	-	-	-	201.588***	53.72158
Sex	-0.2525174	0.753567	-2.696003***	0.6687343	532.3909***	149.381
Age						
[36-50]	-0.7044054	0.7964434	0.1325721	0.7003869	72.12902***	22.72665
50	0.171564	1.067414	1.893145***	0.5614115	-396.766***	108.4682
Level of study						
Primary	2.400828**	1.00973	-2.250527***	0.8249629	150.9589***	38.45184
Post-primary	1.724408	1.244565	-	-	-210.8149***	64.75746
Secondary general 1st cycle	-	-	1.347652**	0.6474676	-279.9293***	72.99134
Secondary general 2nd cycle	-	-	0.4917193	0.7379645	12.53823	95.09253
Superior	-	-	-	-	-4.918816	38.14427
Health	-	-	0.8165368	0.6512437	-178.7869***	46.96896
Household size	-0.42034**	0.1918977			54.57017***	15.20839
Number of possessed dwelling	-2.154802***	0.7281054	1.192241	0.7776246	-	-
Size of the farm	-	-	-	-	-27.35417**	12.68566
Number of land owned	-0.3834352	0.3082359	0.023837	0.1435278	41.56683***	13.16297
Equipment	-	-	-	-	-19.27821	17.62927
Type of seed	-	-	-	-	-2.673384	13.28383

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Result of the three-step regression (rural model in the Sahelian zone) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Cost of fertilizers	-	-	-	-	0.0831407	0.0838399
Cost of pesticides	-	-	-	-	-0.6519247	0.3748418
Cost of labour	-	-	-	-	0.0587396	0.0417234
Cost of seeds	-	-	-	-	0.0028675	0.2857407
Value of production	-0.0038019	0.0039858	0.0028368	0.0028936	-	-
Constant	2.622668*	1.55608	0.1902118	1.039561	-175.4411*	93.82806
Wald chi2 (9, 11, 20)	10.08	Obs=85	39.45	Obs=98	77.10	Obs=111
Log pseudolikelihood	-5286.0256		-13479.682		-389250.53	

Table 1: Result of the three-step regression (rural model for growers of cash crops)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	0.823307**	0.4053307	-	-
Credit	-	-	-	-	72.34252***	23.22693
Sex	-1.040148*	0.6103799	-0.0906036	0.7680649	47.55027	28.87105
Widow	0.2477955	0.660303	-0.6089676	0.732733	-	-
Age						
[36-50]	0.1119907	0.3617661	0.0373997	0.3506271	-62.14711**	24.80548
50	-0.6944937**	0.3309162	0.7041022	0.4347123	-94.48538***	30.79263
Level of study						
Primary	0.0092332	0.5312328	-0.4256372	0.3846116	-10.74957	23.52692
Post-primary	-	-	-0.7116391	1.128191	17.24879	28.18221
Secondary general 1st cycle	0.4668619	0.5760456	-0.934282*	0.5162129	41.44518	32.34128
Secondary general 2nd cycle	-0.7440866	0.7773807	0.1625065	0.6588933	1.141951	45.86022
Technical junior 1 cycle	0.2151535	0.6332365	-1.024316	0.8130904	12.45183	40.31579
Technical secondary 2nd cycle	2.645238***	0.6608181	-3.433334*	1.330876	-24.45215	29.01252
Superior	1.4054	0.9386755	-	-	-130.1637*	70.71122
Health	-	-	-0.2215504	0.2604278	74.19933***	22.3991
Household size	-0.0154521	0.0510791	-0.0514946	0.0428518	4.189699	3.15835
Number of possessed dwelling	0.1077039	0.2180511	-0.4621121**	.2086293	-	-

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Table 1 Continued

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Size of the farm	0.8684138*	0.4712204	-	-	-196.7141***	33.27184
Value of the equipment	-	-	-0.0126658**	0.0054401	-	-
Number of land owned	-0.1720269	0.1454232	0.1566481	0.1182596	-16.63372**	7.208262
Equipment	-	-	-	-	47.28585*	25.68805
Type of seed	-	-	-	-	-0.7529299	27.08757
Cost of fertilizers	-	-	-	-	-0.0935858	0.1059537
Cost of pesticides	-	-	-	-	1.087453***	0.3684555
Cost of labour	-	-	-	-	0.1009984	0.079435
Cost of seeds	-	-	-	-	-0.4361007	0.5485088
Value of production	-0.0013285*	0.0007594	0.0022638 ***	0.0006688	-	-
Constant	-0.6941183	0.9246343	0.9398749	0.8212365	327.7862***	53.79736
Wald chi2 (15, 17, 20)	78.90	Obs=231	39.82	Obs=218	313.33	Obs=207
Log pseudolikelihood	-24867.87		-42820.051		-496820.15	

Result of the three-step regression (rural model for subsistence farmers)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	1.386907***	0.3614353	-	-
Credit	-	-	-	-	135.2095***	51.46867
Sex	-1.333228***	0.3188214	1.263291**	0.5431725	67.10083**	27.0254
Widow	-0.6247025	0.4095965	0.1919403	0.4406463	-	-
Age						
[36-50]	-0.9267098***	0.2591506	1.016511**	0.4195009	29.84869	48.98502
50	-0.2275178	0.2298454	0.3437485	0.2590677	-42.46048	26.80122
Level of study						
Primary	1.313358***	0.2650298	-1.468997***	0.532571	-44.14265	28.32614
Post-primary	2.203218***	0.5806002	-	-	-481.3903***	156.9319
Secondary general 1st cycle	0.7477279**	0.3703874	-0.7174703	0.4407008	-121.7771***	39.75066
Secondary general 2nd cycle	1.559923***	0.3926352	-1.778297***	0.6808665	-91.22234**	38.91974
Technical junior 1 cycle	1.138046**	0.4574637	1.332342**	0.5829466	-122.8188***	43.46776
Technical secondary 2nd cycle	-	-	-	-	-2.97467	76.42613
Superior	2.125587***	0.4994999	-3.387023***	0.8842815	7.905767	102.4269
Health	-	-	0.007232	0.2686338	-24.07605	23.97896
Household size	-0.0054179	0.0249104	-0.0489071*	.00289579	7.345749	4.898268
Number of possessed dwelling	0.2675428***	0.1034753	-0.500834***	0.1428642	-	-

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Result of the three-step regression (rural model for subsistence farmers) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Size of the farm	0.6726663***	0.2622661	-	-	-186.0066***	50.42467
Value of the equipment	-	-	-0.0025525	0.0030987	-	-
Number of land owned	-0.0182807	0.0381766	-0.1603182***	0.0626329	19.22076*	9.933023
Equipment	-	-	-	-	-21.81245	30.93481
Type of seed	-	-	-	-	67.51956	76.3775
Cost of fertilizers	-	-	-	-	0.3594948	0.276114
Cost of pesticides	-	-	-	-	-0.8644394*	0.4624326
Cost of labour	-	-	-	-	0.0936234	0.1178535
Cost of seeds	-	-	-	-	0.0404852	0.1691128
Value of production	0.0001016	0.0002203	-0.0000183	0.0003096	-	-
Constant	-1.60855***	0.477211	1.57663***	0.6121353	360.2651***	71.50795
Wald chi2 (15, 16, 21)	54.84	Obs=362	45.01	Obs=298	150.90	Obs=266
Log pseudolikelihood	-51166.122		-55129.291		-695136.31	

Result of the three-step regression (Smallholder taken as a whole)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	1.806669*	1.063833	-	-
Credit	-	-	-	-	358.3887***	74.80562
Sex	-0.9194015***	0.3146564	1.072205	1.02507	132.0361***	32.21146
Widow	-0.198903	0.3535216	-0.0166557	0.4089559	-	-
Age						
[36-50]	-0.0894807	0.2534445	0.4043126	0.2582591	-138.6739***	29.00002
50	-0.0417244	0.1995098	0.4186108*	0.235168	-192.7685***	35.56842
Level of study						
Primary	0.7128799**	0.2794888	-1.270978*	0.7619286	-50.21108***	19.28418
Post-primary	1.507699**	0.6780923	-2.853836	1.770891	-16.64843	38.23891
Secondary general 1st cycle	0.8706388***	0.3226124	-1.4083	0.9316587	-106.9827***	30.2646
Secondary general 2nd cycle	1.249399***	0.3624123	-2.315504*	1.319385	-34.71881	28.26493
Technical junior 1 cycle	0.8197051**	0.4128082	-1.208467	0.8769234	-208.2439***	37.84515
Technical secondary 2nd cycle	2.756688***	0.4744636	-5.876598**	2.877988	245.5323***	67.5178
Superior	1.930638***	0.5862656	-4.694341**	1.965858	379.9804***	85.55644
Health	-	-	-0.1664006	0.1881872	83.52415***	23.62814
Household size	-0.0249953	0.0273433	-	-	16.86515***	4.107976
Number of possessed dwelling	0.3775168***	0.1123664	-0.9030788**	0.4125743	-	-

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Result of the three-step regression (Smallholder taken as a whole) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment	-	-	-0.0014043	0.0027431	-	-
Number of land owned	-0.0052659	0.0531648	-0.1327274**	0..0590921	44.67253***	12.98364
Equipment	-	-	-	-	16.80696	20.98835
Type of seed	-	-	-	-	-21.77747	30.87494
Cost of fertilizers	-	-	-	-	0.4616355	0.3645886
Cost of pesticides	-	-	-	-	0.2995263	0.3281136
Cost of labour	-	-	-	-	-0.1565482	0.153148
Cost of seeds	-	-	-	-	0.3496091	0.2195121
Value of production	-0.0008311***	0.0003201	0.002438**	0.0009608	-	-
Constant	-1.125682***	0.4129112	2.119045	1.307848	228.3496***	35.76996
Wald chi2 (15, 17, 21)	64.60	Obs=528	38.62	Obs=421	84.74	Obs=417
Log pseudolikelihood	-67647.69		-86081.587		-1024262.7	

Result of the three-step regression (Smallholder in the humid savannah)

Variable	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	2.116809***	0.818891	-	-
Credit	-	-	-	-	328.3347***	98.0323
Sex	-0.6473542*	0.3774662	0.6321836	0.5633143	309.0227***	86.14935
Widow	-0.2337441	0.5157618	0.5527277	0.5062545	-	-
Age						
[36-50]	-1.092738**	0.5350146	2.488209***	0.8282037	-27.28866	42.85551
50	-0.1969739	0.3880685	0.8830552	0.4179954	-194.9607***	58.36599
Level of study						
Primary	0.4690317	0.3960888	-1.06566**	0.5204397	-13.1259	24.8743
Post-primary	1.084358	0.8827895	-1.142447	1.133646	-534.8124***	160.9523
Secondary general 1st cycle	0.6529961	0.4701127	-1.279849*	0.7051284	-133.6551***	38.75618
Secondary general 2nd cycle	1.272401**	0.5687778	-2.706399	1.212436	-139.7984***	48.62012
Technical junior 1 cycle	1.433142**	0.6458666	-3.104991**	1.398969	-72.35191	62.66791
Technical secondary 2nd cycle	1.740557**	0.7986566	-	-	-1357.985***	386.5735
Superior	1.160506	0.859266	-	-	-939.2151***	326.5739
Health	-	-	0.4769412	0.3278359	-92.70572**	36.24758
Household size	0.0564751	0.0502644			-38.78005***	14.4215
Number of possessed dwelling	0.4986817***	0.1592477	-1.212303***	0.4337374	-	-

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Result of the three-step regression (Smallholder in the humid savannah) (continued)

Variable	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment	-	-	0.033034	0.0217569	-	-
Number of land owned	0.1681023*	0.0931238	-0.4720534**	0.1885698	45.72331**	19.24359
Equipment	-	-	-	-	-5.588162	28.20208
Type of seed	-	-	-	-	-1.955173	58.71787
Cost of fertilizers	-	-	-	-	0.3121651	0.3300548
Cost of pesticides	-	-	-	-	-1.515922**	0.702382
Cost of labour	-	-	-	-	-0.1347326	0.2967233
Cost of seeds	-	-	-	-	0.321895**	0.1870887
Value of production	-0.0021568**	0.0009776	0.0056506***	0.0018717	-	-
Constant	-1.270434**	0.6044003	0.9824426	1.300638	444.8985***	108.9538
Wald chi2 (15, 17, 21)	30.35	Obs=141	28.63	Obs=133	64.65	Obs=130
Log pseudolikelihood	-58.599733		-68.775014		-827.5466	

Result of the three-step regression (Smallholder in the mangrove)

Variables	Land tenure security		Credit access		Agricultural productiviy	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	2.704453**	1.231454	-	-
Credit	-	-	-	-	53.04273***	16.46345
Sex	0.0516872	0.5313382	-0.0823285	0.5745199	46.43348	33.82533
Widow	0.6621714	0.7492724				
Age						
[36-50]	0.7077964	0.5185512	-0.4377609	1.011143	-217.4747***	48.82011
50	-1.213569*	0.6250382	4.030743***	1.543113	-155.4118***	46.08508
Level of study						
Primary	-0.1762836	0.6790909	0.2967511	0.4985727	-10.83977	26.28394
Secondary general 1st cycle	1.10968	0.92437	-2.64711	1.712453	141.1736**	67.88035
Secondary general 2nd cycle	-0.1335902	0.8033303	-1.545938*	0.8398096	119.7001**	59.07814
Technical junior 1 cycle	-	-	-	-	-179.1991***	47.95161
Technical secondary 2nd cycle	-	-	-0.1654531	0.9184645	274.5161*	155.5599
Superior	0.524574	1.024904	-0.6678123*	0.3485216	-121.9316	87.4063
Health	-	-	-	-	134.423***	30.97728
Household size	0.0333316	0.0788423	-0.0862526	0.0803429	4.474413	4.709271
Number of possessed dwelling	0.75527***	0.2728949	-2.642966***	1.015808	-	-

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Result of the three-step regression (Smallholder in the mangrove) (continued)

Variables	Land tenure security		Credit access		Agricultural productiviy	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment	-	-	-0.2067365***	0.0674619	-	-
Number of land owned	-1.558535***	0.3862573	4.252611**	1.876359	-41.98786**	17.19018
Equipment	-	-	-	-	25.07479	31.57766
Type of seed	-	-	-	-	-107.0693***	54.5408
Cost of fertilizers	-	-	-	-	0.0342498	0.4886327
Cost of pesticides	-	-	-	-	0.6949047*	0.3446757
Cost of labour	-	-	-	-	0.9995623***	0.3226052
Cost of seeds	-	-	-	-	-0.300865	0.5586142
Value of production	0.0028778***	0.0008836	0.0095309***	0.0035718	-	-
Constant	1.025687	1.148346			184.4307***	68.88567
Wald chi2 (12, 14, 19)	36.72	Obs=108	38.02	Obs=111	662.52	Obs=101
Log pseudolikelihood	-8970.8148		-21772.151		-250253.21	

Result of the three-step regression (Smallholder in the Sahelian zone)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	0.6583427**	0.2604864	-	-
Credit	-	-			25.52519*	14.86761
Sex	-0.2525174	0.753567	-2.696003***	0.6687343	26.56876	60.3204
Age						
[36-50]	-0.7044054	0.7964434	0.1325721	0.7003869	3.720757	15.03562
50	0.171564	1.067414	0.1.893145***	0.5614115	-55.127	39.50363
Level of study						
Primary	2.400828**	1.00973	-2.250527***	0.8249629	39.37657**	18.88954
Post primary	1.724408	1.244565	-	-	8.267487	26.98198
Secondary general 1st cycle	-	-	0. 1.347652**	0.6474676**	-31.71475	30.23231
Secondary general 2nd cycle	-	-	0.4917193	0.7379645	123.1799	85.41659
Superior	-	-	-	-	87.17727*	47.22334
Health	-	-	0.8165368	0.6512437	-31.82768	20.18749
Household size	-0.42034**	0.1918977	-	-	7.458738	4.711512
Number of possessed dwelling	-2.154802**	0.7281054	1.192241	0.7776246	-	-

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Result of the three-step regression (Smallholder in the Sahelian zone) (cotinued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Number of land owned	-0.3834352	0.3082359	0.023837	0.1435278	-	-
Equipment	-	-	-	-	-46.97618*	25.39662
Type of seed	-	-	-	-	8.110615	14.18361
Cost of fertilizers	-	-	-	-	-0.0834257	0.2205472
Cost of pesticides	-	-	-	-	-1.341705 **	0.5886772
Cost of labour	-	-	-	-	0.3425325***	0.1237021
Cost of seeds	-	-	-	-	0.2957721	0.3554883
Value of production	-0.0038019	0.0039858	0.0028368	0.0028936	-	-
Constant	2.622668*	1.55608	0.1902118	1.039561	103.9542**	44.2873
Wald chi2 (12, 14, 19)	10.08	Obs=85	39.45	Obs=98	58.19	Obs=99
Log pseudolikelihood	-5286.0256		-13479.682		-345497.66	

Result of the three-step regression (Smallholder growing cash crops)

Variables	Land tenure security		Credit access		Agricultural productivy	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	0.9265322*	0.5060365	-	-
Credit	-	-			75.64108***	0.8345022
Sex	-1.525145**	0.6261569	0.3286645	0.9682395	47.7579	1.276774
Widow	0.2446364	0.6524544	-0.5232315	0.7461683	-	-
Age						
[36-50]	1.229944**	0.4972309	-0.751691	0.6846536	-85.37768***	1.061707
50	-0.476884	0.5204028	0.7865169	0.4776559	-115.1481***	1.118207
Level of study						
Primary	0.0140589	0.5625105	-0.5755658	0.4427931	-1.231273	1.173167
Post-primary	-	-	-	-	2.308339	5.784998
Secondary general 1st cycle	1.425174**	0.6214764	-1.835721*	0.9549681	44.92094	1.470687
Secondary general 2nd cycle	0.0432595	0.7120983	-0.4218738	0.7539868	3.399069	2.140516
Technical junior 1 cycle	0.156416	0.609388	-0.8515295	0.8819205	3.161693	2.024757
Technical secondary 2nd cycle	3.711805***	0.7024972	-4.3004**	1.826032	-47.71207*	1.967786
Superior	3.559306***	1.032412	-	-	-233.502*	6.364748
Health	-	-	-0.2715477	.0309006	85.89897***	0.8586777
Household size	-0.1090243*	0.0629996	-	-	7.668892*	4.186954
Number of possessed dwelling	-0.1257993	0.2513365	-0.5019452**	0.2526811	-	-

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Result of the three-step regression (Smallholder growing cash crops) (continued)

Variables	Land tenure security		Credit access		Agricultural productivy	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment			-0.0107644*	0.005922	-	-
Number of land owned	-0.4947547*	0.2705501	0.3834891	0.2638968	-13.20829	8.64193
Equipment	-	-	-	-	35.82923	25.51683
Type of seed	-	-	-	-	9.866762	29.43704
Cost of fertilizers	-	-	-	-	-0.3260887	0.3015479
Cost of pesticides	-	-	-	-	1.236846***	0.392467
Cost of labour	-	-	-	-	0.0862013	0.2292912
Cost of seeds	-	-	-	-	-1.05799	0.3591225
Value of production	-00036433***	0.001177	0.0045577**	0.0019338	-	-
Constant	1.252235	0.8416197	0.4051418	0.9005468	119.7674**	51.5599
Wald chi2 (14, 15, 17)	88.23	Obs=206	31.84	Obs=192	285.27	Obs=185
Log pseudolikelihood	-14983.319		-35780.758		-437632.58	

Result of the three-step regression (Small farmer growing food crops)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	0.5121871**	0.2360728	-	-
Credit	-	-	-	-	505.4249***	153.5081
Sex	-1.38366 ***	0.3052529	-	-	239.0566***	72.89708
Widow	-0.5767478	0.3865039	-0.195928	0.3162434	-	-
Age						
[36-50]	-0.4128444	0.2878161	0.3267128	0.3047638	-27.6441	27.86107
50	0.2878161	0.2550404	0.1553986	0.2505466	-117.9681***	34.84712
Level of study						
Primary	1.213838***	0.3023509	-0.4903408	0.3544369	-101.7521***	36.82363
Post-primary	2.248054***	0.6341813	-	-	-597.1687***	155.8153
Secondary general 1st cycle	0.9733949***	0.3692135	-0.0170127	0.3896938	-341.4194***	94.79667
Secondary general 2nd cycle	1.871952***	0.3921518	-1.03912*	0.5682737	-7.395842	41.24174
Technical junior 1 cycle	1.301709***	0.4984931	-0.0392053	0.483391	-353.5241***	94.862
Technical secondary 2nd cycle	-	-	-	-	-80.61293	98.296
Superior	2.296628***	0.6260709	-2.074228	0.7290995	371.9593***	121.1476
Health	-	-	0.1221822	0.2752737	36.0978	29.95884
Household size	-0.0231073	0.0278956	-	-	5.480066*	2.33582
Number of possessed dwelling	0.5247029***	0.104669	-0.3417828*	0.1951926		

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Result of the three-step regression (Small farmer growing food crops) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment	-	-	0.0021791	0.0029851		
Number of land owned	0.0096583	0.0602416	-0.1981741***	0.0724029	93.55765***	32.0268
Equipment	-	-	-	-	1.189062	25.24585
Type of seed	-	-	-	-	46.18528	65.33322
Cost of fertilizers	-	-	-	-	0.4626782	0.346269
Cost of pesticides	-	-	-	-	-0.788335***	0.2803108
Cost of labour	-	-	-	-	-0.2770063	0.2225024
Cost of seeds	-	-	-	-	0.1568957	0..1810318
Value of production	-0.000132	0.00035	0.0007673*	0.0003821		
Constant	-1.392095***	0.4153854	0.5317178	0.6898907	309.2756***	63.21948
Wald chi2 (14, 14, 20)	63.30	Obs=316	22.32	Obs=256	135.03	Obs=232
Log pseudolikelihood	-39089.103		-44458.781		-579621.49	

Result of the three-step regression (model of medium-sized farms)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Land tenure security	-	-	10.4618***	3.156263	-	-
Credit	-	-	-	-	4.881976***	0.6769998
Sex	-8.46262	168.9876	70.77572***	22.84159	24.63682***	8.342236
Widow	-7.699854	168.9876	-	-	-	-
Age						
[36-50]	-1.961573***	0.0319355	15.96429***	5.302155	-13.73917	14.49438
50	-1.534504***	0.0303447	14.07308***	4.787609	-25.62875**	13.0416
Level of study						
Primary	0..596487***	0..0346209	-7.512553***	2.203822	6.803124	6.656138
Post-primary	-	-	-	-	17.72821**	8.526251
Secondary general 1st cycle	-0.1944119***	0.0535843	-1.548156**	0.7219451	31.50539**	13.5377
Secondary general 2nd cycle	-	-	-	-	2.185091	7.434313
Technical junior 1 cycle	1.278132***	0.0560512	-	-	-41.44469 *	24.46395
Technical secondary 2nd cycle	-	-	-	-	45.44128	29.11184
Superior	0.9943265***	0.0873427	-	-	-9.756349	13.44374
Health	-	-	0.4478691	0.9893216	-3.915919	8.814091
Household size	-0.0981211***	0.004429	1.5393***	0.5132164	4.671642***	0.957403
Number of possessed dwelling	0.1707931***	0.0099355	-0.8143873	0.5515554	-	-

continued next page

Result of the three-step regression (model of medium-sized farms) (continued)

Variables	Land tenure security		Credit access		Agricultural productivity	
	Coefficient	Std. Dev.	Coefficient	Std. Dev.	Coefficient	Std. Dev.
Value of the equipment	-	-	0.0058791	0.0539568	-	-
Number of land owned	-0.1478728***	0.0073761	-	-	-0.9623701	0.8451171
Equipment	-	-	-	-	-2.350572	10.88717
Type of seed	-	-	-	-	-30.94654*	17.37664
Cost of fertilizers	-	-	-	-	0.0291153	0.0267896
Cost of pesticides	-	-	-	-	-0.1746901	0.1534851
Cost of labour	-	-	-	-	0.0100645	0.024918
Cost of seeds	-	-	-	-	-0.1306611***	0.0366022
Value of production	-0.0005378***	0.0000273	0.019066	0.0070925	-	-
Constant	9.281199	168.9877	-75.33885***	25.05123	2.483174	20.33403
Wald chi2 (12, 11, 20)	12711.19	Obs=64	761.35	Obs=47	2596.51	Obs=56
Log pseudolikelihood	-10702.081		-2486.7107		-116993.28	

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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