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RESEARCH

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The simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria

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Abstract

Background: Cocoa contributes immensely to Nigeria's economy; it is about 40% of agricultural exports and it is the main source of livelihood for over 200,000 rural households. However, its productivity has remained low in recent years compared to other cocoa-producing countries such as Cote d'Ivoire and Ghana. Low cocoa productivity is attributed to many factors, which include lack of access to credit and cooperative services. However, empirical information on the simultaneous impact of credit access and membership of cooperative society on cocoa productivity is still very scanty. This paper aims at evaluating the impacts of access to credit service, cooperative service, and simultaneous access to credit and cooperative services on cocoa productivity in South-western Nigeria.

Method: A multistage sampling procedure was employed to select 300 cocoa farmers for the study. The endogenous switching regression (ESRM) and the inverse probability-weighted regression adjustment (IPWRA) models were used to analyse the data.

Results: In terms of simultaneous access to credit and cooperative services, age, education, gender, and size of household significantly influence the probability of farmers having simultaneous access to credit and cooperative services. The results of the second stage of the ESRM showed that age, size of household, years of education, and years of experience significantly influence cocoa productivity among farmers who have access to credit and cooperative services. However, age, size of household, size of farm and asset significantly influence the productivity of farmers who do not have access to credit and cooperative services. Average treatment effect on the treated (ATT) revealed that farmers who simultaneously have access to credit and cooperative services achieve significantly higher productivity than farmers who have access to either credit or cooperative services and the set of farmers who do not have access to either credit or cooperative services.

Conclusion: The study concluded that simultaneous access to credit and cooperative services positively impacted cocoa productivity. Farmers who have simultaneous access to credit and cooperative services achieve significantly higher productivity than farmers who have access to either credit or cooperative services or those that do not have access to these services at all. The study recommends that any agricultural productivity-targeted programmes in Nigeria consider farmers' simultaneous access to credit and cooperative services.

Keywords: Credit and cooperative services, Simultaneous impact, Cocoa farmers, Productivity, South-western Nigeria

Background

Cocoa (*Theobroma cacao* L.) contributes greatly to the economic development of Nigeria [1, 2]. The cash crop plays a crucial role in providing employment,

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foreign exchange earnings, and revenue to governments of cocoa-producing States [1]. Additionally, cocoa is an important source of raw material for many agro-industries [3] and it has high nutrient contents such as carbohydrate, protein, fat, and minerals that can be used for manufacturing beverages, wine, chocolate, cream, and livestock feed, among others [4]. However, cocoa productivity has declined significantly in recent years [5–7]. In the past 5 years, the productivity of cocoa plantations in Nigeria began to decline by 0.8 tons per hectare annually [6]. Currently, an average cocoa productivity in Nigeria does not exceed 0.5 tons per hectare; whereas, hybrid varieties developed by Cocoa Research Institutes have yielded potential of 1.5 to 2 tons per hectare. The productivity gap is attributed to a number of challenges. The major sources of these challenges are traced to declining soil fertility of cocoa farms, diseases and pest attacks, poor farming management practices, inadequate infrastructure, and limited use of farm resources.

Studies of [8, 9] propose several investment options to enhance farm productivity. These options include one or more of the following: the automation of farming processes, planting of high-seed varieties, application of fertilizers, irrigation in areas where rainfall is inadequate, and use of pesticides. It has, however, been noted that farmers could often not afford these investments [10]. The majority of the farmers, particularly smallholders, are not rightfully positioned to secure key inputs such as fertilizer, improved seed, pesticides, among others from their own sources due to lack of funds. Rigorous use of farm inputs requires funds at the disposal of farmers. The required funds either come from savings or through borrowings; however, since farmers' savings are quite meagre, they have to borrow for their productive activities. Farmers who manage to gain access to credit services tend to purchase the needed farm inputs to enhance productivity. Unfortunately, lack of access to credit is a major constraint faced by cocoa farmers in Nigeria. Most cocoa farmers rarely have access to credit, which makes it impossible to improve their productivity. Invariably, agricultural credit is essential to meet the required investment to increase Nigeria's cocoa productivity [11].

Agricultural credit is well-thought-out as a strategic resource for pushing crop productivity to the frontier, hence, raises the standards of living of many poor farmers. Therefore, access to agricultural credit is anticipated to assist farmers to optimally combine resources at their disposal. Agricultural credit has two sources: formal and informal. Credit from formal sources in Nigeria has more baneful effects on the rural poor, and its access is abysmally low [11]. This is evident in the fact that the interest rate on formal credits is exorbitantly high in Nigeria [12]. Therefore, low access to formal credit is responsible for limiting farmers' productivity [13] and reducing income and investment in Agriculture [14]. Consequently, this situation further aggravates rural poverty [15, 16]. The farmers are trapped in a vicious cycle of poverty without opportunities or avenues to improve their living standard. It therefore appears that rural farmers may never get out of their present predicament without external positive intervention. Therefore, access to credit and increased agricultural productivity are still critical factors in combating rural poverty [17, 18]. In a bid to encourage farmers' access to credit, governmental and non-governmental organisations instituted many credit programmes. However, these programmes yielded little or no positive effect on cocoa productivity because of lack of trust in the government by the farmers due to their excessively complicated administrative procedure [11, 12, 19, 20]. A number of programmes introduced to improve agriculture in Nigeria, in most cases have not been able to meet up with the goals except agricultural programmes channeled and supported by agricultural cooperative societies. Under these circumstances, the farmers need strong institutions such as cooperative societies to break out of the vicious circle of devastating poverty.

Many farmers with a common interest come together to form cooperative societies which help them gather resources to meet their financial needs and improve their productivity [21]. Evidence showed that access to credit is one of the benefits of belonging to a cooperative society [10, 22–25]. Cooperative societies aggregate people, resources and capital into economic units to provide opportunities for farmers to raise their productivity and income [26]. Participation in a cooperative society improves productivity by influencing a household's propensity to adopt newer farming practices and technologies via the exchange of ideas with other group members [10, 27–29]. Also, many studies, for instance, [30–32] agree that participation in cooperative societies improve the commercialisation behaviour of farmers. This behaviour enhances farm productivity which in turn, leads to improved farm income and food security. According to [33, 34], this is achieved through collective bargaining power, which increases the worth of their products and lowers input prices. However, scholars [35–39] argue that farmers join farmers' cooperative societies primarily to gain access to credit service. Usually, farmers' cooperative society membership provides the platform by which farmers gain access to credit. Therefore, cooperative society membership plays a mediating and hidden role in the relationship between access to credit and cocoa productivity. This implies that cooperative society membership and credit access are not mutually exclusive. However, empirical assessment of the impact of credit access and cooperative society membership on

productivity is still very scanty. In fact, particularly in relation to cocoa productivity of which, to the best of the authors' knowledge, none exists. The authors believe that this is the first study that fills that gap in the literature. Previous studies examined the impact of access to credit on cocoa productivity, but ignored the fact that cooperative society membership could also improve cocoa productivity.

Nevertheless, the few studies that had examined the role of cooperative society membership in improving productivity ignored the fact that access to credit influenced farmers' decision to join cooperative societies [40, 41]. As earlier posited, cooperative society membership and credit access are not mutually exclusive and they are expected to simultaneously increase cocoa productivity. Thus, an important goal of this study is to clearly investigate the synergetic impact of access to credit and cooperative services on cocoa productivity. This attempt is made to ascertain the hidden and mediating role of cooperative society membership in the relationship between access to credit and cocoa productivity, and to ascertain their effects on cocoa productivity. The objectives of this study are in twofold: (1) to analyse the major determinants of access to credit and cooperative services; and (2) to determine the simultaneous impact of access to credit and cooperative services on cocoa productivity. This study contributes to the literature in two ways. Firstly, recent research conducted by [42] suggests that access to credit without simultaneous access to other institutional services may not adequately or substantially increase farm productivity. [12, 43] recommend that simultaneous provision of institutional services, such as formal agricultural credit and agricultural extension services, would substantially increase farm productivity. However, no empirical study has established whether simultaneous access to credit and cooperative services improve farm productivity to the best of our knowledge. Secondly, this study applies the endogenous switching regression model (ESRM), which removes endogeneity issues from the impact assessment. To validate the ESRM results, we use the inverse probability-weighted regression adjustment (IPWRA) approach for more robustness checks. The study makes use of cross-sectional data obtained from multistage sampling procedure. Therefore, we employed ESRM and IPWRA to evaluate the simultaneous impact of access to credit and cooperative services on cocoa productivity. Our empirical study shows that access to credit and cooperative services have significant impact on cocoa productivity in Nigeria. However, when the synergetic access to credit and cooperative services was examined, we found that the synergetic access to credit and cooperative services has a robust and more pronounced significant impact on cocoa productivity. We also found that synergetic access to credit and cooperative services is dependent on some key socioeconomic characteristics of the farmers such as education and size of household. However, the outcome of the research is limited to cocoa productivity in Nigeria. The same study should be encouraged in other crops and countries. Also, research should be conducted on synergetic impact of access to cooperative and credit service on other welfare indicators such as food security, poverty and asset acquisition. The rest of the study is organised as follows: in section two, we briefly discuss the review of literature relating to access to credit, cooperative societies and cocoa productivity in Nigeria. In section three, we present our methodology, data and outline our empirical strategy. Section four presents the main results, discussing the impact of credit access and cooperative society membership on cocoa productivity. Section five is our conclusion.

Literature review

The majority of cocoa consumers live in temperate nations. The crop flourishes in tropical climates, therefore cocoa production is dominated by countries in such regions. West Africa is a major cocoa producer, it makes up over 70% of global output, which varies annually due to climate change. Nigeria is one of the most important cocoa producers in West Africa, and it has grown to become a major exporter in recent years. Cocoa production in Nigeria is primarily small-scale and concentrated in Ekiti, Ondo, Osun, Oyo, and Ogun States, where farmers use either inherited fields or a share-cropping system in which the landowner receives two-thirds of the output and also contributes to the purchase of farm input. Their output is about 70% of the country's entire annual output [44, 45]. Unfortunately, Nigeria is currently suffering from low and declining cocoa productivity, with aged cocoa fields playing the lead role in the decreased productivity, particularly in the South-western States, which produce about 80% of the country's cocoa. Most cocoa farms in Nigeria are old and have low production, according to [46, 47]. This is seen as a stumbling block to the government's plans to triple cocoa production in the country. Though the figures on cocoa productivity are contradicting, annual cocoa productivity in Nigeria is typically considered to be between 300 and 400 kg/ha [48]. Production per hectare is also reported to be 0.8 tonnes, but this has dropped to less than 0.5 tonnes per hectare, owing to a number of factors. Figure 1 shows a decline in cocoa productivity between 2011 and 2014 followed by a consistent decline from 2015 to date in Nigeria. A lot of factors influence the quantity of cocoa produced, and these factors vary depending on the climate or weather conditions. When the weather is favourable, the output

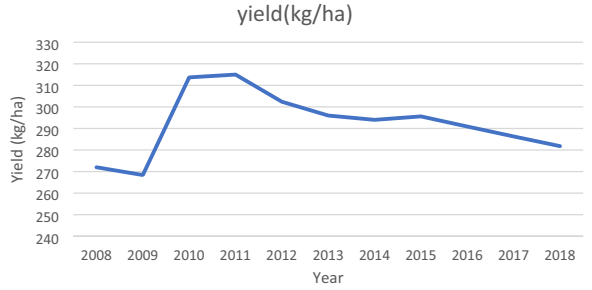

Fig. 1 Nigerian cocoa productivity trend from 2008 to 2018 (FAOSTAT, 2020)

goes up, and when the weather is not so favourable, the output goes down. According to existing research, further problems with cocoa production include lack of market intelligence, distance to market, limited usage of agricultural input, lack of cash remittances, high levels of spoiling, low bean quality, and a very weak link between producers and processors/exporters among others. It is also commonly accepted that agriculture is underinvested, and studies such as [48, 49] have found a substantial link between cocoa productivity and access to funds.

The financial needs of agricultural sector have risen dramatically in recent decades as a result of greater usage of fertilizers, biocides, improved seeds, mechanisation, and other technologies. Credit in the hands of a peasant farmer, on the other hand, will enable him to make great profits, contentment, and increased well-being, as well as develop new and improved products to please an inclusive market. Credit can be defined as a bank or non-bank facility that allows money or goods to be borrowed now for a useful and constructive purpose, with the money or goods to be repaid with reasonable interest at a later period [15]. Credits accessibility refers to how easy or difficult it is for borrowers to obtain credit for productive purposes such as improving farm business. Access to credit is critical for improving the quality and quantity of farm products, as well as increasing farmer's income and preventing rural migration. In support of this fact, some policymakers feel that providing low-interest credit to farmers will considerably increase their productivity. Scholars such as refs. [50–54] suggest that agricultural credit is an effective tool for capitalising farm households in order to spend more and introduce new agricultural technology to increase agricultural productivity. Furthermore, according to certain researchers such as [32, 55, 56], credit improves farmer's living situations by increasing farm output, which boosts their self-confidence by increasing profits and well-being. Despite the importance of credit to agricultural development, many farmers still lack access to it [57]. Meanwhile, a number of researchers have submitted that agricultural cooperatives can secure access to credit, which is a major motivator for farmers to increase their output. Cooperatives boost farm productivity by providing crucial information, finance, and a higher market price for their members' farm products [58, 59].

Cooperative societies, according to [60], are democratic organisations governed by its members, who actively participate in the organisations' policy and decision-making. Men and women functioning as elected representatives are held accountable to the members. Members have equal voting rights and consequently contribute fairly to the cooperative society's investment in this way. Cooperative societies assist smallholder farmers in increasing their negotiating power and becoming more competitive in the cocoa industry [61]. Based on the foregoing, it is reasonable to regard cooperative societies as social enterprises capable of assisting the disadvantaged in breaking free from the cycle of poverty [32, 62–64]. This is why [39] defines a cooperative society as an independent organisation of people who have come together voluntarily to achieve their common economic, social, and cultural needs and ambitions through a jointly owned and democratically run firm. Cooperative societies and their specific contribution to agricultural productivity have been the subject of extensive investigation [39, 65–70]. It is discovered that cooperative societies provide both economic and social benefits to their members, which promote smallholder farmers' commercialisation behaviour, increasing farm productivity and income. This could be critical for the survival of the majority of small-scale farmers. Several studies have found various factors that influence membership in different cooperative societies. Gender, education, farm size, output, and expenditure per hectare are all factors that influence farmers' decisions to join agricultural cooperative organisations in Nigeria [71]. Similarly, [72] finds that education, gender, and farm size are important drivers of farmers' decision to join farmer-based groups. According to [73], there are other motivations that inspire rural farmers to join agricultural cooperative societies apart from personal interests. Access to credit and training, among other things, are major predictors of farmers' willingness to join agricultural cooperative societies, according to the author. Furthermore, according to ref. [74], a household's resource endowment, such as access to off-farm income, education, and the number of adult members in a household, has a major impact on the likelihood of joining a farmer's cooperative society. In conclusion, agricultural cooperative

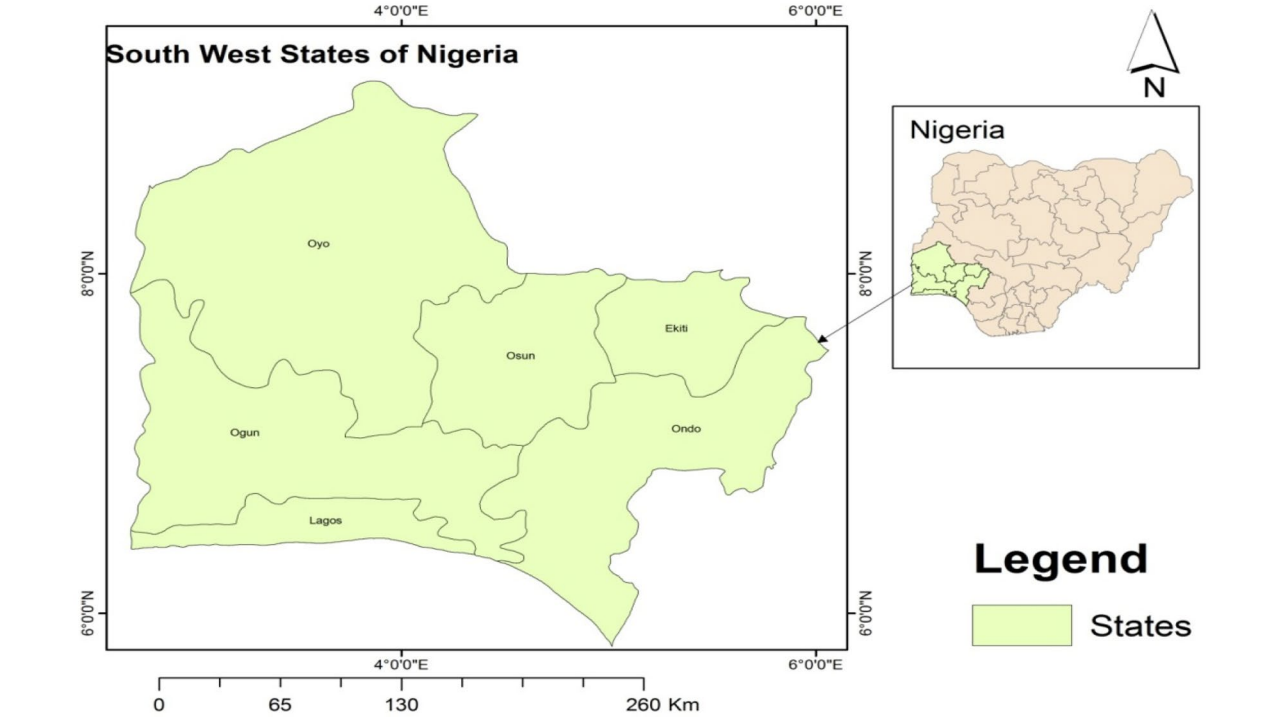

Fig. 2 Map of South-western Nigeria

societies allow optimal utilisation of inputs through the provision of financial services which results in increased cocoa productivity.

Materials and methods

Description of the study area

This study was carried out in the Southwestern part of Nigeria (Fig. 2), which represents a geographical area covered between latitude 6° 21′ N and 8° 37′ N and longitude 2° 31′ E and 6° 00′E [75]. The region is bounded in the north by the Kogi and Kwara States, in the south by the Atlantic Ocean, in the west by the Republic of Benin, and east by the Edo and Delta States. The total population is about 27 581 992 [76]. It is majorly a Yoruba-speaking area, although there are different dialects even within the same state. It is characterised by two climatic seasons, the rainy season and the dry season. The rainy season extends from March to October and the shorter dry season from November to March. The temperature ranges from 21 to 34 °C, while the annual rainfall ranges from 1500 to 3000 mm. The area's favourable climatic and soil condition encourages about 70% of the inhabitants to engage in farming. They grow both permanent and food crops. The climate is ideal for cultivating crops like maize, yam, cassava, millet, rice, plantain, cashew, and cocoa. The region accounts for more than 155 000 tons of cocoa, representing 85% of Nigeria's supplies.

Sampling technique and sample size

A multistage sampling procedure was employed to select respondents for this study. The first stage involved purposive selection of two (2) States from South-western Nigeria (Osun and Ondo States) based on the predominance of cocoa production in these States. The second stage involved purposive selection of three (3) local government areas (LGAs) from each selected State. In the Osun State, the Atakumosa East, Atakumosa West, and Ife North LGAs were selected, while the Ondo West, Idanre, and Ile Oluji/Okeigbo LGAs were selected in the Ondo State, based on the predominance of cocoa production in the LGAs. The third stage entailed the simple random selection of five (5) villages from the list of cocoa-growing villages in each of the LGAs. The fourth stage involved the simple random selection of ten (10) cocoa farmers from each village. In all, a total of 300 cocoa farmers were selected for the study.

Data analysis

This study investigated the simultaneous impact of access to credit and cooperative services on cocoa productivity. First, the data were analysed using descriptive statistics in order to gain an understanding of the socioeconomic characteristics of the farmers. Then, the study assumed that access to credit and cooperative services is endogenous to cocoa productivity. The source of endogeneity

is self-selection into access to credit and cooperative services. The problem of endogeneity arises from the postulation that access to credit and cooperative services is voluntary. In addition, access to credit and cooperative services does not only depend on farmers' observable characteristics alone, but is also on some unobservable characteristics which, if not controlled, one can either overestimate or underestimate their impact. To address this, the endogenous switching regression model (ESRM), the only model that explicitly accounts for selection bias and endogeneity simultaneously, was used, as posited by refs. [71, 77–84].

Consequently, this study exactly corrects for the possibilities of sample selection bias and endogeneity that may arise from other interventions that provide services to farmers in addition to credit and cooperative services. The ESRM allows for interaction between access to credit and cooperative services and other covariates [85, 86]. ESRM is an econometric model that specifies a decision process and the regression models associated with each decision option [85].

The model is divided into two stages: the first stage is correct for endogeneity attributable to self-selection through a probit selection model in which farmers are sorted into access and non-access to credit and cooperative services; the second stage addresses the outcome equations on factors influencing cocoa productivity.

The study first specifies the binary decision choice of cocoa farmers' access to credit and cooperative services, which is conditional on observed covariates by using a probit model as follows:

$$\begin{aligned} Y_i^* &= \beta x_i + \varepsilon_i, \\ Y_i &= 1 \; if \; {}_i^* > 0, \\ Y_i &= 0 \; if \; y_i^* \leq 0, \end{aligned} \tag{1}$$

where Y* is the unobservable variable for access to credit and cooperative services; Y is the observable counterpart (equal to one if the farmer had access to credit or participated in cooperative societies, and zero if otherwise); x_i is a set of explanatory variables used in the model; and ε_i represents the error term. In the second stage, the outcome equation of impact of access to credit and cooperative services on cocoa productivity is measured via a production function, expressed in Eq. 2:

$$P_i = \beta Y_i + \delta z_i + e_i, \tag{2}$$

where P_i is the natural log of cocoa productivity; Y_i is credit access or cooperative society membership; z_i is a set of explanatory variables used in the model; and e_i represents the error term.

However, due to selection biases, farmers are expected to have two regimes. Therefore, separate regressions are performed in the second stage to demonstrate cocoa productivity, conditional on respective credit access/cooperative society membership status:

Regime 1 (access to credit/ cooperative services) :

$$P_{1i} = \delta_1 z_{1i} + e_{1i}, \tag{3}$$

Regime 2 (no access to credit/ cooperative services)

$$P_{2i} = \delta_2 z_{2i} + e_{2i}, \tag{4}$$

where P_{1i} and P_{2i} are the natural log of productivities of cocoa farmers in regimes 1 and 2, respectively; Z_i is the set of exogenous variables that are assumed to determine productivity of cocoa farmers; e_{1i} and e_{2i} are the error terms. But the error terms have a tri-variate normal distribution, with zero mean and non-singular covariance matrix, the covariance matrix of which is expressed as follows:

$$\operatorname{cov}(\varepsilon_i, e_1, e_2) \begin{pmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\varepsilon} \\ \sigma_{12} & \sigma_2^2 & \sigma_{2\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_{2\varepsilon} & \sigma^2 \end{pmatrix}, \tag{5}$$

where, $\sigma_1^2 =$ (e_1); var (e_2);var (ε_i); σ_{12}=$cov(e_1, e_2)$; $\sigma_{1\varepsilon}$ =$cov(e_1, \varepsilon_i)$; $\sigma_{2\varepsilon}$= $ov(e_2, \varepsilon_i)$; σ^2 is the variance of the error term in the selection equation; and σ_1^2, σ_2^2 are the variance of the error term in the outcome equation. Given that unobserved factors affecting the regime switching (selection equation) might also affect cocoa productivity, the error terms ε_i and e_1 may be correlated and the application of ordinary least squares (OLS) may produce inconsistent estimates. Following [79], the existence of latent characteristics related to selection bias indicates that the error structure is based on the account that the error term (ε_i) of the selection Eq. 1 is correlated with the error terms (e_1, e_2) of the outcome Eqs. 3 and 4, and the expected values of (e_{1i}, e_{2i}) conditional on the sample selection are non-zero, as shown in Eqs. 6 and 7:

$$E(e_{1i}|Y_i = 1) = E(e_{1i}|\varepsilon_i > -x_i\beta) = \sigma_{1\varepsilon}\left[\frac{\theta(x_i\beta/\sigma)}{\varphi(x_i\beta/\sigma)}\right] \equiv \beta_{1\varepsilon}\gamma_1, \tag{6}$$

$$\begin{aligned} E(e_{2i}|Y_i = 0) &= E(e_{2i}|\varepsilon_i \leq -x_i\beta) \\ &= \sigma_{2\varepsilon}\left[\frac{-\theta(x_i\beta/\sigma)}{1-\varphi(x_i\beta/\sigma)}\right] \equiv \beta_{2\varepsilon}\gamma_2, \end{aligned} \tag{7}$$

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 βx_i and represented by γ_1 and γ_2 in Eqs. 6 and 7, is referred to as the inverse mills ratios (IMRs) which indicate selection bias terms. The IMRs show the correlation between access to credit/cooperative services and cocoa

productivity. The IMRs predicted by the probit model in the first stage are added to the productivity equation in the second stage to give the following sets of equations:

$$P_{1i} = \vartheta_1 z_i + \beta_{1\varepsilon}\gamma_1 + \phi_1 Y_{1i} + \eta_1, \tag{8}$$

$$P_{2i} = \vartheta_2 z_i + \beta_{2\varepsilon}\gamma_2 + \phi_2 Y_{2i} + \eta_2. \tag{9}$$

The coefficients 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 $\eta_1 and \eta_2$ cannot be used to calculate the standard errors of the two-stage estimates. To address this issue of endogenous regime switching, the estimation of the selection and productivity equations are performed simultaneously by using the full information maximum likelihood (FIML) method [81]. The model is expressed as[1]:

$$\ln Y_i = \sum_{i=1}^{N} \left\{ Y_i t_i \left[\ln F \left(\frac{(x_i\beta + \alpha_{1\varepsilon}(P_{1i} - Z_{1i}\lambda/\pi_1))}{\sqrt{1-\alpha_{1\varepsilon}^2}} \right) + \ln(P_{1i} - Z_{1i}\lambda/\pi \right] \right.$$
$$\left. + (1 - Y_1) t_i \left[\frac{\ln(1 - F(x_i\beta + \alpha_{2\varepsilon}(P_{2i} - Z_{2i}\lambda)/\phi_2)}{\sqrt{1-\alpha_{2\varepsilon}^2}} + \ln(f(P_{2i} - Z_{2i}\lambda)/\phi_2 \right] \right\}. \tag{10}$$

Thus, the average treatment effect on the treated (ATT) of cocoa farmers can be calculated as follows:

$$ATT = E(P_{1i} - P_{2i} | Y_i = 1) = Z_i(\lambda_1 - \lambda_2) + (\sigma_{1v} - \sigma_{2v})\gamma_1. \tag{11}$$

The empirical equation of the ESRM, which are access to credit/ cooperative services and the cocoa productivity function, are specified below.

The access to credit/cooperative services' decision equation is specified as follows:

$$\mathrm{Y} = \beta_0 + \beta_1 \mathrm{X}_1 + \beta_2 \mathrm{X}_2 + \beta_3 \mathrm{X}_3 + \beta_4 \mathrm{X}_4 + \beta_5 \mathrm{X}_5 \cdots \beta_8 \mathrm{X}_8, \tag{12}$$

where Y = access to credit/cooperative services (1 = yes, 0 = otherwise).

The explanatory variables are: X_1 = age of farmers (years); X_2 = age square of farmers (proxy for threshold age) (years); X_3 = household size (actual number); X_4 = education (years spent in formal education); X_5 = farm experience (years); X_6 = farm size (ha); X_7 = gender of the farmer (male = 1, female = 0); X_8 = own asset (1 = yes, 0 = otherwise).

Then, the separate productivity function for cocoa farmers with access to credit/cooperative services and those without access to credit/cooperative services:

$$\mathrm{Y} = \beta_0 + \beta_1 \mathrm{X}_1 + \beta_2 \mathrm{X}_2 + \beta_3 \mathrm{X}_3 + \beta_4 \mathrm{X}_4 + \beta_5 \mathrm{X}_5 \cdots \beta_8 \mathrm{X}_8, \tag{13}$$

where Y = natural logarithm of productivity is the total output of cocoa per hectare.

The explanatory variables are: X_1 = age of farmers (years); X_2 = age square of farmers (proxy for threshold age) (years); X_3 = household size (actual number); X_4 = education (years spent in formal education); X_5 = farm experience (years); X_6 = farm size (ha); X_7 = gender of the farmer (male = 1, female = 0); X_8 = own asset (1 = yes, 0 = otherwise).

Description of variables

According to Table 1, age is measured in years. It is expected that the older farmers are more mature and responsible, which therefore, improves their farm productivity. It is expected that when farmers attain a certain age threshold, their productivity will decrease and therefore, age squared negatively relate to farm productivity. Household size is measured as the total number of people in the farmer's household who are 18 years or above and able to work. It is used as a proxy to measure the labour force that is available for farm work. It is expected to be positively related to farm productivity since more labour would cultivate more expanse of land. Education is measured as the number of years spent in school. It is expected to positively relate to farm productivity because that education equips farmers with the necessary knowledge and skills to utilise improved technologies, improving their productivity. Farming experience is measured in the number of years a respondent has been working on his/her cocoa farm. This is used as a proxy to measure the experience which a respondent has on cocoa farming in order to make an informed decision on increase farm productivity. The farm size, measured in hectares, is used as a proxy to measure the potential income of respondents. Therefore, it is expected to be positively related to farm productivity. Gender is captured in the model as

[1] According to [147], the signs of the correlation coefficients of $\alpha_{1\varepsilon}$ and $\alpha_{2\varepsilon}$ have economic meanings. If $\alpha_{1\varepsilon}$ and $\alpha_{2\varepsilon}$ have alternate signs, cocoa farmers had access to credit/cooperative services on the basis of their comparative advantage. These sets of farmers achieved above-average productivity. Still, coefficients with the same sign indicate hierarchical sorting. This implies that cocoa farmers achieved above-average productivity whether they had access to credit/ cooperative services or not, but they were better off when they had access to credit/ cooperative services.

Table 1 Description of variables and their expected impact on access to credit/cooperative services and cocoa productivity

Variables	Description	Unit	Expected sign	Summary statistics
Natural log of productivity	Measured in kg/Ha	kg/ha		8.115 ([a]5.91)
Age	Measured in years	Year	+	51.30 (10.06)
Age squared	Measured in years	Year	–	2722.12 (960.29)
Household size	Measured in number of household members	Number of persons	+	7.07 (5.29)
Education	Measured in years spent in school	Years spent in school	+	8.88 (3.48)
Farming experience	Measured in years spent in farming	Years spent in farming	+	24.12 (7.15)
Farm size	Measured in hectares	Hectares	+	9.10 (5.47)
Gender	1 = male 0 = female	Dummy	+	0.89 (0.24)
Own asset	1 = if farmer owns an asset 0 = otherwise	Dummy	+	0.70 (0.13)

[a] Figures in parentheses are standard deviation

the sex of respondent and measured as a dummy, where a male respondent is (1) and female respondent is (0). It is expected to be positive because of the freedom of mobility among male farmers in term of participating in field days and other technology demonstrations, which invariably grants them more access to information to improve their productivity. Asset is measured as a dummy, where (1) is assigned to respondents who own physical asset and (0) otherwise, where respondents have no physical asset. This is used as a proxy to measure the net worth of respondents. It is expected to be positively related to farm productivity.

Inverse probability-weighted regression adjustment (IPWRA)

IPWRA is used to check for the robustness of ESRM. IPWRA provides an appropriate solution for ATTs that may arise in the presence of misspecification [87–89]. This is possible because IPWRA has a double robust characteristic, which provides consistent outcomes, and avoids misspecification bias by giving the response and treatment models to account for misspecification. In addition, if the treatment model is correctly specified, then IPWRA can provide consistent estimates, even when the outcome model is incorrectly specified. This is why IPWRA estimates are consistent with the presence of misspecification in the treatment or outcome model. To calculate the treatment effects by applying IPWRA, this study measures the treatment model parameters and obtains inverse probability weights. Then, the study fits the weighted regression outcome models for each treatment level and obtains the treatment-specific predicted results by employing the estimated inverse probability weights. Lastly, the means of the treatment-specific expected results are estimated. To this end, the study chose the estimator to check the robustness of the

Table 2 Access to credit and cooperative services

Variables	Cocoa farmers
Credit access (%)	76
Cooperative membership (%)	67
Credit access and cooperative membership	67
Volume of credit	132,500 (± 100,149)
Average distance to loan source (km)	0.46 (±0.17)
Obs	300

estimates obtained from the ESRM. According to [90], calculating ATT using IPWRA is a two-step method. Consider that outcome indicator, as usual, is Yi which can be represented by a linear function specified as:

$$Y_i = \delta_i + \varphi_i X_i + \varepsilon_i \ \ for\ i\ =\ [0,1]. \tag{14}$$

The propensity score generated from the selection equation can be represented as:

$$ps\ =\ p(X;\gamma). \tag{15}$$

First, the propensity score is estimated as $p\left(X;\hat{\gamma}\right)$. Second, it employs linear OLS to estimate (δ_0, φ_0) and (δ_1, φ_1) using inverse probability-weighted least square.

The inverse probability-weighted least squares can be specified as follows:

$$\min_{\delta_0,\varphi_0} \sum^{N} (Y_i - \delta_0 - \varphi_0 X_i)/p\left(X;\hat{\gamma}\right)\ \ if\ k_i\ =\ 1. \tag{16}$$

The ATT can then be computed as the difference between Eqs. (15) and (16):

$$ATT = \frac{1}{N_w} \sum_{i}^{N_w} [(\hat{\delta}_1 - \hat{\delta}_0) - (\hat{\varphi}_1 - \hat{\varphi}_0) X_i], \tag{17}$$

Table 3 Socioeconomic characteristics of the respondents by access to credit

Variables	Pooled	Access to credit	Non-access to credit	Minimum	Maximum	t-test
Age	51.30 (10.06)	51.92 (9.28)	48.78 (9.97)	21	72	2.31**
Age^2	2722.12 (960.29)	2781.69 (952.31)	2473.64 (961.71)	441	5184	2.21**
Household size	7.07 (5.29)	6.97 (1.97)	7.41 (2.68)	1	14	1.42
Years of education	8.88 (3.48)	9.12 (4.58)	7.84 (3.23)	0	19	2.02**
Years of experience	24.12 (7.15)	24.84 (8.69)	23.77 (9.39)	5	54	0.791
Farm size	9.10 (5.47)	11.79 (9.27)	6.07 (4.98)	1	18	4.53***
Natural log of productivity	8.12 (5.907)	8.24 (6.84)	7.36 (6.71)	6.58	11.13	2.15**
Gender (male) (%)	89.34	91.32	8.68			
Own asset	70.67	80.58	19.42			
Obs	300	228	72			

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

where $(\hat{\delta}_1, \hat{\varphi}_1)$ are the inverse probability-weighted estimates for the treated farmers and $(\hat{\delta}_0, \hat{\varphi}_0)$ are the inverse probability-weighted estimates for the control households. Finally, N_w denotes the treated households [91].[2]

Results and discussion

Access to credit and cooperative services

Access to credit and cooperative services and other essential credit variables are presented in Table 2. About 76% of the respondents have access to credit in the previous production season, while about 67% of the respondents are members of cooperative societies. Interestingly, about 67% of the respondents have simultaneous access to credit and cooperative society's services. This implies that the farmers in the area have organised themselves into social capital networks in order to gain access to credit services. This study supports the general assumption that individuals are affiliated to these networks primarily because of their perceived economic benefit [92, 93]. The average amount of loan borrowed was ₦132,500 ([3]$322.47). This implies that credit agencies or institutions in the study area provide short-term loans. This could further imply that the agencies lack sufficient capacity to provide high volume of loans. The result further reveals that households in the study area trekked an average distance of 0.46 km from their homestead to the designated credit agencies' buildings. This implies that the credit agencies' location is situated around the homestead of the households which could increase the chances of farmers' access to credit [94].

Socioeconomic characteristics of the respondents by access to credit services

The socioeconomic characteristics of the respondents by access to credit services are shown in Table 3. The independent sample t-test reveals that the socioeconomic characteristics of cocoa farmers with credit access differ entirely from those without credit access. This suggests that cocoa farmers with access to credit are relatively older, and they spent quality time in school rather than those without access to credit. The farmers with access to credit also achieve significantly higher productivity and farm size than those without access to credit. This result indicates the presence of selection bias and endogeneity in the selected sample. Similarly, descriptive statistics shows that farmers with access to credit have better access to assets compared to their counterparts without access to credit. Male farmers also have better access to credit than their female counterparts.

Socioeconomic characteristics of the respondents by access to cooperative services

The socioeconomic characteristics of the respondents by access to cooperative services are shown in Table 4. The independent sample t-test reveals that the socioeconomic characteristics of cocoa farmers who have access to cooperative services differ entirely from those who lack access to cooperative services. This suggests that cocoa farmers

[2] In addition to examining the impacts of access to credit/cooperative services separately, this study also examines the synergetic impact of access to credit/cooperative services on the economic outcome under study, specifically, cocoa productivity. This study consists of three groups; they are, farmers who had access to credit (access to credit services). Access to credit service is marked as a binary variable in which "one" indicates that the farmers accessed some form of credit for farm production and "zero" otherwise. Secondly, farmers who are members of cooperative societies (access to cooperative services). Access to cooperative service is also a binary variable, with "one" indicating a farmer who is a member of a cooperative society and "zero" indicating otherwise. Thirdly, farmers who have used both services simultaneously (access to credit and cooperative services) are assigned "one", and farmers who did not receive either of these two services are assigned "zero".

[3] $1 = ₦ 410.89.

Table 4 Socioeconomic characteristics of the respondents by access to cooperative services

Variables	Pooled	Access to cooperative services	Non-access to cooperative services	Minimum	Maximum	t-test
Age	51.30 (10.06)	53.52 (9.41)	50.21 (9.35)	21	72	2.86***
Age^2	2722.12 (960.29)	2951.59 (994.80)	2609.95 (924.55)	441	5184	2.94***
Household size	7.07 (5.29)	7.48 (2.23)	6.19 (1.59)	1	14	5.14***
Years of education	8.88 (3.48)	10.73 (4.28)	7.99 (3.99)	0	19	5.36***
Years of experience	24.12 (7.15)	24.61 (11.22)	23.66 (8.13)	5	54	0.83
Farm size	9.10 (5.47)	13.02 (9.09)	5.92 (3.22)	1	18	7.00***
Natural log of productivity	8.12 (5.91)	8.92 (7.39)	7.15 (6.89)	6.58	11.13	5.21***
Gender (male) (%)	89.34	87.06	12.94			
Own asset	70.67	78.61	21.39			
Obs	300	201	99			

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

Table 5 Socioeconomic characteristics of the respondents by simultaneous access to credit and cooperative services

Variables	Pooled	Access to credit and cooperative services	Non-access to credit and cooperative services	Minimum	Maximum	t-test
Age	51.30 (10.06)	50.45 (18.56)	48.98 (13.53)	21	72	3.38**
Age^2	2722.12 (960.29)	2618.94 (845.44)	2408.29 (732.64)	441	5184	3.66**
Household size	7.07 (5.29)	7.27 (2.21)	6.88 (2.00)	1	14	1.55
Years of education	8.88 (3.48)	9.449 (4.65)	6.18 (4.08)	0	19	2.51**
Years of experience	24.12 (7.15)	25.13 (10.23)	22.53 (7.99)	5	54	2.43**
Farm size	9.10 (5.47)	14.58 (9.25)	7.57 (4.25)	1	18	7.35***
Natural log of Productivity	8.12 (5.91)	9.18 (8.48)	7.30 (5.41)	6.58	11.13	2.61***
Gender (male) (%)	89.34	90.42	87.95			
Own asset	70.67	82.93	42.03			
Obs	300	201	99			

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

who are members of cooperative societies are relatively older and spent quality time in school rather than those who are non-members. Members of cooperative societies also achieve significantly higher farm size, productivity, and larger households than those who are non-members. This result shows the presence of selection bias and endogeneity in the selected sample. In the same vein, descriptive statistics shows that cocoa farmers who are members of cooperative societies have better access to assets compared to their counterparts who are non-members. Male farmers are mostly members of cooperative societies.

Socioeconomic characteristics of the respondents by simultaneous access to credit and cooperative services

The socioeconomic characteristics of the respondents by simultaneous access to credit and cooperative services are shown in Table 5. The independent sample t-test reveals that the socioeconomic characteristics of cocoa farmers who have simultaneous access to credit and cooperative services differ entirely from those who lack access to the services. This suggests that cocoa farmers who have simultaneous access to credit and cooperative services are relatively older, experienced and spent quality time in school rather than those who did not. Farmers with simultaneous access to credit and cooperative services also achieve significantly higher farm size and productivity than those who are without simultaneous access. This result evidently shows the presence of selection bias and endogeneity in the selected sample. In the same vein, descriptive statistics shows that cocoa farmers with simultaneous access to credit and cooperative services have better

Table 6 Test for multicollinearity and heteroscedasticity

Variables	VIF	1/VIF
Age	1.42	0.702
Household size	1.23	0.810
Years of education	1.12	0.810
Years of farming experience	1.40	0.713
Farm size	1.27	0.787
Gender	1.08	0.929
Asset	1.16	0.864
Mean VIF	1.24	
Heteroscedasticity		
Test	X^2	P value
Breusch–Pagan (BP) test	0.02	0.897

Source: Field Survey (2018)

Table 7 Impact of credit access on cocoa productivity

Variables	Access to credit	Productivity with credit access	Productivity without credit access
Age	0.629*** (3.00)	0.131** (2.04)	0.087** (1.98)
Age^2	0.482*** (3.36)	0.425 (0.03)	0.056 (0.31)
Household size	−0.564*** (−2.80)	0.878** (2.07)	−0.778 (−0.81)
Years of education	0.378 (0.69)	0.382** (2.04)	0.101** (2.27)
Year of experience	0.120 (0.44)	0.135*** (2.69)	0.436 (1.14)
Farm size	0.695*** (3.55)	0.138*** (6.82)	0.090** (2.05)
Gender	0.482 (1.08)	1.310 (0.57)	0.330*** (2.68)
Asset	0.174 (0.51)	1.194*** (2.65)	0.159 (0.70)
Constant	0.166*** (3.01)	3.181*** (5.84)	1.790*** (5.49)
/lns0	0.336* (1.71)		
/lns1	0.898** (1.98)		
/r0	0.495 (0.48)		
/r1	1.070 (1.52)		
Sigma_ 0	1.400** (2.06)		
Sigma _1	2.455* (1.91)		
Rho_0	0.458** (2.25)		
Rho_1	0.492** (2.19)		
Observations	300	228	99

LR test of Indep. Eqns: Chi^2 (2) = 292.73 Prob > Chi^2 = 0.000

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

access to assets as compared to their counterparts without simultaneous access. Male cocoa farmers mostly have simultaneous access to credit and cooperative services.

Test for multicollinearity and heteroscedasticity

Multicollinearity refers to the presence of linear relationships among the explanatory variable captured in the model. In the presence of multicollinearity, the model yields wrong signs of coefficients, high standard errors of coefficients and high R^2 value even when the parameter estimates are not significant [95]. The variation inflation factor (VIF) for each variable was evaluated to check for multicollinearity. If the VIF exceeds 10, that variable is said to be highly collinear and can be excluded from the model. The result of the test is presented in Table 6. The result shows that the mean value is 1.24. The result further shows that none of the variables of the model has VIF greater than 10. This indicates that there is no problem of multicollinearity among the independent variables considered in the model. The result of heteroscedasticity test is also presented in Table 6. The Chi-square (0.02) is not statistically significant. This shows that the error terms across the observations have constant variance, and there is no problem of heteroscedasticity in the data set.

Impact of access to credit service on cocoa productivity

Table 7 reveals the impact of credit access on cocoa productivity. The likelihood ratio test (Chi^2 (2) = 292.73, $P > 0.000$) of the joint independence is significant. This shows that the three equations in the models are not jointly independent and should not be estimated disjointedly. The result, therefore, supports the use of ESRM to control for the selection bias and the issue of endogeneity in the sample. The correlation coefficients rho_1 and rho_2 of the ESRM are both positive and statistically significant. This shows that the farmers with credit access achieve above-average productivity regardless of whether they actually have access to credit or not, however, they are better off when they have access to credit; whereas farmers without access to credit have below-average productivity in either case, but would be better off when they have access to credit.

The impact of access to credit service on cocoa productivity is assessed in two stages, the first being the probit model. The model shows that age, age square, household size, and farm size significantly influence the probability of farmers' access to credit services. The coefficients of age, age square, and farm size have positive implications in that an increase in any of these variables may increase the probability of farmers gaining access to credit services. A reasonable explanation for the positive effect of age and age square on credit access could be ascribed to the fact that older farmers are more responsible and secure than their younger counterparts. Older farmers have integrity and would not likely default in loan repayment or spoil their

family's reputation. Furthermore, the square of age, which is a representation for old age, is positive and significant. This implies that the probability of credit access will still increase, even after the farmers have reached a certain age threshold, probably into old age. This finding supports the result of studies conducted by refs. [96–98].

Moreover, the positive effect of farm size on credit access could be ascribed to the fact that financial institutions presume that farmers with large farm sizes would own the capacity to manage loans with their associated risks and uncertainties, especially when these farmers possess a prescribed title. This suggests that such farmers are credit-worthy, which is an important factor for seeking financial assistance in order to put their resources to optimum use. This result is consistent with the findings of refs. [99–101]. Conversely, the coefficient of household size has a negative sign, which implies that an increase in this variable may decrease the probability of farmers gaining access to credit. This can be attributed to the fact that farmers with large families may be forced to divert part of their loans to household activities to ease the consumption pressure imposed by a large family. Hence, they may default on loan repayment. It is also possible that the economic activities of large households are enough to bring a net economic benefit to a household without seeking external assistance. This could be ascribed to the communal nature of the African system, which allows several members of a given family to live together and take part in the economic activities of the household. However, this finding confirms the findings of ref. [102] that households with more adults are likely to participate more in formal credit as it increases confidence to repay credit.

The second stage of the access to credit service model is the switching regression model. The results of the switching regression model of productivity among cocoa farmers with credit access and those without credit access are presented in the third and fourth columns of Table 7, respectively. Age, household size, years of education, years of experience, asset, and farm size significantly influence the cocoa productivity of farmers with credit access. The coefficients of age, household size, years of education, years of experience, asset and farm size have positive signs. This implies that an increase in any of these variables increases the cocoa productivity of farmers with credit access. In the same vein, age, years of education, farm size, and gender also have positive coefficients and are statistically significant in influencing the variation of cocoa productivity among farmers without credit access.

The reasonable explanation for a positive relationship between age and productivity is the fact that older farmers have better access to labour, land and first-hand information on enhancing their productivity than their younger counterparts. Older farmers are expected to have gathered experience about skills and practices and become experts in different management practices, hence improving their productivity over the years. This result is consistent with the findings of refs. [103–106]. Years of education has a positive relationship with cocoa productivity. This could be traced to the fact that education enables farmers to gain the necessary knowledge and skills to utilise existing technologies and boost their productivity. This is premised on the fact that investment in knowledge improves resource utilisation and, consequently, higher productivity [107]. This study is in line with the finding of refs. [104, 105, 108, 109]. Moreover, this study also found that household size has a positive effect on cocoa productivity, which is traced to the fact that the household members contribute significantly to supplying labour needed for farm work. This is premised on the fact that farmers in developing countries use family labour to reduce production cost and, consequently, increase cocoa productivity. This is in consonance with the findings of refs. [110–113], who posit that farmers with increased household size obtain higher yields because of the contribution of family labour.

The reasonable explanation for a positive relationship between farm size and productivity is that big-sized farms, especially those with secured tenure, could encourage farmers to adopt improved technologies to increase their farm productivity. Big-sized farms are expected to be more efficient than small-sized farms because of the large amount of timely financial resources on larger farms and its advantage of economies of scale. This can be explained by the fact that a large farm size increases the timeliness of input used and the managing ability of farmers. This aligns with studies by refs. [110, 114–117] that crop productivity is positively influenced by farm size. Therefore, this study supports the notion that large farms achieve significantly higher productivity than small farms. Gender also has a positive and statistically significant effect on productivity. This study submits that male-headed households achieve significantly higher productivity than female-headed households. Because of some sociocultural values and norms of Africans, males have freedom of mobility and participation in different organisations or meetings, consequently, they have greater access to information [118]. Gender division of labour also exists in African settings. In Africa, non-economic activities such as child care, cooking, cleaning, fetching firewood and other activities performed by females in a household affect their productivity. This finding is in line with [119] that female-headed households generate lower productivity than male-headed households.

Table 8 Results of impact models

Variable	Mean	Standard error	t-test
ATT	0.594	0.297	3.64***
IPWRA	0.413	0.131	2.76***

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

A plausible explanation for the positive relationship between farming experience and productivity could be attributed to the fact that a high number of years of experience enable farmers to make sound decisions regarding resource allocation and management of farm operations that are economically worthwhile and technically feasible. A farmer with more experience is expected to have acquired information and better knowledge in using available technologies and resources prudently in order to enhance his farm's productivity. This finding is in line with studies of ref. [120, 121] which claim that years of farming experience increases agricultural productivity in Nigeria. The result further reveals that households' social and wealth status in the form of access to assets has an important influence on productivity. This is premised on the fact that households with better access to assets can purchase any improved technology to enhance their productivity. This study agrees with the study of ref. [122], which states that social and wealth status of farmers is an important factor that drives the adoption of improved technologies. Accordingly, households with better access to assets are likely to be more productive.

Table 8 reveals that the mean ATT is 0.594. The t-test reveals that the ATT is statistically significant. This implies that farmers with access to credit achieve significantly higher cocoa productivity than those without access to credit. This could be based on the fact that credit availability may facilitate the timely acquisition of more production inputs or improved technologies like high-yielding seeds [123, 124]. Compared to the IPWRA (0.413), the results of the ESR model show a higher impact of credit access on cocoa productivity. The positive sign of rho means that unobservable variables that increase productivity correlate with unobservable variables that increase credit access. This study submits that the least productive farmers are more likely to secure access to credit services and invest the credit in cocoa production. In this case, failure to take endogeneity issues into account will result in underestimating the impact of access to credit service on cocoa productivity. Hence, the reason for obtaining a greater impact coefficient in the ESR model. Actually, cocoa farmers spend the accessed credit on intended purposes, such as the purchase of inputs for production, and consequently improve their productivity. This result corresponds with the finding of ref. [86, 125, 126] who conclude that farmers with access to credit contribute to improved farm productivity. However, the study contradicts the findings of [42] that access to credit has no significant contribution to farmers' productivity.

Impact of access to cooperative service on cocoa productivity

Table 9 reveals the impact of access to cooperative service on cocoa productivity. The likelihood ratio test ($Chi^2(2) = 441.90$, $P > 0.000$) of the joint independence was significant. It shows that the three equations in the model are not jointly independent and should not be estimated disjointedly. The result therefore supports the use of ESRM to control the selection bias and the issue of endogeneity. The correlation coefficients rho_1 and rho_2 of the ESRM are both positive and statistically significant. This shows that farmers who have access to cooperative service achieve above-average productivity and are better off than farmers who do not and have below-average productivity. The model is assessed in two stages, the first stage being the probit model. This model reveals that age, age square, household size, years of education and farm size significantly influence the probability of farmers gaining access to cooperative service. The coefficients of age, age square, household size, years of education and farm size have positive signs which implies that an increase in any of these variables may increase the probability of farmers gaining access to cooperative service.

A reasonable explanation for the positive effect of age and age square on the probability of farmers gaining access to cooperative service could be that older farmers are likely to join a cooperative society in order to secure a market for their increasing output or for old age reasons. Furthermore, some cooperative societies prefer older members because they seem to be more credible in group formations than their younger counterparts who tend to be more aggressive. On the other hand, older farmers may want to join cooperative societies to seek assistance because they may not be energetic enough to participate in other fund-generating activities. The study corroborates the studies of ref. [30, 36, 65, 127, 128] which state that the age of farmers positively and significantly relates to the decision to join cooperative societies. This study found that years of education positively affect the decision to join cooperative societies, which could be ascribed to the fact that education gives farmers the ability to understand the general benefits of joining a cooperative society. The finding concurs with the studies of ref. [58, 129, 130]. The study also finds that farm size has a positive influence on cooperative membership. The plausible explanation is that the production on large farms is significant enough to justify joining cooperative societies,

Table 9 Impact of access to cooperative services on cocoa productivity

Variables	Cooperative membership	Productivity of cooperative members	Productivity of cooperative non-members
Age	0.416*** (3.01)	0.146*** (2.75)	− 0.077* (− 1.82)
Age^2	0.785*** (4.57)	0.110** (2.07)	0.137*** (2.90)
Household size	0.148*** (3.81)	0.115*** (3.20)	− 1.697*** (− 12.10)
Years of education	0.303* (1.81)	0.509*** (3.01)	0.506*** (7.11)
Year of experience	0.417 (0.41)	0.260*** (2.78)	− 0.152 (− 0.56)
Farm size	0.291*** (3.55)	0.132 (1.50)	0.653*** (32.89)
Gender	0.161 (0.78)	0.375* (1.73)	5.960*** (6.09)
Asset	0.014 (0.08)	0.779*** (4.16)	− 0.248 (− 0.47)
Constant	1.052*** (3.67)	3.701*** (2.74)	2.247*** (2.77)
/lns0	0.565** (1.97)		
/lns1	0.856*** (3.67)		
/r0	0.901** (2.46)		
/r1	1.071*** (5.46)		
Sigma_ 0	2.354 (1.45)		
Sigma _1	0.991*** (4.98)		
Rho_0	1.093** (2.25)		
Rho_1	0.202** (2.05)		
Observations	300	201	99

LR test of Indep. Eqns: Chi^2 (2) = 441.90 Prob > Chi^2 = 0.000

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

and returns on membership of cooperative societies are greater than membership costs. In addition, farmers use large land assets as informal safeguards to join cooperative societies. The study is in agreement with [36, 37, 127, 130–133]. Household size also has a positive influence on membership of cooperative society. This can be explained by the fact that consumption pressure from household members may push farmers to join a cooperative society. The finding is in agreement with the studies of ref. [30, 130].

The second stage of the model for cocoa productivity is the switching regression model. The results of this model among farmers who have access to cooperative services and those who do not are presented in the third and fourth columns of Table 9, respectively. Age, age square, household size, years of education, years of experience, gender, and asset have positive coefficients and are statistically significant in influencing the cocoa productivity among farmers with access to cooperative services. This implies that an increase in any of these variables increases the cocoa productivity of farmers who are members of cooperative societies. However, age, age square, household size, years of education, farm size, and gender significantly influence the cocoa productivity among farmers who are not members of cooperative societies. The coefficients of age, age square, years of education, farm size and gender have positive signs. This implies that an increase in any of these variables increases the cocoa productivity among farmers who are not members of cooperative societies. However, the coefficient of household size has a negative sign, which implies that an increase in this variable decreases the cocoa productivity among farmers who are not members of cooperative societies. The plausible explanation for the relationship between these significant variables and cocoa productivity has been thoroughly stated in the previous section. However, the negative relationship between the household size and productivity could be ascribed to the fact that some parts of households' labour force have been diverted to non-farm activities in an attempt to earn more income to ease the consumption pressure imposed by a large family. This finding concurs with the studies of ref. [134, 135]. Furthermore, the study shows difference in the sign of impact of household size on cocoa productivity of co-operators and non-co-operators. This could be traced to the fact that agricultural cooperative societies through access to credit, trainings and exchange of ideas among members have a positive influence on the adoption of productivity-enhancing technologies [10–12]; whereas, agricultural household members of non-cooperator engage in non-farm activities in an attempt to secure access to credit which may take their interest away from farming and this negatively affects their productivity. Cooperative societies give no opportunity to the farmers' household members to engage in non-farm

Table 10 Results of impact models

Variable	Mean	Standard error	t-test
ATT	0.828	0.282	3.85***
IPWRA	0.736	0.398	2.68***

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

Source: Field Survey (2018)

activities because the societies provide services to households to ease production constraints which has direct influence on availability of family labour supply to undertake farm operation on time. The finding is in line with the result of ref. [136]. It is important to point out that the results of the impact of access to cooperative services on cocoa productivity are almost similar to the impact of access to credit service on cocoa productivity. As explained earlier, this shows that access to cooperative and credit services are not mutually exclusive and cooperative membership plays a mediating and hidden role between credit access and cocoa productivity.

Table 10 reveals a mean ATT of 0.828. The t-test reveals that the ATT is statistically significant. This implies that farmers who have access to cooperative services achieve significantly higher production than those who do not. Compared to the IPWRA (0.736), the results of the ESR model show a higher impact of access to cooperative services on cocoa productivity. The positive sign of rho means that unobservable variables that increase yields correlate with unobservable variables that increase access to cooperative services. This means that the least productive farmers are more likely to be members of cooperative societies and invest the services in cocoa production. In this case, failure to consider it will lead to underestimating the impact of access to cooperative services on cocoa productivity. This explains why we obtain a greater effect in the ESR model. This could be ascribed to the fact that cooperative societies provide an avenue to diffuse information on new technologies and provide input subsidies and credit services to their members. Therefore, a farmer who is a member of a cooperative society is more likely to adopt improved agricultural technologies and obtain credit. Cooperative societies also support their members in providing training on the production of crops. These kinds of support could increase the productivity of cooperative farmers. This finding is in line with the studies of refs. [38, 39, 41].

Simultaneous impact of access to credit and cooperative service on cocoa productivity

Table 11 reveals the impact of access to credit and cooperative services on cocoa productivity. The likelihood ratio test (Chi^2 (2) = 529.33, $P > 0.000$) of the joint independence is significant. It shows that the three equations in the model are not jointly independent and should not be estimated disjointedly. The result, therefore, supports

Table 11 Simultaneous impact of access to credit and cooperative membership on cocoa productivity

Variables	Credit access and cooperative membership	Productivity with credit access cooperative members	Productivity without credit access and cooperative non-members
Age	0.240*** (2.41)	0.978*** (2.68)	0.296** (2.15)
Age^2	0.316 (0.99)	0.716 (1.08)	0.678 (0.77)
Household size	0.285*** (3.05)	0.274*** (5.32)	−0.162*** (−2.10)
Years of education	0.337*** (4.99)	0.685*** (3.72)	0.499 (0.38)
Year of experience	0.754 (0.17)	0.738** (2.39)	0.413 (0.22)
Farm size	0.509 (1.16)	0.655 (0.23)	0.846*** (7.40)
Gender	0.277*** (3.94)	0.665 (1.50)	0.359 (0.25)
Asset	0.209 (1.35)	0.471 (1.17)	0.180*** (6.25)
Constant	1.676** (2.29)	1.457*** (2.90)	1.568*** (3.94)
/lns0	0.372** (3.08)		
/lns1	0.569*** (6.16)		
/r0	0.625** (2.25)		
/r1	1.601*** (9.48)		
Sigma_ 0	1.641** (2.09)		
Sigma _1	0.514 (1.26)		
Rho_0	1.518** (4.39)		
Rho_1	0.296** (6.13)		
Observations	300	201	99

LR test of Indep. Eqns: Chi^2 (2) = 529.33 Prob > Chi^2 = 0.000

the use of ESRM to control for the selection bias and the issue of endogeneity. The correlation coefficients rho_1 and rho_2 of the ESRM are both positive and statistically significant. This shows that farmers who have access to credit and cooperative services achieve above-average productivity and are better off than farmers who do not have access to credit and cooperative services and have below-average productivity. The model is assessed in two stages, the first stage being the probit model. This model reveals that age, household size, years of education, and gender significantly influence the probability of farmers gaining access to credit and cooperative services. The coefficients of age, household size, years of education, and gender have positive signs which implies that an increase in any of these variables may increase the probability of farmers gaining access to credit and cooperative services.

The reasonable explanation for a positive effect of age on simultaneous access to credit and cooperative services is that the ability to access credit and participate in cooperative society increases as the household head grows older. This is because older farmers may source external funds to invest in agricultural-related activities and secure a market for their increasing output. Also, they could understand the importance of cooperative societies and actively engage in the commitments and activities shared in the societies. This result contradicts the findings of [137, 138] that age had a significant but negative effect on accessing credits. The finding supports other studies such as [30, 36, 65, 130, 139–141]. The positive effect of gender on simultaneous access to credit and cooperative services suggests that the male farmers are very much endowed with resources which serve as collateral security in accessing the formal credit and participating in cooperative societies. Thus, male respondents gain better access to credit, and they are likely to join a cooperative society since men generally undertake less reproductive functions. This finding corroborates the findings of [132, 142]. The formal education of respondents has a positive and significant influence on access to credit and cooperative services. This is ascribed to the fact that farmers who attain the high level of education are more able to accumulate and have better knowledge on access to the credit [143, 144], as well as ability to cope with the procedure to participate in cooperative society and understand the benefits of cooperative societies [129, 130]. The possible explanation for a positive effect of household size on simultaneous access to credit and cooperative services is that as farmers' household size increases, the consumption requirements also increase, and as a result of this, there is pressure on limited resources. Therefore, households with more household members have high credit demand and chances of being members of cooperative societies in order to enlarge their limited resources and meet their households' consumption requirements. This finding concurs with the studies of [30, 130, 145]. The finding also contradicts that of [133].

Table 12 Results of Impact models

Variable	Mean	Standard error	t-test
ATT	0.978	0.685	4.41***
IPWRA	0.915	0.585	3.98***

***, ** &* represent significance levels at 1%, 5% & 10%, respectively

The second stage of the model for cocoa productivity is the switching regression model. The results of this model among farmers who have simultaneous access to credit and cooperative services and those who do not have access to credit and cooperative services are presented in the third and fourth columns of Table 11, respectively. Age, household size, years of education, and years of experience have positive coefficients and are statistically significant in influencing cocoa productivity among farmers who have access to credit and cooperative services. This implies that an increase in these variables increase the cocoa productivity of farmers who have access to credit and cooperative services. However, age, household size, farm size, and asset significantly influence the cocoa productivity among farmers who do not have simultaneous access to credit and cooperative services. The coefficients of age, farm size and asset have positive signs. This implies that an increase in any of these variables increases cocoa productivity among farmers who do not have simultaneous access to credit and cooperative services. However, the coefficient of household size has a negative sign, which implies that an increase in this variable decreases the cocoa productivity among farmers who do not have simultaneous access to credit and cooperative services. The previous section has thoroughly stated the plausible explanation for the relationship between these significant variables and cocoa productivity. As explained earlier, this shows that access to credit and cooperative services is not mutually exclusive and both services simultaneously have a significant impact on cocoa productivity.

The farmers who simultaneously accessed both credit and cooperative services have higher productivity than the other categories of farmers considered in this study (Table 12). ESRM results reveal a mean ATT of 0.978. The t-test reveals that the ATT is statistically significant. This implies that farmers who have access to credit and cooperative services achieve significantly higher productivity than those who do not have access to credit and cooperative services. Compared to the IPWRA (0.915), the results of the ESR model show a higher impact of access to credit and cooperative services on cocoa productivity. The result further shows that the farmers who simultaneously accessed both services obtain

much higher productivity than those who accessed the services separately or farmers who do not have access to both services at all. The higher productivity in all estimations was highly significant. Therefore, simultaneous access to credit and cooperative services has increased and this has a far much higher impact on cocoa farmers' productivity.

This study investigates the simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria. A multistage sampling procedure is used to obtain data for the study. Data are analysed by using descriptive statistics, IPWRA and the ESRM. This paper uses IPWRA and ESRM approaches to provide causally interpretable results. Descriptive statistics reveals the statistical difference between cocoa farmers with access to credit and cooperative services and those without such access, in terms of the variables such as age, age square, years of formal education, farm size and productivity. This is an indication of selection bias in the sample. In terms of access to credit service model, the results of the first stage of the ESRM (probit model) shows that age, age square, household size and farm size significantly influence the probability of farmers' access to credit. The results of the second stage of the ESRM shows that age, household size, years of education, years of experience, asset and farm size significantly influence the cocoa productivity of farmers with access to credit. Similarly, age, years of education, farm size, and gender have positive coefficients and are statistically significant in influencing the variation of cocoa productivity among the farmers without access to credit. The t-test of ATT reveals that farmers with access to credit achieve significantly higher cocoa productivity than those without access to credit. In terms of access to cooperative service model, the results of the first stage of the ESRM (probit model) shows that age, age square, household size, years of education and farm size significantly influence the probability of farmers being members of cooperative societies. The results of the second stage of the ESRM shows that age, age square, household size, years of education, years of experience, gender and asset have positive coefficients and are statistically significant in influencing the variation of cocoa productivity among the farmers who are members of cooperative societies. Conversely, age, age square, household size, years of education, farm size and gender significantly influence the cocoa productivity of farmers who are not members of cooperative societies. The t-test of ATT reveals that farmers who are members of cooperative societies achieve significantly higher cocoa productivity than those who are not members. This study has further shed light on simultaneous effect of access of cooperative and credit services on cocoa productivity. In terms of simultaneous access to credit and cooperative service model, age, education, gender and household size significantly influence the probability of farmers simultaneously having access to credit and cooperative services. The results of the second stage of the ESRM showed that age, household size, years of education, and years of experience significantly influence cocoa productivity among farmers who have access to credit and cooperative services. However, age, household size, farm size and asset significantly influence the productivity of farmers who do not have access to credit and cooperative services. ATT reveals that farmers who have access to credit and cooperative services achieve far more productivity than farmers who are cooperative members and have access to credit separately; and the set of farmers who do not have access to credit and cooperative services. This result implies that simultaneous access to credit and cooperative services has a stronger and far more significant impact on cocoa productivity. Our findings are consistent with previous studies such as [16, 55, 56, 146], which report significant impact of access to credit and cooperative services on the livelihood of farmers in developing countries. However, the impact is more pronounced in the case of simultaneous access to credit and cooperative services. Therefore, to have a greater impact, credit services should be bundled with cooperative services. The study recommends that simultaneous access to credit and cooperative services to cocoa farmers should be reinforced, for instance, a microcredit scheme through rural cooperative societies should be launched to support cocoa farmers in Nigeria. Owing to the fact that credit access stimulates both productivity and production [146], cocoa farmers should be encouraged to join cooperative societies of their choice in order to access credit and improve their productivity. Accordingly, future development policies should seek to simultaneously address cooperative and credit services to enhance the livelihood of farmers. These polices should aim at expanding cooperative institutions' credit portfolio to embrace cocoa farmers. In addition, financial institutions should supply agricultural credit to small-scale farmers at low interest rate and the terms and conditions should be made easy and flexible. However, the study primarily focuses on the simultaneous impact of access to credit and cooperative services on cocoa productivity in the study area. The same study should be encouraged in other zones of the country. A study should be conducted on the simultaneous impact of access to credit and cooperative services on food security, poverty and assets acquisition in the area.

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Authors' contributions
ADK applied statistical, mathematical, computational and other formal techniques to analyse and synthesize study data; he also prepared and formatted the manuscript. The formulation or evolution of overarching research goals and aims was done by AAO. He designed the methodology and identification of models. Both authors read and approved the final manuscript.

Authors' agreement
We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for

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Declarations

Ethics approval and consent to participate
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Consent for publication
The authors transfer to *Journal of Agriculture and Food Security* the non-exclusive rights to publish our manuscript.

Competing interests
The authors declare that they have no competing interests.

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References

1. Nkang NM, Ajah EA, Abang SO, Edet EO. Investment in cocoa production in Nigeria: a cost and return analysis of three cocoa production management systems in the cross river state cocoa belt. Afr J Food Agric Nutr Devel. 2009;9:713–27.
2. Arene CJ, Nwachukwu EC. Response of cocoa export market to climate and trade policy changes in Nigeria. J Agric Sustain. 2013;4(2):245–77.
3. Folayan JA, Daramola GA, Oguntade AE. Structure and performance evaluation of cocoa marketing institutions in South Western Nigeria. Econ Soc Stud. 2006;42(1):113–20.
4. Amos TT. An analysis of productivity and technical efficiency of smallholder cocoa farmers in Nigeria. J Soc Sci. 2007;15(2):127–33.
5. FAO. Production data base for Nigeria. 2011.
6. FAOSTAT. Retrieved from http://faostat.fao.org. 2016.
7. International Cocoa Organization (ICCO). Quarterly Bulletin of Cocoa Statistics. 2018; 19 (4).
8. Adeleke OA, Adesiyan OI, Olaniyi OA, Adelalu KO, Matanmi HM. Gender differentials in the productivity of cereal crop farmers: a case study of maize farmers in Oluyole Local Government Area of Oyo State. Agric J. 2008;3:193–8.
9. Folorunso ST. Impact of Fadama III on Productivity, Food Security and Poverty Status of Tuber Farmers in Central States of Nigeria. Ph.D. Ahmadu Bello University, Zaria. 2015.
10. Liverpool-Tasie LS, Kuku O, Ajibola A. A Review of Literature on Agricultural Productivity, Social Capital and Food Security in Nigeria. NSSP Working Paper No. 21. https://www.ifpri.org; 2011.
11. Oke JTO, Kehinde AD, Akindele AJ. Determinants of access to credit by cocoa farmers in Osun state Nigeria. Int J Agric Res Innov Tech. 2019;9(2):57–61.
12. Moahid M, Khan GD, Yoshida Y, Joshi NP, Maharjan KL. Agricultural credit and extension services: does their synergy augment farmers' economic outcomes? Sustainability. 2021;13:3758.
13. Mukasa AN, Simpasa AM, Salami AO. Credit Constraints and Farm Productivity: Micro-Level Evidence from Smallholder Farmers in Ethiopia; African Development Bank: Abidjan, Côte d'Ivoire, 2017.
14. Jing W, Khan I, Channa A, Magsi H. Farm level impacts of credit constraints on agricultural investment and income. Pak J Agric Sci. 2019;52:511–21.
15. Ige AO, Adeyemo R. Differentials in poverty levels of cocoa farmer cooperators and non-cooperators in Southwestern Nigeria. Int J Commun Cooper Stud. 2019;7:17–29.
16. Masaood M, Maharjan KL. An exploration of the informal credit practices for agriculture in Afghanistan: reasons for availing informal and not availing formal credit. J Int Dev Coop. 2020;26:95–108.
17. Omonona BT, Udoh EJ, Adeniran AA. Poverty and its determinants among nigerian farming households: evidence from Akinyele LGA of Oyo State Nigeria. Eur J Soc Sci. 2008;6(3):402–13.
18. Akinlade RJ, Adeyonu AG, Carim-Sanni A. Income inequality and poverty among farming households in Southwest Nigeria. Int J Agric Econ Rural Devel. 2015;7(1):59–66.
19. Ugbajah M, Ugwumba C. Analysis of micro credit as a veritable tool for poverty reduction among rural farmers in Anambra State. Nigeria Discourse J Agric Food Sci. 2013;1(10):152–9.
20. Alao TB, Bamire AS, Kehinde AD. Gender analysis of agricultural financing in cocoa-based farming system in Oyo and Osun States of South Western Nigeria. Ghana Jnl Agric Sci. 2020;55(1):34–42.
21. Ogunleye AS, Adeyemo R, Bamire AS, Kehinde AD. Assessment of profitability and efficiency of cassava production among government and non-government assisted farmers association in Osun State Nigeria. Afr J Rural Dev. 2017;2(2):225–33.
22. Katungi EM. Social Capital and Technology Adoption on Small Farms: The Case of Keenan D P, Olson C, Hersey JC and S M Parmer, "Measures of Food Insecurity/ Security. J Nutr Educ. 2007;33(1):49–58.
23. Persson S. Organizational Constraints in Rural Development Causes of Different Performance among Ugandan Cooperatives. M.Sc: Lund University; 2010.
24. Toluwase SOW, Apata OM. Impact of Farmers' Cooperative on Agricultural Productivity in Ekiti State Nigeria Greener. J Agric Sci. 2013;3(1):063–7.
25. Yamusa I, Adefila JO. Farmers' Cooperatives and Agricultural Development in Kwali Area Council Federal Capital Territory Abuja, Nigeria. Int J Human Soc Sci. 2014;4(7):1.
26. Arcas-Lario N, Martín-Ugedo JF, Mínguez-Vera A. Farmers' satisfaction with fresh fruit and vegetable marketing Spanish cooperatives: An explanation from agency theory. Int Food Agribusiness Manag Rev. 2014;17(1):127–46.
27. Wollni M, Zeller M. Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica. Agric Econ. 2007;37:243–8.
28. Arnould EJ, Plastina A, Ball D. Market disintermediation and producer value capture: the case of fair-trade coffee in Nicaragua, Peru, and Guatemala Product and Market development for subsistence marketplaces. Adv Int Manag. 2007;20:319–40.
29. Nwankwo UM, Peters KJ. Bokelmann, W. Can cooperative membership and participation affect adoption decisions? Issues for sustainable biotechnology dissemination. AgBioForum. 2009; 12 (3–4):437–451.
30. Bernard T, Spielman DJ. Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia. Food Policy. 2009;34(1):60–9.
31. Markelova H, Mwangi E. Collective action for smallholder market access: evidence and implications for Africa. Rev Policy Res. 2010;27(5):621–40.
32. Abate GT, Francesconi GN, Getnet K. Impact of agricultural cooperatives on smallholders' technical efficiency: empirical evidence from Ethiopia. Ann Public Coop Econ. 2014;85(2):257–86.
33. Hellin J, Lundy M, Meijer M. Farmer organization, collective action and market access in Meso-America. Food Policy. 2009;34(1):16–22.
34. Trebbin A. Linking small farmers to modern retail through producer organizations—experiences with producer companies in India. Food Policy. 2014;45:35–44.
35. Baden S, Pionetti C. Women's collective action in agricultural markets: synthesis of preliminary findings from Ethiopia, Mali, and Tanzania. Oxfam Policy Pract Agric Food Lands. 2011;11(7):70–126.
36. Asante B, Sefa V, Saprong D. Determinants of Small-Scale Farmers' Decision to Join a Farmer Based Organizations in Ghana CSIR-Crops Research Institute. Afr J Agric Res. 2011;6(10):2273–9.

37. Bagher A. Identifying the factors affecting the participation of agricultural cooperatives' members. Am J Agric Biol Sci. 2011;4(6):560–6.
38. Okwoche VA, Osogura BC, Ckukwudi P. Evaluation of agricultural credit utilization by cooperative farmers in Benue State of Nigeria. Eur J Econ Finance Adm Sci. 2012;47:123–33.
39. Kumar VK, Wankhede G, Gena HC. Role of cooperatives in improving livelihood of farmers on sustainable basis. Am J Educ Res. 2015;3(10):1258–66.
40. Osterberg P, Nilsson J. Members' perception of their participation in the governance of cooperatives: the key to trust and commitment in agricultural cooperatives. Agribusiness. 2007;25(2):181–97.
41. Nkechi C, Uchenna C. Effects of membership of cooperative organisation and determinants of farmer-members' income in rural Anambra State, Nigeria. Int J Sci Technol Res. 2015;4(8):28–35.
42. Nakano Y, Magezi EF. The impact of microcredit on agricultural technology adoption and productivity: evidence from randomized control trial in Tanzania. World Dev. 2020;133:104997.
43. Makate C, Makate M, Mutenje M, Mango N, Siziba S. Synergistic impacts of agricultural credit and extension on the adoption of climate-smart agricultural technologies in southern Africa. Environ Dev. 2019;32:100458.
44. Central Bank of Nigeria. Annual Report and Statement of Account. CBN. 2007
45. Adetunji MO, Olaniyi OA, Raufu MO. Assessment of benefits derived by cocoa farmers from cocoa development unit activities of Oyo State. J Human Ecol. 2007;22(3):211–4.
46. Adeogun S, Olawoye J, Akinbile W. Information Sources to Cocoa Farmers on Cocoa Rehabilitation Techniques (CRTs) in Selected States of Nigeria. J Media Commun Stud. 2010;2(1):9–15.
47. Iremiren GO. Soil fertility and ageing cocoa farms in Nigeria. WCF Partnership Meeting and Round Table Session, Accra. 2011;26–27:16.
48. FAO. Statistics Cocoa Production. Agricultural production data. Food and Agricultural Organization. 2020.
49. Fadipe AEA, Adenuga AH, Ilori TE. Economic Analysis of Cocoa Production in Oyo State Nigeria. Nigerian J Agric Food Environ. 2012;8(4):58–63.
50. Kehinde AD, Tijani AA. Effect of Access to Livelihood Capitals on the Adoption of European Union (EU) approved pesticides among cocoa-producing households in Osun State Nigeria. Agric Trop Subtrop. 2011;54:57–70.
51. Kokoye SEH, Tovignan SD, Yabi JA, Yegbemey RN. (2013), "Econometric modeling of farm household land allocation in the municipality of Banikoara in Northern Benin." Land Use Policy. 2013;34:72–9.
52. Saqib SE, Ahmad MM, Panezai S. Landholding size and farmers' access to credit and its utilisation in Pakistan. Dev Pract. 2016;26:1060–71.
53. Afrin S, Haider MZ, Islam MS. Impact of financial inclusion on technical efficiency of paddy farmers in Bangladesh. Agric Financ Rev. 2017;77:484–505.
54. Chandio AA, Jiang Y, Wei F, Guangshun X. Effects of agricultural credit on wheat productivity of small farms in Sindh, Pakistan: are short-term loans better? Agric Financ Rev. 2018;78:592–610.
55. Silong AKF, Gadanakis Y. (2019), "Credit sources, access and factors influencing credit demand among rural livestock farmers in Nigeria. Agric Financ Rev. 2019;80(1):68–90.
56. Duy VQ, Neuberger D, Suwanaporn C. Access to credit and rice production efficiency of rural households in the Mekong Delta". Sociol Anthropol. 2015;3:425–33.
57. Motsoari C, Cloete PC, Van Schalkwyk HD. An analysis of factors affecting access to credit in Lesotho's smallholder agricultural sector. Dev South Afr. 2015;32(5):592–602.
58. Verhofstadt E, Maertens M. Can agricultural cooperatives reduce poverty? Heterogeneous impact of cooperative membership on farmers' welfare in Rwanda. Appl Econ Perspect Policy. 2014;37(1):86–106.
59. Chandio AA, Magsi H, Rehman A, Sahito JGM. Types Sources and Importance of Agricultural Credits in Pakistan. J Appl Environ Biol Sci. 2017;7(3):144–9.
60. Ma W, Abdulai A. (2016), "Linking apple farmers to markets determinants and impacts of marketing contracts in China." China Agric Econ Rev. 2016;8(1):2–21. https://doi.org/10.1108/CAER-04-2015-0035.
61. Nigussie Z. Performance Evaluation of Coffee Marketing Cooperatives Union: The case of Chercher Oda Balttom Cooperative Union, West Haraghe, Oromia Region, Ethiopia, Maters Thesis, Department of Cooperative Studies, Makelle University, Ethiopia; 2013.
62. Joitsa A, Musima O, Yambene H. Cooperative movements in the Western Highlands of Cameroon. J Alpine Res. 2015. https://doi.org/10.4000/rga.2764.
63. Zeuli K, Cropp R. Cooperatives: Principles and practices in the 21st Century. http://learningstore.uwex.edu/assets/pdfs; 2004.
64. Birchall J, Ketilson L. Resilience of the Cooperative Business Model in Times of Crisis, Sustainable Enterprise Programme. Geneva, Switzerland: International Labour Organization; 2009.
65. Azmah O, Fatimah K, Rohana J, Rosita H. Factors influencing cooperative membership and share increment: an application of the logistic regression analysis in the Malaysian cooperatives. World Rev Business Res. 2012;2(5):24–35.
66. Ito J, Bao Z, Su Q. Distributional effects of agricultural cooperatives in China: exclusion of smallholders and potential gains on participation. Food Policy. 2012;37(6):700–9.
67. Birchall J, Simmons R. The role of cooperatives in poverty reduction: network perspectives. J Socio-Econ. 2008;37:2131–40.
68. Bernard T, Abate G, Lemma S. Agricultural cooperatives in Ethiopia: results of the 2012 ATA baseline survey. Washington, DC: International Food Policy Research Institute; 2013.
69. Divine M. Evaluation of factors influencing membership in coffee cooperatives in Huye district, Rwanda," 2014
70. Frederick D. Co-ops 101: An Introduction to Cooperatives U.S. Department of Agriculture, Rural Business -Cooperative Service Division, Cooperative Information Report 55; 1997. http://www.rurdev.usda.gov/rbs/pub/cir55/cir55rpt.htm Accessed 14 Aug 2018.
71. Maddala GS, Nelson FD. Switching Regression Models with Exogenous and Endogenous Switching. In: Proceedings of the American Statistical Association, Business and Economics Section. 1975; (5):423–426.
72. Kimutai BD, Chepchumba RT. Determinants of small-scale horticulture farmers' decision to join farmer-based organizations in Nandi County, Kenya. J Econ Commerce Manag. 2016;4(4):1171–84.
73. Nugussie Z. Why some rural people become members of agricultural cooperatives while others do not. J Dev Agric Econ. 2009;2(4):138–44.
74. Ouma E, Abdulai A. Contributions of social capital theory in predicting collective action behavior among livestock keeping communities in Kenya. Paper presented at the proceedings of International Association of Agricultural Economists Conference, Beijing (pp. 1–18). 2009.
75. NBS, National Bureau of Statistics. Nigerian Gross Domestic Product Report. 2017.
76. NBS, National Bureau of Statistics. The Nigeria Poverty Profile Report. 2010.
77. Lee LF. Unionism and wage rates: a simultaneous equations model with qualitative and limited dependent variables. Int Econ Rev. 1978;19(2):415–33.
78. Hausman JA. Specification and Estimation of Simultaneous Equation Models. In: Handbook of Econometrics. 1983; 1, 391–448.
79. Maddala GS. Limited Dependent and Qualitative Variables in Econometrics. Cambridge: Cambridge University Press; 1983.
80. Freeman HA, Simeon KE, Jabbar MA. Credit constraints and smallholder dairy production in the East African highlands: application of a switching regression model. Agric Econ. 1998;19:33–44.
81. Lokshin M, Sajaia Z. Maximum likelihood estimation of endogenous switching regression models. Stand Genomic Sci. 2004;4(3):282–9.
82. Nyangena W, Köhlin G. Estimating Returns to Soil and Water Conservation Investments: An Application to Crop Yield in Kenya. Environment for Development Discussion Paper Series. 2008; EfD DP 08–32.
83. Asfaw S, Mithöfer D, Waibel H. (2010). What Impact Are EU Supermarket Standards Having on Developing Countries' Export of High-Value Horticultural Products? Evidence from Kenya. J Int Food Agribus Market. 2010; 22 (3–4):252–276.
84. Aravindakshan S, Rossi F, Amjath-Babu TS, Veettil PC, Krupnik TJ. Application of a bias-corrected meta-frontier approach and an endogenous switching regression to analyze the technical efficiency of conservation tillage for wheat in South Asia. J Prod Anal. 2018;49(2–3):153–71.
85. Alene AD, Manyong VM. The effects of education on agricultural productivity under traditional and improved technology in Nigeria: an endogenous switching regression analysis. Emp Econ. 2007;32:141–59.

86. Awotide BA, Abdoulaye T, Alene A, Manyong VM, Impact of Access to Credit on Agricultural Productivity: Evidence from Smallholder Cassava Farmers in Nigeria. In: International Conference of Agricultural Economists (ICAE). August 9–14, 2015, Milan, Italy.
87. Ogunleye AS, Kehinde AD, Kolapo A. Effects of Social Capital on Income of Cocoa Farming Households in Osun State Tanzania. J Agric Sci. 2020;19(2):131–7.
88. Ogunleye AS, Adeyemo R. Social capital networks, microcredit and poverty status of rural households in Nigeria. J Agribus Rural Dev. 2020;4:369–78.
89. Kehinde AD, Adeyemo R, Ogundeji AA. Does Social Capital improve Farm Productivity and Food Security? Evidence from Cocoa-based farming Households in South-western Nigeria. Heliyon. 2021;7(3):1–14.
90. Robins J, Sued M, Lei-Gomez Q, Rotnitzky A. Comment: performance of double robust estimators when "inverse probability" weights are highly variable. Stat Sci. 2007;1:544e559.
91. Wooldridge JM. Cluster-sample methods in applied econometrics. Am Econ Rev. 2003;93:133–8.
92. Kuwornu JKM, Amoah E, Seini W. Technical efficiency analysis of maize farmers in the Eastern Region of Ghana. J Soc Dev Sci. 2013;4(2):84–99.
93. Wooldridge JM. Inverse probability weighted estimation for general missing data problems. J Econ. 2007;141(2):1281e1301.
94. Tadesse M. Fertilizer adoption, credit access, and safety nets in rural Ethiopia. Agric Financ Rev. 2014;74(3):290–310.
95. Wossen T, Abdoulaye T, Alene A, Haile MG, Feleke S, Olanrewaju A, Manyong V. Impacts of extension access and cooperative membership on technology adoption and household welfare. J Rural Stud. 2017;54:223–33.
96. Hananu B, Abdul-Hanan A, Zakaria H. Factors influencing agricultural credit demand in Northern Ghana. Afr J Agric Res. 2015;10(7):645–52.
97. Goldstein M, Udry C. The profits of power: land rights and agricultural investment in Ghana. J Polit Econ. 2008;116(6):981–1022.
98. Guirkinger C, Boucher SR. Credit constraints and productivity in peruvian agriculture. Agric Econ. 2008;39(3):295–308.
99. Ayamga M, Dzanku F. The land rights and farm investment Ghana: the missing link in the operationalisation of tenure security. In: 4th International Conference of the African Association of Agricultural Economists. September 22–25, 2013, Hammamet, Tunisia, 4 (9):1–22.
100. Gujarati ND. Basic Econometrics. 3rd ed. Singapore: McGraw-Hill; 1995.
101. Asogwa BC, Abu O, Ocheche GE. Analysis of Peasant Farmers" Access to Agricultural Credit in Benue State, Nigeria. Br J Econ Manag Trade. 2014;4(10):1525–43.
102. Moahid M, Maharjan KL. Factors affecting farmers' access to formal and informal credit: evidence from rural Afghanistan. Sustainability. 2020;12(3):1268.
103. Mesay Y, Tesfaye S, Bedada B, Fekadu F, Tolesa A, Dawit A. Source of technical inefficiency of smallholder wheat farmers in selected waterlogged areas of Ethiopia. Afr J Agric Res. 2013;8(29):3930–40.
104. Solomon B. Technical efficiency of major crops in Ethiopia: stochastic frontier model. M.Phil: University of Oslo; 2014.
105. Zinabu T. Analysis of technical efficiency of teff producer farmers in Raya Kobo district. Amhara National Regional State, Ethiopia. 2016.
106. Agboola WL, Yusuf SA, Oloniniyi MT. Effect of social capital and access to microcredit on productivity of arable crop farmers in Kwara State, Nigeria. J Agric Vet Sci. 2016;9(20):9–16.
107. Solís D, Bravo-Ureta BE, Quiroga RE. Technical efficiency among peasant farmers participating in natural resource management programmes in Central America. J Agric Econ. 2009;60(1):202–19.
108. Bamlaku AA, Nuppenau EA, Boland H. Technical efficiency of farming systems across agro-ecological zones in Ethiopia: an application of stochastic frontier analysis. Agric J. 2007;4:202–7.
109. Benin S, Smale M, Pender J, Gebremedhin B, Ehui S. The economic determinants of cereal crop diversity on farms in the Ethiopian highlands. Agric Econ. 2004;31(2–3):197–208.
110. Wondimu T, Hassen B, Chaurasia SPR. Determinants of technical efficiency in maize production: the case of smallholder farmers in Dhidhessa District, Illubabor Zone, Ethiopia. Published at proceeding of the 11th international conference of the Ethiopian economics Association, July 2014.
111. Shumet A. Analysis of technical efficiency of crop producing smallholder farmers in Tigray region, Ethiopia. Stochastic frontier analysis. Retrieved from http://mpra.ub.uni-muenchen.de/40461/. MPRA Paper No. 40461 posted 6, August 2012 13:41 UTC. 2011.
112. Okorie FC, Okeke I, Nnaji A, Chibo C, Pat-Mbano E. Evidence of climate variability in Imo State of Southeastern Nigeria. J Earth Sci Eng. 2012;2(9):544–53.
113. Danso-Abbeam G, Baiyegunhi LJS. Adoption of Agrochemical Management Practices among Smallholder Cocoa Farmers in Ghana. Afr J Sci Technol Innov Dev. 2017;9(6):717–28.
114. Tijani AA, Alimi T, Adesiyan AT. Profit efficiency among Nigerian poultry egg farmers: a case study of aiyedoto farm settlement, Nigeria. Res J Agric Biol Sci. 2006;2(6):256–61.
115. Rahman S. Whether crop diversification is a desired strategy for agricultural growth in Bangladesh? Food Policy. 2009;34(4):340–9.
116. Aboki E, Jongur AAU, Onu JI, Umaru II. Analysis of technical, economic and allocative efficiencies of cassava production in Taraba State, Nigeria. IOSR J Agric Vet Sci. 2013;5(3):19–26.
117. Abdallah AH. Agricultural credit and technical efficiency in Ghana: Is There a Nexus? Agric Financ Rev. 2016;76(2):309–24.
118. Odendo M, Obare G, Salasya B. Factors responsible for differences in uptake of integrated soil fertility management practices amongst smallholders in western Kenya. Afr J Agric Resource. 2009;4(11):1303–11.
119. Sisay D. Agricultural technology adoption, crop diversification and efficiency of maize-dominated smallholder farming system in Jimma Zone. Southwestern Ethiopia. Ph.D: Haramaya University; 2016.
120. Ogundele OO, Okoruwa VO. Technical efficiency differentials in rice production technologies in Nigeria, African Economic Research Consortium research paper 154, Nairobi: AERC. 2006.
121. Ajewole OC. Farmer's response to adoption of commercially available organic fertilizers in Oyo state Nigeria. Afr J Agric Res. 2010;5(18):2497–503.
122. Abdoulaye T, Wossen T, Awotide B. Impacts of improved maize varieties in Nigeria: ex-post assessment of productivity and welfare outcomes. Food Sec. 2018;10:369–79.
123. Daniel O. Analysis of production efficiency in Irish potato production in Kenya: the case of Nyandarua North district. M.Sc: Egerton University; 2009.
124. Bekele A. Technical efficiency variation for smallholder irrigated maize producers: a case study of Tibila surface water irrigation scheme. Ethiopia. M.Sc: Mekelle University; 2013.
125. Nosiru MO. Microcredits and agricultural productivity in Ogun State Nigeria. World J Agric Sci. 2010;6(3):290–6.
126. Bolarinwa KK, Fakoya EO. Impact of farm credit on farmers socio-economic status in Ogun State Nigeria. J Soc Sci. 2011;26(1):67–71.
127. Baffoe G, Matsuda H, Nagao M, Akiyama T. The dynamics of rural credit and its impacts on agricultural productivity: an empirical study in rural Ghana. OIDA Int J Sustain Dev. 2014;7(5):19–34.
128. Weber R, Musshoff O. Is agricultural microcredit really more risky? Evidence from Tanzania. Agric Finance Rev. 2012;72(3):416–35.
129. Mojo D, Fischer C, Degefa T. Social and environmental impacts of agricultural cooperatives: evidence from Ethiopia. Int J Sust Dev World. 2015;22(5):388–400.
130. Francesconi GN, Heerink N. Ethiopian agricultural cooperatives in an era of global commodity exchange: does organizational form matter? J Afr Econ. 2011;20(1):153–77.
131. Abebaw D, Haile MG. The impact of cooperatives on agricultural technology adoption: empirical evidence from Ethiopia. Food Policy. 2014;38(1):82–91.
132. Etwire PM, Dogbe W, Wiredu AN, Martey E, Etwire E, Owusu RK, Wahaga E. Factors influencing farmer's participation in agricultural projects: the case of the agricultural value chain mentorship project in the northern region of Ghana. J Econ Sustain Dev. 2013;4(10):36–43.
133. Hasen M, Mekonnen H. The impact of agricultural cooperatives membership on the wellbeing of smallholder farmers: empirical evidence from Eastern Ethiopia. Agric Food Econ. 2017;5(6):1–20.
134. Tizale CY. The dynamics of soil degradation and incentives for optimal management in the Central Highlands of Ethiopia. Ph.D: University of Pretoria; 2007.
135. Yirga CT. The dynamics of soil degradation and incentives for optimal management in Central Highlands of Ethiopia. Ph.D: University of Pretoria; 2007.

136. Ma W, Renwick A, Yuan P, Ratna N. Agricultural cooperative membership and technical efficiency of apple farmers in China: An analysis accounting for selectivity bias. Food Policy. 2018;81:122–32.
137. Obisesan A. Credit accessibility and poverty among small holder cassava farming households in south west Nigeria. Greener J Agric Sci. 2012;3(2):120–7.
138. Adegbite AJ, Adeleye AO. Determinants of Farmers' Access to Micro-Credit in Oyo State. Nigeria J Agric Res Devel. 2011;10:1.
139. Ma W, Abdulai A. The economic impacts of agricultural cooperatives on smallholder farmers in rural China. Agribusiness. 2017;00:1–15.
140. Gyau A, Mbugua M, Oduol J. Determinants of participation and intensity of participation in collective action: evidence from smallholder avocado farmers in Kenya. J Chain Netw Sci. 2016;16(2):147–56.
141. Hoken H, Su Q. Measuring the effect of agricultural cooperatives on household income: case study of a rice-producing cooperative in China. Agribusiness. 2018;34(4):831–46.
142. Balgah RA. Applying participatory rural appraisal to unlock gender group differences in some communities in rural Cameroon. Asian J Agric Exten Econ Sociol. 2016;12(3):1–11.
143. Duniya KP, Adinah I. Probit analysis of cotton farmers' accessibility to credit in northern Guinea savannah of Nigeria. Asian J Agric Exten Econ Sociol. 2015;4:296–301.
144. Ibrahim SS, Aliero HM. An analysis of farmers' access to formal credit in the rural areas of Nigeria. Afr J Agric Res. 2012;7:6249–53.
145. Nuryartono N. Credit rationing of farm households and agricultural production: empirical evidence in the rural areas of central Sulawesi Indonesia. Jurnal Manajemen Agribisnis. 2007;4:15–21.
146. Magazzino C, Mele M, Santeramo FG. Using an artificial neural networks experiment to assess the links among financial development and growth in agriculture. Sustainability. 2021;13:2828. https://doi.org/10.3390/asu13052828.
147. Fuglie KO, Bosch DJ. Economic and environmental implications of soil nitrogen testing: a switching-regression analysis. Am J Agr Econ. 1995;77(4):891–900.

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