Impact of Access to Credit on Agricultural Productivity: Evidence from Smallholder Cassava Farmers in Nigeria

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Abstract

This study examines the impact of access to credit on agricultural productivity in Nigeria using the Endogenous Switching Regression Model (ESRM)). The first stage of the ESRM reveals that total livestock unit and farm size are positive and statistically significant in determining the farmers' access to credit. The second stage reveals that total livestock unit and farm size are negative and statistically significant in explaining the variations in cassava productivity among the farmers that have access to credit, while household size, farm size, and access to information assets are negative and statistically significant in explaining the variation in cassava productivity among the farmers without access to credit. Access to credit has a significant positive impact on cassava productivity. Thus, credit institutions should consider boosting their credit services to rural farming households in order to guarantee that more households benefit from it.

Keywords: Credit, Impact, Cassava, Productivity, Farmers, Nigeria

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1. Introduction

It is interesting though disturbing to note that sub-Saharan Africa (SSA) with its very large population happens to be the poorest region in the world (Chauvin *et al.,* 2012). The average real per capita income in 2010 was $688 (in constant 2000 US$) compared to $1717 in the rest of the developing world. Over the past 30 years, GDP growth per capita in SSA has averaged 0.16 percent per year. This failure of growth over the long term has resulted in high levels of poverty in the region, such that in 2008, 47 percent of the population of SSA lived on $1.25 a day or less (United Nations, 2012). The United Nations Food and Agriculture Organization (UN-FAO) estimates that 239 million people in SSA were hungry/undernourished in 2010. This implies that almost one in three people who live in SSA were hungry, far more than any other region of the world, with the exception of South Asia. Poverty has been reported as the principal cause of hunger.

The above scenario has been made worse by several decades of economic crises and government reforms which affected both rural and urban African populations. The attendant increases in the costs of production and consumer prices rising faster and higher than the price of farm produce has adversely affected smallholder farmers' livelihoods. The downsizing of the public sector work force, coupled with restrictions on wage levels has caused a fall in urban incomes, thus reducing the demand for agricultural produce. Increases in food prices and service charges and cuts in public expenditure—especially in the health and education sectors—and in infrastructure expenditure have been felt particularly by low-income groups (Bah *et al.,* 2003). Additionally, severe product price volatility and erratic climatic conditions increasingly exposed farmers to immeasurable income risks and, sometimes, loss of assets (Olomola *et al.,* 2008). These conditions constitute a serious impediment to the adoption of improved agricultural technologies and financial investment in agricultural production. Consequently, the production of notable staple food crops such as cassava has been on the decline in many countries of SSA, particularly in Nigeria and generally lags behind the rate of population growth. Hence, despite its vast agricultural potential, SSA has remained a net importer of agricultural products for many decades (FAOSTAT, 2011).

One major source of achieving a drastic reduction in poverty and alleviating the poor welfare situation of the rural farmers is to increase agricultural productivity. This will, at the micro level, translate to an increase in farm income, food security, poverty reduction, and improved rural household welfare, while leading to inclusive industrial development and economic growth on the aggregate. An increase in agricultural productivity according to Kuznet (1964), can support and sustain industrial development in many dimensions. It allows the agricultural sector to release its labor force to the non-agricultural sector while meeting the food demand of the non-agricultural sector. It also raises agricultural sector income and creates rural purchasing power needed to purchase industrial goods. In addition, it enables the agricultural sector to supply food to industrial workers at affordable prices to the profitability of the industries.

Successive Nigerian governments have embarked on different policies and strategies to achieve increases in agricultural productivity. In view of the importance of cassava as one of the major staple food crop particularly for the poor rural households in Nigeria, specifically, in 1999 the Federal Government of Nigeria embarked on the Presidential Initiative on Cassava (*Manihot esculenta*) Production. The main objective of this program was to achieve self-sufficiency in cassava production and for export with a targeted output of about 150 million tons of cassava per annum. Despite the fact that many studies support the hypothesis that access to credit increases the productivity and profit of the farm households (Diagne and Zeller, 2001; Adesina and Djato, 1996; Hazarika and Alwang; 2003; Foltz, 2004),couples with the fact that at farm level, the production costs for cassava in Nigeria are high, relative to other countries (Akinnagbe, 2010), this program adopted many strategies in order to achieve all its stated objective, but access to credit was not included. Consequently, after many years of investing massively in the program, the objective of the program has not been met.

The positive correlation between access to credit and agricultural productivity notwithstanding, some empirical studies have revealed cases of credit insufficiency among rural farmers in Nigeria (Deaton 1997; Udry 1990; Zeller 1994; Idachaba, 2006; Adebayo and Adeola, 2008 and Ololade and Olagunju, 2013) and some empirical literature has also found that in rural areas of developing countries, credit constraints have significant adverse effects on farm output (Feder *et al.,* 1990; Sial and Carter, 1996), farm investment (Carter and Olinto, 2003), and farm profit (Carter, 1989). However, empirical assessment of the impact of access to credit on any outcome is very scanty in Nigeria, and particularly in relation to cassava productivity, none exists to the best knowledge of the authors. This shows that there is still a gap in the literature that must be filled.

In spite attempts made in the past by some studies to explore the link between access to agricultural credit and agricultural productivity in Nigeria (Rahaman and Marcus, 2004, Abu, *et al.,* 2010, Ugbajah, 2011), many of these studies did not apply the widely accepted impact assessment methodologies and are therefore subject to serious problems arising from selection bias. Conspicuously missing in the empirical impact evaluation literature is the significant role of access to credit on agricultural productivity in developing countries like Nigeria. However, according to

Freeman et al.(|1998) it is very crucial to specifically evaluate the extent of the expected gains in productivity arising from the provision of agricultural credit. If the marginal contribution of credit to farm productivity is zero or relatively small then re-allocatioon of credit to other activities or sectors with higher marginal productivity may actually lead to an improvement in the welfare of the society.

In order to fill this gap in the literature and complement other studies, this study assesses the impact of access to credit on cassava productivity among smallholder rural farmers in Nigeria. We focus essentially on productivity, because agricultural productivity is a measure of the performance of the agricultural sector and thus provides a guide to the efficiency of the sector (Thirtle *et a*l., 1993; Thirtle *et al.*, 2005; Kirsten *et al.*, 2003; and Conradie *et al.*, 2009).

In order to achieve the objectives of this study we intend to provide answers to these pertinent questions : could it be that those farmers that have access to credit have higher productivity than those that did not? What is the impact of of access to credit on productivity? These are important questions that have not yet been fully explored and been given tangible answers to in the literature. Meanwhile, from a policy perspective, we noted that answers to these questions are very important in addressing the dwindling agricultural productivity and attaining the objectives of poverty reduction and welfare improvement in Nigeria, particularly among the rural smallholder cassava farmers.

The rest of the paper is organized as follows: section 2 presents the literature review. The analytical framework and estimation techniques are presented in section 3. Section 4 presents the data and descriptive statistics. Section 5 contains the results and discussion. Finally, section 6 provides a brief summary of the main findings, the conclusion, and some policy recommendations.

2. Literature Review

2.1. The Structure of the Rural Agrarian Credit Market in Nigeria

A common feature of rural credit markets in developing countries is the coexistence of formal and informal credit markets (Hoff and Stiglitz, 1990; Besley, 1995; Kochar, 1997; Bell et al., 1997; Mohieldin and Wright, 2000; Anderson and Malchow-Moller, 2006; Boucher and Guirkinger, 2007; Barslund and Tapp, 2008). Ghate (1992) defined formal financial service providers as registered companies that are licensed to offer financial services by a central monetary authority. He asserted that these institutions are largely urban based in terms of distribution of branches and the concentration of deposit and lending activities. According to Kashuliza et al. (1998) informal financial services refer to all transaction, loans, and deposits that take place outside the regulated monetary system and this includes the activities of intermediaries such as relatives and friends, traders, and money lenders. Semi-formal institutions are described by Steel and Andah (2004) as institutions which are registered to provide financial services and are not controlled by a central monetary authority. Badiru (2010) categorized credit institutions into three groups: (i) formal, such as commercial banks, microfinance banks, the Nigeria Agricultural and Cooperative Rural Development Bank (NACRDB), and state government-owned credit institutions; (ii) semi-formal, such as nongovernmental organizations–microfinance institutions (NGO–MFIs) and cooperative societies; and (iii) informal, such as money lenders, and rotating savings and credit associations (RoSCAs).

The Federal Government of Nigeria (FGN) established credit schemes such as the Agricultural Credit Guarantee Scheme (ACGS) in 1977 and the Agricultural Credit Support Scheme (ACSS) to ensure farmers' access to agricultural credit. The ACGS fund was set up with the sole purpose of providing a guarantee in respect of loans granted by any bank for agricultural purposes (Central Bank of Nigeria, 1990). Nwosu *et al.* (2010) noted that the ACGSF was formed solely with the objective of encouraging financial institutions to lend funds to those engaged in agricultural production as well as agroprocessing activities with the aim of enhancing export capacity of the nation as well as for local consumption. However, this is noted to be exclusively in favour of large-scale farming (Somayina, 1981) as smallholder farmers seldom obtain credit from formal credit sources.

Rural borrowers in particular are not an attractive proposition for formal financial institutes because they cannot meet the minimum requirements and are perceived as high risk borrowers (Onumah, 2003). In a review of the literature carried out by Badiru (2010), many other reasons were provided for the lack of access to credit by the farmers from the formal sources. For instance, Agnet (2004) opined that the complex mechanism of commercial banking is least understood by small-scale farmers and this limits their access. Rahji and Fakayode (2009) blamed the limitation on imperfect and costly information problems encountered in the financial markets; credit rationing policies; and banks' perception of agricultural credit as a highly risky venture; while Philip *et al.* (2009) stated that high interest rates and the short-term nature of loans with fixed repayment periods do not suit annual cropping, and thus constitute a hindrance to credit access. Adegbite (2009), citing Ezike (1984), Nweke and Onyia (2001), and Kodieche (2002), stated that financial lending Institutions in Nigeria often shy away from giving loans to farmers because of the high cost of administering such loans and the perceived high default rates among farmers. Ghosh et al., (2000), believe that it is largely because poorer farmers lack sufficient assets to put up as collateral—a usual prerequisite for borrowing from banks.

Lack of access to credit can be a function of both demand and supply. On the supply side, banks may find it very risky and expensive to provide credit to rural smallholders, thus rationing the supply of credit or making available contracts that may be too expensive or too demanding on collateral. On the demand side, apart from the situations where farmers may not have adequate collateral, even in situations where credit is available, farmers may find it too risky to borrow (Boucher *et al*., 2008).

2.2. Access to Credit and Agricultural Productivity Linkage

The importance of access to credit in agricultural production cannot be overemphasised. According to Carter and Weibe (1990), Farmers need both ex-ante and ex-post access to capital. Ex-ante capital access is required in order to finance vital production costs such as labour and purchase inputs which needed to be paid ex-ante, that is, prior to the actual realization of production. On the other hands, access to capital after the realization of the production process, that is ex-post capital access, is of particular importance when there is no insurance as it's often the case in low income agrarian economies. Thus, in case of annual fluntuation in production, ex-post access to capital is highly essential for the stabilization of households' consumption from year to year

This implies that access to credit may not have a direct impact on productivity, but it could have a positive and significant indirect impact through its positive influence on agricultural technologies adoption, increased capital for farm investment, hired labor, and improved household welfare through improved health care and better nutrition. In addition, Feder *et al.* (1990) posit that credit allows farmers to satisfy the cash needs induced by the production cycle which characterize agriculture; land preparation, planting, cultivation, and harvesting are typically done over a period of several months in which very little cash revenue is earned, while expenditure on materials, purchased inputs, and consumption need to be made in cash. Thus, access to credit may affect farm productivity because farmers facing binding capital constraints would tend to use lower levels of inputs in their production activities compared to those not constrained (Feder et al., 1989; Petrick, 2004).

Agricultural production is strongly conditioned by the fact that inputs are transformed into outputs with considerable time lags (Conning and Udry, 2005), causing the rural household to balance its budget during the season when expenditure is high for input purchases and consumption and revenue is small. With limited access to credit, the budget balance within the year can become a constraint to agricultural production. When liquidity is a binding constraint, the amounts and combinations of inputs used by a farmer may deviate from optimal levels that in turn limit optimum production or consumption choices. Economic theory suggests that farmers facing binding capital constraints would tend to use lower levels and combinations of inputs than those whose production activities are not limited by capital constraints (Freeman *et al.*, 1998). The implication of this is that access to credit could increase rural poor households' willingness to adopt new technologies that raise both mean levels and riskiness of income (Rosenzweig and Binswanger, 1993; Carter, 1984).

Although, it is noted that good planting material improves cassava productivity and enhances varietal yield stability and the type of planting material plays a significant role in determining the quantity of roots at harvest, a review of factors that affect technology adoption carried out by Feder and Umali (1993) and Cornejo and McBride (2002) highlight access to credit as a key determinant of adoption of most agricultural innovations. It is believed that access to credit promotes the adoption of risky agricultural technologies through the relaxation of the liquidity constraint as well as through the boosting of household's risk bearing ability. With an option of borrowing, a household can do away with risk reducing , but inefficient income diversification strategies and concentrate on more risky but efficient investments (Eswaran and Kotwal, 1990). In the case of cassava production in Nigeria, credit constraint has been singled out as a major factor militating against adoption of modern cassava production techniques such as herbicides, hybrid cassava stake, insecticides, inorganic fertilizer, tractor, appropriate spacing, planting date and tillage practice (Nweke et al., 2002). Yet, many findings in the literature (Iyanda et al., 2014) have pointed to the immense role of adoption of these technologies in enhancing productivity, poverty eradication and attainment of food security in developing countries like Nigeria.

More importantly, according to Freeman *et al.* (1998), farmers' access to credit is also very crucial in the sence that it can facilitate the levels of input use closer to their potential levels when capital is not a constraint, consequently leading to higher levels of output per farm and productivity, given fixed resources such as land. This implies that the marginal contribution of credit brings input levels closer to the optimal levels, thereby increasing output and productivity (Feder *et al.*, 1990). Additionally, access to credit is also considered to be an important tool for smoothing consumption and promoting production especially for poor households (e.g. Swain *et al.,* 2008; Conning and Udry, 2005; Armendariz and Morduch, 2005; Robinson, 2001; Zeller *et al.,* 1997). This means that access to credit can significantly increase the ability of households with no or few savings to meet their financial needs for agricultural inputs; especially those that are highly necessary for weed, pest, and disease control and productive investments . Furthermore, easy availability and access to credit enables farmers and entrepreneurs to diversify by undertaking new investment.

3. Analytical Framework and Estimation Techniques

3.1. Intensity of Credit use

According to Schultz (1964), farmers in traditional agriculture act economically rationally within the context of available resources and existing technology. Accordingly, poor farmers allocate resources in a manner consistent with the neo-classical profit maximization model. Thus, in the context of this study the cassava farmers' decision to access credit is based on the assumption of expected utility maximization. When confronted with a choice between whether to borrow money or not, the smallholder cassava farmers would compare the expected utility of borrowing with non-borrowing. The farmers' decision to borrow is expected to be influenced by a set of household socioeconomic and demographic variables. Thus, famer *J's* expected utility of access and non-access to credit can be expressed as follows:

$$EU_{kj} = \beta_k Z_j + \tau_{kj} \qquad (1)$$

$$EU_{mj} = \beta_m Z_j + \tau_{mj} \qquad (2)$$

Where EU_{kj} and EU_{mj} denote the expected utility with non-access and access to credit, respectively, and Z represents a set of the cassava farmer J's socioeconomic and demographic variables. τ is a random disturbance and assumed to be independently and identically distributed with mean zero. Then the difference in expected utility may be written as:

$$EU_{mj} - EU_{kj} = (\beta_{mj} Z_j + \tau_{mj}) - (\beta_{kj} Z_j - \tau_{kj})$$

$$= (\beta_m - \beta_j) Z_j + (\tau_{mj} - \tau_{kj}) = \beta Z_j + \tau_j \qquad (3)$$

If $EU_{mj} - EU_{kj} > 0$,the cassava farmer will prefer to borrow money. Thus, the difference of the expected utility between access and non-access to credit is the potential factor that influences the farmers' decisions.

Many of the numerous studies that assessed the determinants of access to credit had treated access to credit as a binary variable and utilized the Logit, Probit, or Linear probability. Logit and Probit models are appropriate when the dependent variable is dichotomous (0, 1). In this study our objective goes beyond the determinants of access to credit to analyze the intensity of the credit use, therefore we adopt the Tobit model. This is because the Tobit model which is an extension of the Probit model is useful for continuous values that are censored at or below zero (Anley *et al*., 2007) as we have in this data set. When a variable is censored, regression models for truncated data provide inconsistent estimates of the parameters.

The Tobit model assesses not only the probability of access to credit, but also the intensity or degree of access to credit measured by the total amount of credit obtained by the farmer for the production season under study in relation to the farmer's socioeconomic and demographic variables. The Tobit model supposes that there is a latent unobserved variable g_i^* that depends linearly on z_i through a parameter vector α . There is a normally distribute error term τ_i to capture the random influence on this relationship. The observed variable g_i is defined as being equal to the latent variable whenever the latent variable is above zero and equal to zero otherwise.

$$g_i = \begin{cases} g_i^* & if \quad > 0 \\ 0 \quad if & g_i^* \leq 0 \end{cases} \qquad (4)$$

Where g_i^* is a latent variable:

$$g_i^* = \alpha z_i + \tau_i, \ \ \tau_i N(0, \sigma^2)$$

If the relationship parameter α is estimated by regressing the observed g_i on z_i the resulting Ordinary Least Squares estimator (OLS) is inconsistent. Maddala (1983) has proven that the likelihood estimator suggested by Tobin (1958) for this model is consistent.

The likelihood function of the model (4) is given by L as follows:

$$L = \prod_0 F_i(g_{0i}) \prod_1 f_i(g_i) \qquad (5)$$

$$L = \prod_0 \left[1 - F(z_i \alpha / \sigma)\right] \prod_i \sigma^{-1} f\left[(g_i - z_i \alpha) / \sigma\right]$$

where f and F are the standard normal density and cumulative distribution functions, respectively. Then we can write the log-likelihood function as:

$$LogL = \sum_0 \log(1 - F(z_i \alpha / \sigma) + \sum_1 \log(\frac{1}{(2\prod \sigma^2)^{1/2}}) - \sum_1 \frac{1}{2\sigma^2}(g_i - \alpha z_i)^2 \qquad (6)$$

The parameters α and σ are estimated by maximizing the log-likelihood function:

$$\begin{cases} \dfrac{\partial LogL}{\partial \alpha} = -\sum_0 \dfrac{z_i f(z_i\alpha)/\sigma}{1-F(z_i\alpha/\sigma)} + \dfrac{1}{\sigma^2}\sum_1 (g_i - \alpha z_i) z_i = 0 \\ \dfrac{\partial LogL}{\partial \sigma^2} = \dfrac{1}{2\sigma^2}\sum_0 \dfrac{\alpha z_i f(z_i\alpha/\sigma)}{1-F(z_i\alpha/\sigma)} - \dfrac{n_i}{2\sigma^2} + \dfrac{1}{2\sigma^4}\sum_1 (g_i - \alpha z_i)^2 = 0 \end{cases} \quad (7)$$

Since the two equations (7) are non-linear, the maximum likelihood estimator must be obtained by an iterative process (Greene, 2003).

3.1.1. The Empirical Tobit Model

The variables used in the analysis are presented in Table 2. The dependent variable indicating the farmers' access to credit is measured by the total amount of credit obtained by the farmers from all available credit sources, for the productive season under investigation**.** Following the literature on the determinants of access to credit, the following explanatory variables were included in the model: the farmers' age, the farm size, the total livestock units, household size, years of formal education, the monetary value of household productive assets, income from off-farm employment, own television , rented land for farming, gender of the household head, and total cassava output. The empirical model is presented implicitly below:

CREDITAMT=f (AGE, GENDER, OUTPUT, PRODASSET, LAND, HHSIZE, NFINC, TTLU, RENTEDLAND, OWNTELE, EDUC) *(8)*

The family ability as proxy by *AGE* of the household head is hypothesized to be negatively related to the dependent variable. This implies that the younger farmers who tend to be more risk neutral are expected to have access to credit than the older farmers. *GENDER* is a dummy variable that takes the value of 1 if the household head is male and zero otherwise and was hypothesized to be positively related to the dependent variable. This is because male-headed households have more access to credit than the female-headed households. Total farm output is hypothesized to be positively related to the dependent variable. The higher the output, the larger the amount of credit a farmer will be likely to obtain.

The household endowments measured by the monetary value of the household production assets is hypothesized to be positively related to the dependent variable. The farmers farming and loan repayment capacity proxy by the area of farmland is hypothesized to be positively related to the dependent variable. This is because the size of the farmland owned by a farmer is an indication of wealth and perhaps a proxy for social status and influence within a community. Family labor endowment represented by the number of people in the household is also hypothesized to be positively related to the dependent variable. In the same vein, income earned through non-farm employment is also expected to be positively related to the dependent variable. Off-farm income will reduce the perception of risk and increase the likelihood of access to credit.

Total Tropical Livestock Unit (TTLU) which is used as a measure of the household livestock endowment and was calculated using the following conversion factors for the livestock: 0.7, 0.2, 0.1, and 0.01 for cattle, pig, Shot (goat/sheep) and poultry, respectively. TTLU is expected to be positively related to the dependent variable, as they may act as productive assets (oxen and manure) and can also act as additional sources of household income (African Agricultural Technology Foundation, 2009). Land ownership status measured is a dummy variable that is 1 if the farmer rented land for farming and it is hypothesized to be negatively related to the dependent variable. Other household non-productive asset include a television set which is a dummy variable that takes the value of one if the household has a television and zero otherwise. The non-productive asset is also a measure of the financial strength of the farmers and is also hypothesized to be positively related to the dependent variable. Education of household head is measured by the number of years of schooling and it is hypothesized to be positively related to the dependent variable.

3.2. The Impact Evaluation Framework: Endogenous Switching Regression Model (ESRM)

This study investigates the impact of rural smallholder cassava farmers' access to credit on agricultural productivity. Some past studies have attempted to identify the effect of credit on many outcomes by estimating separate production or supply functions for those farmers that have access to credit and those that did not and then proceed to compare the estimates. One major weakness of this approach is the implicit assumption that all farmers that have access to credit and those that did not are respectively identical with respect to their credit demand or supply situation. In addition, there is also the problem of endogeneity which arises from the fact that access to credit is either voluntary or some farmers are in better position than others to have access to credit. For example, wealthy, educated, or more productive farmers are more likely to have access to credit than others. Thus, self-selection into access to credit is the major source of endogeneity in this study. One of the best solutions to explicitly account for such endogeneity is to use simultaneous models (Hausman, 1983). More importantly, we adopt an ESRM in this study to specifically correct for any possible sample selection bias which may arise from other interventions that provide multiple services to farmers in addition to credit (Lee, 1978; Madalla, 1983; Freeman *et al*., 1998).

Basically, the ESRM is an econometric model that specifies a decision process and the regression models associated with each decision option, and it is used to address issues of self-selection and the estimation of treatment effects when there is non-random allocation of subjects to treatment and non-treatment groups as is generally the case with observational (as opposed to experimental) data (Alene and Manyong, 2007). The sample-selection and disequilibrium models belong to this general class of switching models with the switch determined endogenously (Maddala and Nelson, 1975). With the problem of selection bias which can arise as a result of endogenous program placement, we are likely not to get a consistent estimate of the impact of the treatment on our outcomes of interest without adopting an estimation approach that can remove the selection bias (observable and unobservable bias). The literature has shown that access to credit depends not only on the farmers' observable characteristics, but is also a function of some unobservable characteristics which if not controlled for can either overestimate, underestimate, or report impact where none exists at all. Therefore, we estimated an ESRM to control for the selection bias. Using the ESRM we can evaluate the direction and degree of non-random selection of farmers with access to credit and the selection biases that are implicit in Ordinary Least Square (OLS) estimates of access to credit effects. In addition, it is also possible to simulate how the cassava farmers would fare if placed in an alternative scenario (Mare and Winship, 1987)

The model used in this study is adapted from Feder *et al.* (1990), Alene and Manyong (2007), Nyangena and Köhlin (2008), Asfaw *et al. (*2010), and Lokshin and Sajaia, (2004). We first specify the binary decision choice of cassava farmers' access to credit conditional on observed covariates using a Probit model as follows:

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

$$P_i = 1 \text{ if } P_i^* > 0 \qquad (9)$$

$$P_i = 0 \text{ if } P_i^* \leq 0$$

Due to the selection biases, the cassava farmers' are believed to experience two regimes as follows:

Regime 1 (access credit): $G_{1i} = \lambda_1 H_i + \phi_1 C_{1i} + \nu_{1i}$ *(10a)*

Regime 2 (No access to credit): $G_{2i} = \lambda_2 H_i + \phi_2 C_{2i} + \nu_{2i}$ *(10b)*

where G_{1i} and G_{2i} are the productivities of the farmers in regimes 1 and 2, respectively. H_i represents a vector of exogenous variables which are hypothetically assumed to determine the cassava productivity function. ϕ_1, and ϕ_2 are the parameters to be estimated and ν_1 and ν_2 are the error terms. Finally, the error terms are believed to have a trivariate normal distribution, with zero mean and non-singular covariance matrix expressed as follows:

$$\text{cov}(\varepsilon_i, \nu_1, \nu_2)\begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{12} & \sigma_2^2 & \sigma_{2\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_{2\varepsilon} & \sigma^2 \end{bmatrix} \quad (11)$$

Where

$\sigma_1^2 = \text{var}(\nu_1)$; $\sigma_2^2 = \text{var}(\nu_2)$; $\sigma^2 = \text{var}(\varepsilon_1)$; $\sigma_{12} = \text{cov}(\nu_1, \nu_2)$; $\sigma_{1\varepsilon} = \text{cov}(\nu_1, \varepsilon_i)$; $\sigma_{2\varepsilon} = \text{cov}(\nu_2, \varepsilon_i)$;$\sigma^2$ represents variance of the error term in the selection equation and σ_1^2, σ_2^2 represents variance of the error term in the outcome equations.

According to Maddala (1983), when there are unobservable factors associated with selection bias, the important implication of the error structure is based on the fact that the error term (ε_i) of the selection equation (9) is correlated with the error terms (ν_1, ν_2) of the outcome functions 10a and 10b, the expected values of ν_{1i}, ν_{2i} conditional on the sample selection are non-zero:

$$E(\nu_{1i} \mid P_i = 1) = E(\nu_{1i} \mid \varepsilon_i > -Z_i\beta) = \sigma_{1\varepsilon}\left[\frac{\theta(Z_i\beta/\sigma)}{\varphi(Z_i\beta/\sigma)}\right] \equiv \beta_{1\varepsilon}\gamma_1 \quad (12a)$$

$$E(\nu_{2i} \mid P = 0_i) = E(\nu_{2i} \mid \varepsilon_i \le -Z_i\beta) = \sigma_{2\varepsilon}\left[\frac{-\theta(Z_i\beta/\sigma)}{1-\varphi(Z_i\beta/\sigma)}\right] \equiv \beta_{2\varepsilon}\gamma_2 \quad (12b)$$

Where θ and φ are the probability density and cumulative distribution functions of the standard normal distribution, respectively. The ratio of θ and φ evaluated at βZ_i, represented by γ_1 and γ_2 in equations 12a and 12b is referred to as the Inverse Mills Ratio (IMR) which denotes selection bias terms. The IMR provide the correlation between access to credit and the productivity. Previous studies have used a two-stage method to estimate the endogenous switching model (e.g., Lee, 1978; Feder *et al*., 1990; Fuglie and Bosch, 1995; Freeman *et al*., 1998). In the first stage, a Probit model of the criterion equation is estimated and the IMRs γ_1 and γ_2 are derived according to definitions in equation 12a and 12b. In the second stage, these predicted variables are added to the appropriate equation in 10a and 10b, respectively to yield the following sets of equations.

$$G_{1i} = \lambda_1 H_i + \beta_{1\varepsilon}\gamma_1 + \phi_1 P_{1i} + \eta_1 \quad (13a)$$

$$G_{2i} = \lambda_2 H_i + \beta_{2\varepsilon}\gamma_2 + \phi_{21} P_{2i} + \eta_2 \quad (13b)$$

The coefficient of the variables γ_1 and γ_2 provide estimates of the covariance terms $\beta_{1\varepsilon}$ and $\beta_{2\varepsilon}$ respectively. Since the variables γ_1 and γ_2 have been estimated, the residuals η_1 and η_2 cannot be used to calculate the standard errors of the two-stage estimates. While Lee (1978) suggested a procedure to derive consistent standard errors most especially for the two-stage approach, Maddala (1983) argues that such a procedure requires a potentially cumbersome and complicated process which most studies failed to implement. According to by Lokshin and Sajaia (2004), Full Information Maximum Likelihood (FIML) is an efficient method to analyze the ESRM. Thus, this study utilizes a single-stage approach proposed by Lokshin and Sajaia (2004) where the FIML method was estimated using the movestay command available in the STATA statistical software. The FIML method has been adopted by Alene and Manyong (2007) and Asfaw *et al*. (2010) among many others.

The FIML considers the complete system of equations, and all the parameters are jointly estimated. Estimators obtained by FIML enjoy all the properties of maximum likelihood estimators. They are consistent and asymptotically normally distributed. The FIML simultaneously fit the selection (equation 9) and outcomes (10a and 10b) equations in order to yield consistent standard errors, thus making γ_1 and γ_2 in equation 13a and 13b, respectively homoscedastic. The FIML's log likelihood function for switching regression model employed in this study proposed by Lokshin and Sajaia (2004) is described below:

$$\ln P_i = \sum_{i=1}^{N} \left\{ \begin{array}{c} P_i t_i \left[\ln F\left(\frac{(Z_i\beta + \alpha_{1\varepsilon}(G_{1i} - H_{1i}\lambda/\pi_1))}{\sqrt{1-\alpha_{1\varepsilon}^2}}\right) + \ln(f(G_{1i} - H_{1i}\lambda/\pi) \right] \\ + (1-P_i)t_i \left[\frac{\ln(1 - F(Z_i\beta + \alpha_{2\varepsilon}(G_{2i} - H_{21}\lambda)/\phi_2)}{\sqrt{1-\alpha_{2\varepsilon}^2}} + \ln(f((G_{2i} - H_{2i}\lambda)/\phi_2) \right] \end{array} \right\} \quad (14)$$

The sign of the correlation coefficients $\alpha_{1\varepsilon}$ and $\alpha_{2\varepsilon}$ have economic interpretations (Fuglie and Bosch, 1995). If $\alpha_{1\varepsilon}$ and $\alpha_{2\varepsilon}$ have alternate signs, then individual farmers obtain credit on the basis of their comparative advantage: those farmers that have access to credit have above average returns from access to credit and those who choose not to access credit have above-average returns from non-access to credit. On the other hand, if the coefficient has the same sign, it indicates hierarchical sorting: the cassava farmers that have access to credit have above-average returns whether they have access to credit or not, but they are better-off if they have access to credit, whereas farmers without access to credit have below-average returns in either case, but they are better off not having access to credit. The ATT of farmers without access to credit can be calculated as:

$$ATT = E(G_{1i} - G_{2i} \mid P_i = 1) = H_i(\lambda_1 - \lambda_2) + (\sigma_{1\mu} - \sigma_{2\mu})\gamma_1 \quad (15)$$

In equation 10, $E(G_{1i} | P_i = 1) = H_i\lambda_1 - \sigma_{1\mu}\gamma_1$ represents the expected outcome for households that have access to credit, had they chose to have access to credit. $E(G_{2i}P = 1) = H_i\lambda_2 - \sigma_{2\mu}\gamma_1$ represents the expected cassava productivity for the farming households who have access to credit, had they chose not to have access to credit. For convenience, the estimation of the above equations was carried out using the add-on command movestay in STATA statistical package, written by M. Lokshin (DECRG, The World Bank) and Z. Sajaya (Stanford University), which was designed especially for this type of endogenous switching regression model. The empirical equation of the ESRM to be estimated is demand of credit function, which is a Probit regression and a cassava production function. The access to credit decision equation, which is equivalent to equation (9), is specified as follows:

CREDITACCESS= f (AGE, AGE2, EDUC, NFINC, HHSIZE, GENDER, DEPENDRATION, TTLU, LAND, ACCINFOASSET, OFFFARMINC, INSTITUTEREL) *(16)*

The dependent variable is binary taking the value of 1 if the farmer has access to credit and 0 otherwise. The separate productivity function for the cassava farmers that have access to credit and those that did not have access to credit similar to equation (13) is as follows:

Ln (PRODUCTIVITY) = f (AGE, AGE2, EDUC, NFINC, HHSIZE, GENDER, DEPENDRATIO, TTLU, LAND, ACCESSINFOASSET, OFFFARMINC) *(17)*

Where ln is a natural logarithm, productivity is the total output of cassava per hectare. The definition and description of the variables included in the model is presented in Table 1.

Table 1: Variable Definition and Description.

Variable	Definition	Mean	SD
CREDITACCESS	Dummy = 1 if farmer has access to credit	0.17	0.38
LANDPRESS	Pressure on the farm land calculated as total farm size divided by the household size	3.74	3.36
RENTEDLAND	Dummy = 1 if the farmer rented the land for farming	0.76	0.43
DEPENDRATIO	The ratio of dependents to the total household size	0.64	0.78
AGE	The age of the household heads in years	50.00	16.00
AGE2	Square of the age of household head	2754.42	1643.09
TTLU	Total livestock unit	0.39	0.47
GENDER	Dummy = 1 if the household head is male	0.83	0.38
EDUC	Years of formal education, 0 otherwise	6.00	4.89
LAND	Total farm size	2.59	2.44
OWNTELE	Dummy = 1 if farmer owns television, 0 otherwise	0.40	0.49
OUTPUT	Cassava output in kg	3523.36	2878.08
ACCINFOASSET	Dummy = 1 if the farmer has radio, mobile phone or television set, 0 otherwise	0.86	0.34

NFINC	Dummy = 1 if the farmer participate in off-farm activities	0.27	0.44
HHSIZE	The total household size (number)	4.00	2.00
NPRODASSET	Monetary value of non-farm assets (₦)	72988.43	84396.05
PRODASSET	Monetary value of farm assets (₦)	11052.84	9966.942
EKITIDUM	Dummy = 1 if the farmer is from Ekiti State	0.10	0.30
OGUNDUM	Dummy = 1 if the farmer is from Ogun State	0.15	0.35
ONDODUM	Dummy = 1 if the farmer is from Ondo State	0.19	0.39
OSUNDUM	Dummy = 1 if the farmer is from Osun State	0.24	0.43

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4. Data and Descriptive Statistics

4.1.Data

The study area is Nigeria. Nigeria is the most populous country in Africa and has 36 States and a Federal Capital Territory (FCT), Abuja. The States are also sub-divided into smaller administrative units known as Local Government Areas (LGAs). The country is also disaggregated into six geo-political zones: north–east, north-west, north-central, south-east, south-west, and south-south. This study was carried out in the south-west zone because of its importance in the extent and dynamics of ICV adoption. The south-west zone comprises six States, out of which five States (Ekiti, Osun, Ogun, Ondo, and Oyo) were purposively selected due to the vast dissemination of ICVs in those States.

To ensure a sub-nationally representative sample of communities and households, a three-stage stratified random sampling procedure was adopted, whereby States were used as strata to improve sampling efficiency and account for possible major differences in access to credit among the smallholder cassava farmers across the States. LGAs that are basically rural were used as primary sampling units (PSUs). Enumeration areas (EAs), defined as a cluster of housing units, were used as secondary sampling units (SSUs). The rural smallholder farming households were used as the final sampling units. LGAs were selected from each State based on probability proportional to size, where size is measured in terms of the number of EAs. The EAs that formed the sampling frame were obtained from the Nigerian Bureau of Statistics (NBS) which uses the 2003/2004 master sample frame of the National Integrated Survey of Households (NISH). The advantage of using EAs as sampling units is that each is approximately equal in size. This ensured that all farmers had an equal probability of being selected, unlike the situation when sampling units are towns or villages of unequal size. Within each LGA, four EAs were selected at random from a sampling frame of EAs classified as rural or semi-urban, giving a total of 80 EAs or villages. (As clusters of housing units, the EAs are similar to villages or communities.)

Finally, a list of households was developed for the selected EAs and a sample of at least 10 farming households was selected randomly in each of the sampled EAs, giving a total sample of 860 households (Table 2). The survey was carried between August and October, 2011. Community and household questionnaires were administered by trained enumerators under the field supervision of a senior agricultural economist and the direction of IITA's economist.The data was collected using well-structured questionnaire. After data cleaning, about 856 (99.5%) of the questionnaires were useful for the analysis.

Table 2: Distribution of the Sample Households across the Selected States.

	State					
Characteristics	**Ekiti**	**Ogun**	**Ondo**	**Osun**	**Oyo**	**All**
All Enumeration Areas (EAs)	11,561	12,754	19,213	25,910	31,137	100,575
All Local Government Areas	16	20	18	30	33	117
Sample LGAs	2	3	4	5	6	20
Sample EAs or communities	8	12	16	20	24	80
Sample households	88	125	175	209	244	841

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2. Descriptive Statistics

4.2.1.Variables definition and description

The definition and description of the variables used for the empirical analyses is presented in Table 1. The result shows that the average age of the respondents is 50 years, thus they are still in their productive age. The majority of the respondents (83%) are male, with an average household size of four persons. The average farm size is 2.59 ha, with an average land pressure of about 4 persons per hectare. This implies land access is a problem among the cassava farmers and this explains why about 76% plant cassava on rented farmland. The respondents are literate with an average of six years of formal education. Access to credit is still a major constraint to agricultural production as evidently revealed by the small number (17%) of farmers that have access to credit. A larger percentage (86%) of the respondents have access to information enhanced assets such as radio, mobile phone, and television. The average monetary value of the respondents' farm and non-farm assets is about ₦11,052.84 and ₦72,988.43, respectively. This suggests that the farmers are creditworthy, since they could use some of these assets as collateral to gain access to credit.

4.2.2. Distribution of Respondents according to Socioeconomic Characteristics

Table 3 presents the distribution of the farmers according to some notable socioeconomic characteristics. The results show that male-headed households dominate cassava production in Nigeria. This is understandable in view of the tedious nature of the activities involved in cassava production. For instance, some cassava varieties perform better on big heaps, which are not easy for the women farmers to make. About 76% of the respondents are between 18 and 60 years of age. This implies that cassava production is not in the hands of too old people. The farmers are still very active and should be highly productive if they have access to adequate productivity enhancing inputs at the right time. About 73% of the respondents have a household size of between 1 and 5 persons, while about 26% have between 6 and 10 persons. About 27% of the respondents cultivate less than 1 ha of farmland. Most respondents cultivate between one to four hectares of farmland. This shows that that cassava production in Nigeria is still largely concentrated in the hands of small-scale farmers.

Table 3: Distribution of Respondents according to Socioeconomic Characteristics.

Socioeconomic Characteristic	Number of Respondents	Percentage
Gender		
Male	707	82.59
Female	149	17.41
Credit		
Demand for credit (1 = yes))	167	19.51
Access to credit (1 = yes)	146	17.06
Acquire credit for agricultural production (1 = yes)	146	17.06
Acquire credit for non-agricultural purposes(1 = yes)	35	4.09
Acquire credit for both agricultural and non-agricultural purposes	81	9.46
Household size		
1–5	625	73.01
6–10	221	25.82
> 10	10	1.17
Age		
< 31	113	13.20
31–40	148	17.29
41–50	228	26.64
51–60	160	18.69
61–-70	120	14.02
71–80	73	8.53
> 80	14	1.64
Years of Formal Education		
0	243	28.39
1—6	333	38.90
7–12	204	23.83
13–16	58	6.78
> 16	9	1.05

Farm Size		
> 1	235	27.45
1–2	273	31.89
2.1–3	102	11.92
3.1–4	102	11.92
4.1–5	24	2.80
5.1–6	20	2.34
6.1–7	9	1.05
7.1–8	38	4.44
> 8	50	5.84

Source: IITA/DIIVA Adoption and Impact Survey (2011).

About 39% of the farmers are literate with only primary education. This level of education will afford the farmers the opportunity to read and write and also to be able to process information that can enhance their access to credit. Despite this endowment, only about 20% of the farmers demanded for credit out of which only 17% have access to the credit. In addition, 17% acquired the credit for agricultural production purposes, while 4% obtained the credit for other non-agricultural purposes. In the same vein about 9% of the farmers obtained the credit for both agricultural and non-agricultural purposes.

4.2.3.Average Credit Obtained by Selected Household Characteristics

Evidence of variation in the amount of credit obtained by socioeconomic characteristics is presented in Table 4. The analysis reveals that gender of household head influences the amount of credit obtained. Male-headed households on the average obtain large amounts of credit, up to about 31.59% higher than female-headed households. This is in support of the facts presented in the literature that female-headed households in general lack access to agricultural productive resources. Consequently, productivity of female-headed households is usually lower compared with that of male-headed households.

Similarly, farmers that adopt improved planting materials also obtained higher credit to the tune of about 39% more than the non-adopters. This is an indication that adoption of improved agricultural technologies is capital intensive, and hence access to credit is necessary for the realization of the desired optimum output. Education of the household head is also important in the amount of credit obtained. Education facilitates access to and productive use of information. Consequently, educated farmers obtained larger amounts of credit (14.86%) than the non-educated farmers.

In view of the fact that land is one measure of wealth among rural dwellers, therefore, as expected, farmers that own their farmland obtained higher credit of about 37.09% more than those that operate on rented farmland. However, having agriculture as the main occupation appears to be a disincentive to credit access. This is reflected in the low amount of credit obtained by sole farmers compared with those that have agriculture as a secondary occupation. Farmers obtained about −35.72% credit less than those that have agriculture as a secondary occupation. This could be attributed to the risky nature of farming.

Table 4: Average Credit Obtained by Selected Household Characteristics.

Characteristics	Average credit obtained (₦)
Gender	
Male	61,336.36
Female	41,955.56
Adoption of improved cassava varieties	
Adopter	62,795.08
Non-adopters	38,304.35
Location	
Ogun	38,325.00
Ondo	57,900.00
Oyo	48,417.30
Ekiti	66,504.76
Osun	70,954.65
Education Background	
Educated	61,125.80
No education	52,042.86
Rented land	
Own farmland	78,330.61
Rent farmland	49,279.49
Primary occupation	
Agriculture	56,756.41
Non-agriculture	77,031.25

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2.4.Proportion that Demanded Credit for Agricultural and Non-Agricultural Use

The assessment of credit demand, acquire credit, and credit constraint status of the farming households is presented in Table 5. The analysis shows the different reasons/purposes for which credit was demanded. The reasons were broadly categorized into agricultural and non-agricultural purposes. The major reasons for demanding a loan for agricultural uses was related to planting material purchases (24.02%), fertilizer purchases (15.14%), crop operations (27.94%), and land acquisition (2.87%). The main reasons for which credit is demanded for non-agricultural uses related to business/trade (4.44%), food (4.18%), children’s education (11.23%), health medical (5.48%), and other social obligations such as burial, marriage, and naming ceremonies (4.69%). We discover that not all the farmers that demanded credit actually acquired the credit. Overall, 383 farmers demanded for credit, while only 157 (40.99%) of the farmers actually obtained the credit. Thus, 226 (59%) of the farmers that asked for credit were not able to acquire it and hence are classified as credit constrained. This shows that there are credit market imperfections in Nigeria and this could limit the investment and operation of the farms. Most importantly, credit constraints can limit the size of farms, as well as their growth, profits, and scope of operation. Above all it has a detrimental effect on poverty reduction.

Table 5: Proportion that Demand Credit for Agricultural and Non-Agricultural Uses.

	Demand Credit		**Acquire Credit**		**Credit Constrained**	
Uses of Credit	**Freq. (A)**	**%**	**Freq. (B)**	**%**	**Freq. (A–B)**	**%**
Agricultural						
Planting material	92.00	24.02	45.00	28.66	47.00	20.79
Fertilizer	58.00	15.14	20.00	12.74	38.00	16.81
Crop operations	107.00	27.94	39.00	24.84	68.00	30.09
Land Acquisition	11.00	2.87	3.00	1.91	8.00	3.54
Non-agricultural						
Business or trade	17.00	4.44	4.00	2.55	13.00	5.75
Food	16.00	4.18	6.00	3.82	10.00	4.42
Children's	43.00	11.23	21.00	13.38	22.00	9.73
education	21.00	5.48	8.00	5.09	13.00	5.75
Health/medical	18.00	4.69	11.00	7.00	7.00	3.09
Social obligations	**383.00**	**100.00**	**157.00**	100.00	**226.00**	**100.00**
Total						

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2.5. Distribution of Respondents According to Amount of Loan obtained for Agricultural Production

Farmers require credit mainly for agricultural production which includes purchase of inputs such as fertilizer, seed and agrochemicals (herbicides and pesticides), land acquisition, and hired labor. Table 6 presents the distribution of the respondents according to the amount of credit obtained for agricultural purposes. The average amount of credit obtained for agricultural production purposes was ₦6338.90. A larger percentage (86%) of the respondents obtained between ₦0 and ₦5000. About 3% of the respondents obtained between ₦16,000 and ₦ 20,000. A negligible proportion (0.95%) obtained above ₦100,000. This reveals that the amount of credit required by the farmers is still very small and might not be able to transform the farmers into commercial cassava producers.

Table 6: Distribution of Respondents According to Amount of Loan Obtained for Agricultural Production .

Amount (₦)	Frequency	Percentage (%)
0–5000	740	86.45
6000–10,000	13	1.52
11,000–15,000	9	1.05
16,000–20,000	22	2.57
21,000–30,000	17	1.99
31,000–40,000	13	1.52
41,000–50,000	15	1.75
51,000–100,000	19	2.22
> 100,000	8	0.95
Total	**856.00**	**100.00**

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2.6. Distribution of Respondents According to Amount of Loan Obtained for Non-Agricultural Production.

Access to credit is also an important source of cash for the farmers to meet other household financial needs aside from farming operations. Many other needs listed by the farmers include payment of children school fees, food, off-farm business, family health, and other social obligations which include ceremonies such as naming, marriage, and burial. Fulfilling all these needs through access to credit can also improve the farming households' well-being. Average credit obtained for non-agricultural purposes is ₦3788.79. As shown in Table 7, a large percentage (84%) of the respondents got between 0 and ₦5000. About 3% obtained between ₦51,000 and ₦100,000. Only eight of the respondents (0.94%) obtained more than ₦200,000 for non-agricultural purposes.

Table 7: Distribution of Respondents According to Amount of Loan Obtained for Non-Agricultural Production.

Amount (₦)	Frequency	Percentage (%)
0–5000	723	84.46
6000–10,000	10	1.17
11,000–15,000	9	1.05
16,000–20,000	20	2.34
21,000–30,000	19	2.22
31,000–40,000	17	1.99
41,000–50,000	17	1.99
51,000–100,000	22	2.57
110,000–200,000	11	1.29
> 200,000	8	0.94
Total	856.00	100.00

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2.7. Average Variable Cost Structure of Cassava Production

The average variable cost of cassava production in the study area (Table 8) reveals that the average variable cost for the total sample is ₦46,166.43. This shows that cassava production in Nigeria is highly capital intensive and this high average cost of production could be a disincentive for smallholder cassava farmers and in the presence of credit constraints or lack of access to credit this could lead to a reduction in productivity. The breakdown of the variable cost into the different farm activities shows that the cost of hired labor for all the related farm activities represents a larger percentage (89.23%) of the variable cost of cassava production. The cost of labor for land preparation is the highest among all the costs at about 36.24% of the total cost of cassava production and it is followed closely by the cost of labor for weeding (26.80%). The total cost of farm inputs such as improved planting material, and inorganic fertilizer, herbicide and pesticides represents about 20% of the total cost of production. In essence, cassava production is highly costly.

Table 8: Average Variable Cost Structure of Cassava Production.

Activity	**Cost (₦)**	**Percentage of total cost**
Cost of inorganic fertilizer	225.99	0.44
Cost of cassava planting material	5346.08	10.33
Hired labor for land preparation	18,751.76	**36.24**
Hired labor for cassava planting	6962.72	13.46
Hired labor for weeding	**13,868.41**	**26.80**
Hired labor for harvesting	6583.51	12.72
Cost of herbicide/pesticide	4748.88	9.18
Total variable cost	51,738.47	100.00
Total cost of hired labor	**46,166.43**	**89.23**
Cost of improved agricultural technology	**10,320.95**	**19.95**

Source: IITA/DIIVA Adoption and Impact Survey (2011).

4.2.8.Test of Mean Differences in Socioeconomic/Demographic Characteristics between Borrowers and Non-Borrowers

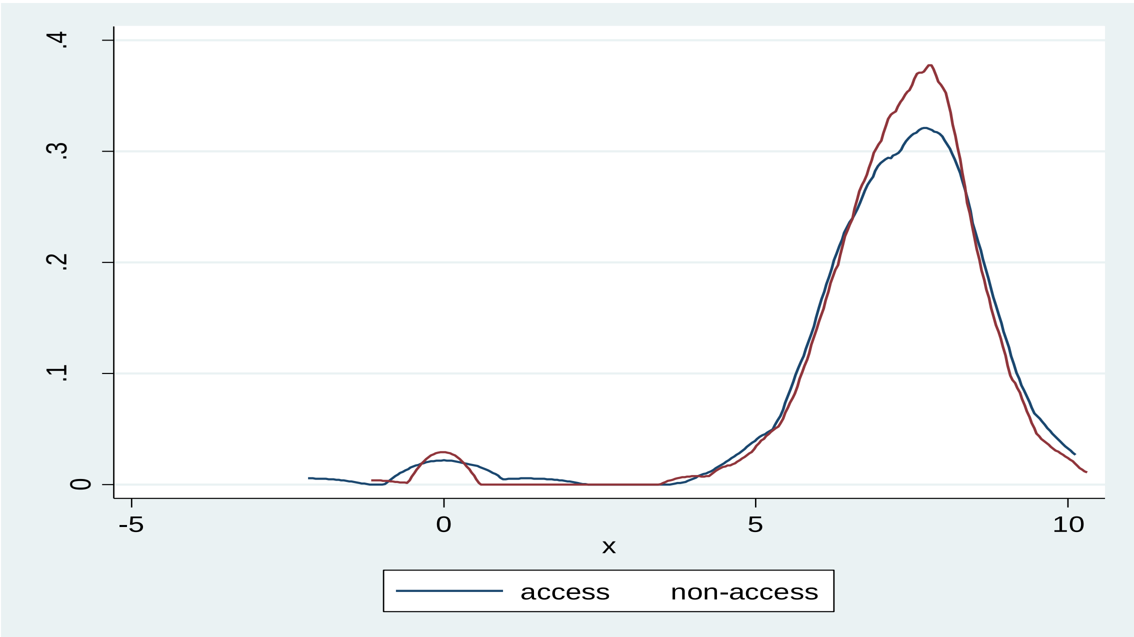
This section presents the test of the mean differences in some selected socioeconomic characteristics of the farmers. The results as revealed in Table 9 show that the farmers that have access to credit are not entirely similar to those that did not have access to credit. Those farmers that have access to credit have statistically significant higher output, farm size, productive and non-productive assets, agricultural expenditure, and years of formal education than those farmers that have no access to credit. However, the results show no significant difference in yield between the two farmers, although the kernel density graph (Fig. 1) of the log of yield reveals clearly that the farmers with access to credit have higher yield compared with the farmers without access to credit.

Table 9: Test of Mean Differences in Socioeconomic/Demographic Characteristics between Borrowers and Non-Borrowers.

Variable	Total	Access to credit = 1	Access to credit = 0	Mean Difference	t-test
Output (kg)	3523.36 (100.51)	4148.83 (252.73)	3365.79 (107.77)	783.04 (249.35)	3.14***
Farm size (ha)	2.59 (0.08)	3.04 (0.20)	2.48 (0.09)	0.56 (0.21)	2.67***
Yield (kg/ha)	2803.27 (120.94)	3032.42 (324.77)	2746.99 (127.84)	285.43 (304.43)	0.94
Productive Asset value (₦)	11,052.84 (344.09)	13,488.38 (819.99)	10,447.57 (374.88)	3040.81 (855.43)	3.55***
Non-productive asset value (₦)	72,988.43 (2913.68)	83,417.66 (6788.58)	70,396.65 (3217.71)	13021.02 (7287.74)	1.79*
Agricultural expenditure (₦)	1845.04 (217.05)	3041.92 (828.68)	1554.94 (178.74)	1486.98 (545.67)	2.73***
Education (Years)	6.00 (0.17)	7.00 (0.39)	6.00 (0.19)	0.79 (0.42)	1.87*
Household size (Number)	5.00 (0.07)	5.00 (0.17)	4.00 (0.08)	0.21 (0.17)	1.02
Age (Years)	50.00 (0.53)	49.00 (1.19)	50.00 (0.59)	1.16 (1.34)	0.86

Source: IITA/DIIVA Adoption and Impact Survey (2011)
Note: figures in parentheses are the standard errors.

Figure 1: Kernel Density-logyield



The above findings are not a reflection of the impact of access to credit on productivity; neither do they indicate that those households that have access to credit are better in output or in other variables than those that did not. Basically, this result is only a pointer to the fact that there is selection bias in the sample and any conclusion on the impact of access to credit on any outcome of interest based on the mean differences will be biased and generate erroneous policy recommendations. Thus, the observed differences in yield and output between those farmers with access to credit and those without have no causal interpretation. Therefore, to empirically determine the impact of access to credit on our outcome of interest, we adopted other econometric models such as endogenous Switching Regression model that conveniently eliminate observable and unobservable biases in the sample and provide a consistent estimate of the impact.

5. Results and Discussion

This section presents the result of the Tobit model, and the ESRM.

5.1.Estimation Result of the Tobit Model of Amount of Credit Obtained

The Tobit model was adopted in this study to assess the factors that influence smallholder farmers' access to credit. The maximum likelihood estimates of the Tobit model was carried out using STATA 11.0 statistical package. The result is presented in Table 10. Due to some missing data only 817 observations in our data set were used in the analysis. The final log likelihood is –2058.58 and the likelihood ratio chi-square of 36.55 (df = 11) with a *P*-value of 0.0002 implies that the model as a whole fits significantly better than an empty model (i.e., a model with no predictors).

Table 10: Estimation result of the Tobit model of amount of credit obtained

Variable	Coefficient	Std. Err.	t-value	P>t
NFINC	329.09	975.59	0.34	0.736
TTLU	21,841.84**	10,505.98	2.08	0.038
OUTPUT	2.00*	1.11	1.81	0.071
OWNTELE	–22,887.10**	10,991.40	–2.08	0.038
RENTEDLAND	–24,994.69**	11,031.10	–2.27	0.024
LAND	2547.26	2112.11	1.21	0.228
PRODASSET	0.97*	0.55	1.77	0.078
AGE	–604.15*	349.93	–1.73	0.085
GENDER	1712.06	15,281.33	0.11	0.911
HHSIZE	3889.32*	2337.07	1.66	0.096
EDUC	503.57	1132.67	0.44	0.657
CONSTANT	–92,799.37***	28,282.97	–3.28	0.001
/sigma	95,616.36	6596.01		
Log likelihood	–2058.58			

Number	817.00
LR Chi2(11)	35.75
Prob > chi2	0.0002
Pseudo R^2	0.0086

Source: IITA/DIIVA Adoption and Impact Survey (2011)

Tobit regression coefficients are interpreted in the similar manner to OLS regression coefficients; however, the linear effect is on the uncensored latent variable, not the observed outcome (McDonald, 1980). The empirical model of the Tobit model indicates that 10 out of the 11 variables included in model have the hypothesized signs. The sign of OWNTELE variable is not consistent with our expectation. The coefficient of the *LAND, GENDER, EDUC* and *NFINC,* variables are consistent with our expectation, but not statistically significant. However, only seven variables significantly affect the farmers' decision to access credit.

The estimated coefficient of the *TTLU* variable is positive and statistically significant at 5%.The positive sign as expected, implies that farmers with more livestock are more likely to obtain credit. For a unit change in number of livestock, there is 21,841.84 point increase in the predicted value of the amount of credit obtained by the farmers.

The estimated coefficient of cassava output (*OUTPUT*) variable is positive and statistically significant at 10%, which implies that cassava output has a positive effect on the amount of credit obtained by the farmers. For a unit increase in cassava output, there is 2.00 point increase in the predicted value of the amount of credit obtained by the farmers. The term for *OWNTELE* and *RENTLAND* variables has a slightly different interpretation. The predicted value of amount of credit obtained by the farmers is –22,887.10 point lower for the farmers that own television than for those that did not. In the same vein the predicted value of the amount of credit obtained by the farmers that rented land for farming is –24,994.69 point lower for those farmers that rented the farmland than for those that own the farmland.

The estimated coefficient of the *PRODASSET* variable is positive and statistically significant at 10%, which suggests that the monetary value of the farmers' productive assets such as hoes, cutlass, machetes, wheelbarrow, sprayers, etc. has a positive effect on the amount of credit obtained. This is contrary to the finding of Elhiraika and Ahmed (1998). In addition, for a unit increase in the households' productive asset, there is 0.97 point increase in the predicted value of the amount of credit obtained by the farmers.

The estimated coefficient of *AGE* of household head variable is negative and statistically significant. This implies that the age of the household has a negative effect on the amount of credit obtained. Specifically, younger farmers are more likely to obtain credit than the older farmers and for a unit increase in age, there is a –604.15 point reduction in the amount of credit obtained. This could be because older farmers due to experience are more risk averse than the younger farmers. The coefficient of the *HHSIZE* variable is positive and statistically significant at 10%. This shows that the larger the household size, the higher the amount of credit a farmer will obtain. A unit increase in the number of the household members increases the amount of credit obtained by 3889.32 points.

The ancillary statistic/sigma is analogous to the square root of the residual variance in OLS regression. The value of 95,616.36 can be compared to the standard deviation of amount of credit obtained which is 29,232.25, and represents a substantial increase.

5.2. Full Information Maximum Likelihood Estimates of the ESRM

This section presents the empirical evaluation of the impact assessment. The basic impact model adopted is the ESRM capable of controlling for all possible biases that could confound our results.

The results of the estimation are presented in Table 11. The result of the estimates is in three parts, one part consists of the Probit model of the determinants of access to credit. The result of the Probit model reveals that total livestock unit and the farm size are positive and statistically significant in determining the farmers access to credit. This can be explained by the fact that these two variables represent a measure of farmers' social status and wealth and the larger these assets, the more the farmers gain access to credit.

Table 11: FIML Estimates of the Endogenous Switching Regression Model.

Variable	Access to credit (0/1)	Access to credit = 1	Access to credit = 0
AGE	–0.016 (0.018)	0.034 (0.059)	0.016 (0.018)
AGE2	0.000 (0.000)	–0.000 (0.001)	–0.000 (0.000)
EDUC	0.015 (0.012)	–0.024 (0.037)	0.014 (0.011)
NFINC	–0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
HHSIZE	0.037 (0.025)	–0.025 (0.078)	–0.052 (0.024)**
GENDER	0.001(0.163)	0.611 (0.527)	–0.198 (0.144)
DEPENDRATIO	0.069 (0.062)	–0.181 (0.194)	–0.069 (0.063)
TTLU	0.202 (0.109)*	–0.588 (0.354)*	0.014 (0.106)
LAND	0.039 (0.021)*	–0.398 (0.069)***	–0.237(0.021)***
ACCINFOASSET	–0.015 (0.182)	–0.323 (0.584)	–0.278 (0.160)*
OFFFARMINC	0.141(0.137)	–0.292 (0.450)	–0.051 (0.107)
CONSTANT	–1.077 (0.528)**	12.106 (1 .743)***	8.274 (0.494)***
INSTITUTEREL	0.051(0.084)		

/lns1	1.112 (0.080)***
/lns2	0.201 (0.027)***
/r1	–2.711 (0252)***
/r2	–0.015 (0.224)
sigma_1	3.040 (0.245)
sigma_2	1.223 (0.033)
rho_1	–0.991(0.004)***
rho_2	–0.016 (0.224)
LR test of indep. eqns. : $chi^2(1)$ = 117.26 Prob > chi^2 = 0.0000	

Source: IITA/DIIVA Adoption and Impact Survey (2011)

The coefficient estimates of the second stage switching regression model for the cassava productivity (output per hectare) are shown in the second and third column of Table 11. The results of the productivity regressions among the farmers that have access to credit are reported in the access to credit = 1 column, and the productivity among the farmers without access to credit is presented in the access to credit = 0 column. The total livestock unit and farm size have negative coefficients and are statistically significant in explaining the variations in cassava productivity among the farmers that have access to credit. This could be due to the fact that the more livestock farmers have, the less devoted to farm production they would likely become. Livestock rearing could have the capacity to take resources away from cassava production and hence, contribute to a reduction in productivity. Similarly, large farm size could imply multiple cropping, which could also be competing with cassava production for inputs and cash, thereby leading to reduced productivity.

In the same vein, household size, farm size, and access to information assets also have negative coefficients and are statistically significant in explaining the variation in cassava productivity among the farmers without access to credit. Large household size has been identified as a major contribution to poverty among the rural farming households in Nigeria (Omonona and Okunmadewa, 2009). Therefore, the larger the household size the greater the probability of being poor and the lesser the availability of resources for agricultural production and hence there is more likelihood of reduced productivity.

The correlation coefficients rho_1 and rho_2 are both negative, but are statistically significant only for the correlation between the credit access choice equation and the yield of those farmers with access to credit. Since rho_1 is negative and statistically significantly different from zero, the model suggests that farmers who choose to obtain credit have higher productivity than a random farmer from the sample would have obtained. Those farmers without access to credit are not better or worse than a random farmer. The likelihood ratio test for joint independence of the three equations is statistically significant at 1%, this implies that these three models are not jointly independent and should not be estimated separately. Table 12 reveals that the mean Average Treatment effect on the Treated (ATT) is 5.39 and the t-test of the ATT shows that it is statistically and significantly different from zero. This implies that those farmers that have access to credit have higher productivity than those that did not have access to credit.

Table 12: One-sample t-test.

Variable	Obs	Mean	Std. Err.	Std. Dev.
ATT	856	5.392667	0.0714716	2.091077

Source: IITA/DIIVA Adoption and Impact Survey (2011)

6. Summary, Conclusion, and Policy Recommendations

Improving the production capacity of agriculture in developing countries like Nigeria through productivity increase is an important policy goal, especially in Nigeria where agriculture represents an important sector in the economy. In this study we adopted the ESRM that accounts for both heterogeneity and sample selection issues to examine the impact of access to credit on agricultural productivity in rural Nigeria. The results show that majority of the farmers are still in their productive age, cultivating an average of 2.59 ha of farm land, most of which is on rented farmland. Credit is obtained mostly for agricultural and non-agricultural purposes.

The male-headed households obtained higher credit than the female counterparts. Similarly adopters of improved cassava varieties and those that own the farmland for farming also obtained higher credit than the other counterparts. However, the analysis shows that not all the farmers that demanded for credit actually got the credit. The average variable cost of cassava production is high (₦ 46,166.43), which suggests that cassava production in Nigeria is capital intensive.

The test of mean difference in some selected socioeconomic characteristics of the farmers shows significant differences between the farmers that have access to credit and those that did not. This is an indication of selection bias in the sample. The empirical model of the Tobit model indicates that only five out of the 11 variables included in the model are positively related to the intensity of credit use. These positive and statistically significant variables include: the total livestock unit, output, monetary value of the households' productive assets, age of the household head, and household size.

The result of the first stage of the ESRM: the Probit model shows that total livestock unit and the farm size are positive and statistically significant in determining the farmers access to credit. The results of the second stage of the ESRM shows that the total livestock unit and farm size have negative coefficients and are statistically significant in explaining the variations in cassava productivity among the farmers that have access to credit, while household size, farm size, and access to information assets are also have negative coefficients and are statistically significant in explaining the variation in cassava productivity among the farmers without access to credit. In addition, the result shows that farmers who choose to obtain credit have higher productivity levels than a random farmer from the sample. This suggests that access to credit has a positive impact on productivity. In conclusion, access to credit is an important factor in the quest to achieve increase agricultural productivity and hence, this study recommends that access to credit should be included in any agricultural development programs in Nigeria.

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