Margin—The Journal of Applied Economic Research 14 : 2 (2020): 226–246
SAGE Publications Los Angeles/London/New Delhi/Singapore/Washington DC/Melbourne
DOI: 10.1177/0973801020904490

Access to Credit, Farm Productivity and Market Participation in Ghana: A Conditional Mixed Process Approach

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This study tests the hypothesis of whether credit impacts productivity, and whether productivity in turn impacts market participation under a simultaneous modelling framework of credit, productivity and market participation, which has not been pursued in the literature. Using data from the Ghana Living Standards Survey Round 6, we applied a conditional mixed process estimation technique to correct for selectivity bias and unobserved endogeneity. We find that credit positively impacts productivity, which in turn positively impacts market participation. Furthermore, other determinants such as roads, public transport, radio and phone, and compliance with extension advice positively influence productivity while availability of markets and multiple cropping in a season increase the decision to sell maize. These findings imply that the transmission mechanism to transform the subsistence nature of Ghanaian agriculture into a sector characterized by commercial agriculture is to enhance access to credit, which in turn would stimulate productivity, which in turn would enhance market engagement.

Keywords: *Access to Credit, Productivity, Market Participation, Conditional Mixed Process, Ghana*
JEL Classification: *Q12, Q13, Q14*

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1. Introduction

Ghana is principally an agrarian economy, as the majority of the country's labour force makes their living through agriculture. Specifically, about 45 per cent of the economically active population are into agriculture (GSS, 2014). In the rural areas, where agriculture is predominant, more than 60 per cent are engaged in the sector. The dominance of agriculture points to an obvious conclusion, namely the development of the Ghanaian economy is tied to the development of agriculture. Interestingly, agricultural policies crafted by various governments since independence indicate that the country is not oblivious to the fact that its development is inextricably linked to agricultural development.

A review of most agricultural policy documents (such as Accelerated Agricultural Growth and Development Strategy, Food and Agriculture Sector Development Policy [FASDEP] I and FASDEP II) shows that the concentration of government in its quest to develop agriculture lies in three key interlinked issues, namely, enhancing farmers' access to finance, boosting farm productivity and stimulating farmers access to markets. For example, the Ghana Commercial Agriculture Project developed by the Ministry of Food and Agriculture (MoFA) acknowledged the 'importance of graduating from a subsistence-based smallholder system to a sector characterized by a stronger market-based orientation based on a combination of productive smallholders', while the FASDEP II included among its strategies, boosting productivity of staple crops by providing farmers with access to productive resources such as credit and irrigation facilities. It also included a policy objective of enhancing smallholder farmer participation in domestic and international markets as a means of boosting their incomes. Further, the Government of Ghana (2010) indicated that the quest to boost agricultural performance should stimulate investments that improve and enhance market access.

The thinking is that access to credit by farmers would stimulate a reduction in capital and liquidity constraints and propel investments in farm enterprises through adopting modern technology, leading to productivity and output growth, and a subsequent stimulation of market engagement by farmers. Given that the proportion of sale is heavily dependent on the marketed surplus ratio (which is dependent on the excess of output over household consumption), output growth is indeed the surest way to stimulate agricultural commercialization.

There are numerous studies on credit by farm households in the literature and these studies, especially those on Africa, are based on evidence that the credit market is rife with failures. Such credit market failures are observed to be

occasioned by adverse selection and moral hazards (see, Akerlof, 1970; Stiglitz & Weiss, 1981), which in turn impose the need for credit institutions to screen credit applicants. Sekyi, Abu, and Nkegbe (2017) note that the screening and sorting behaviours of financial institutions are the underlying explanation for the dichotomous response from credit application: either an applicant secures the credit or otherwise. Therefore, if a set of farmers apply for credit, credit institutions screen the applications on the basis of personal, household, institutional factors among others, and determine those that qualify for credit. Several empirical studies have been devoted to understanding the socioeconomic factors that stimulate access to credit. For example, Akudugu, Egyir, and Mensah-Bonsu (2009), Dabone, Osei, and Petershie (2014), Etonihu, Rahman, and Usman (2013), Denkyirah, Aziz, Denkyirah, Nketiah, and Okoffo (2016) and Awotide, Abdoulaye, Alene, and Manyong (2015) examined the determinants of credit access using different estimation approaches.

In terms of empirical studies on agricultural productivity, the literature has concentrated on the relationship between farm size and productivity (Sekyi et al., 2017) and has generally found that small farms are more productive than large farms (see Barrett, Bellemare, & Hou, 2010; Kimhi, 2003; Larson, Otsuka, Matsumoto, & Kilic, 2012; Mazumdar, 1965). For example, the studies of Kimhi (2003) and Larson et al. (2012) showed that productivity responds negatively to increases in farm sizes. Barrett et al. (2010) noted that the inverse productivity–size relationship, in a class of development economics puzzles, represents one of the oldest. They identified two prominent justifications proffered to explain this puzzle: first, imperfections in the factor market induce cross-sectional variation in household-specific shadow prices and, second, the omission of soil quality measurements in empirical studies. However, beyond the inverse productivity–size relationship, there are other studies that explored other determinants of productivity. For example, Wiebe, Soule, and Schimmelpfennig (2001) found that educational status of farmers and research in agriculture are important determinants of productivity growth. Empirical evidence of determinants of market participation are varied and numerous. Key studies include Goetz (1992), Sadoulet, de Janvry, and Benjamin (1998), Key, Sadoulet, and de Janvry (2000), Holloway, Dorfman, and Ehui (2001), Holloway, Dorfman, and Ehui (2000), Makhura, Kirsten, and Delgado (2001), Fafchamps and Hill (2005), Bellemare and Barrett (2006), Barrett (2008) and Burke, Myers, and Jayne (2015).

We acknowledge numerous studies that have investigated the effect of credit on productivity and the pathways through which credit relates to agricultural productivity. For instance, Misra, Chavan, and Verma (2016), Lawal, Omonona, Ajani, and Oni (2009) and Duong and Izumida (2002) found that credit

enhances adoption of technology and subsequently boosting productivity and output growth. In Nigeria, Sogo-Temi and Olubiyo (2004) observed that credit promotes growth in agricultural output. Narayanan (2016) found that credit supports the purchases of farm inputs, but its impact on agricultural gross domestic product is weak. Similarly, Kumar, Mishra, Saroj, and Joshi (2017), reported positive effects of institutional credit on net farm income and per capita household consumption expenditure in India. Rehman, Chandio, Hussain, and Jingdong (2017) also found evidence to prove that credit increases agricultural gross domestic product in Pakistan. In their study in Pakistan, Chandio, Jiang, Wei, and Guangshun (2018) reported that agricultural credit has a positive impact on smallholder wheat productivity.

Other studies have examined how credit constraints impede technology adoption and agricultural productivity. Akudugu, Guo, and Dadzie (2012) and Foltz (2004) found that credit constraints stifle technology adoption. Ali, Deininger, and Duponchel (2014) demonstrated that elimination of credit constraints increases output in rural Rwanda. Mukasa, Simpasa, and Salami (2017) found similar evidence among smallholder farmers in Ethiopia indicating that the elimination of credit constraints induces productivity gains of up to 60 per cent. WoldeKidan, Hadush, and Gerezihar (2017) also reported that credit constraint decreases adoption of technology in South Ethiopia.

Also, there are several studies that have identified the role of productivity in stimulating the selling decisions of farmers. For example, Rios, Shively, and Masters (2009) observed that farm households who are more productive have higher market participation rates. In addition, Abu, Issahaku, and Nkegbe (2016) found that maize and groundnut farmers who have higher land productivity participate in the markets more than famers with low productivity. In a similar vein, Mekonnen (2017) provided evidence to show that the use of improved agricultural inputs has higher marketable surplus ratios.

However, there is no empirical evidence that tests, in a structural fashion, the composite transmission mechanism in most agricultural policies in Ghana: credit impacting productivity and productivity impacting market participation. The preceding empirical evidences of the effect of credit on productivity and the effect of productivity on market participation are standalone models. Therefore, this article seeks to employ an appropriate econometric technique to estimate the structural determinants of credit access, productivity and market participation and in the process determine the effect of credit on productivity, and the effect of productivity on market participation. Two main contributions are made in the process of pursuing the objective of this article. First, this article is the first attempt at structurally estimating the determinants of credit access, productivity and market participation as well

as indicating the effect of credit and productivity in a structural system. The gain in this empirical approach cannot be underestimated. Since the literature clearly shows that there are relationships between credit and productivity and then between productivity and market participation, more consistent and efficient impacts would be unravelled if these are estimated as a system. Second, this article contributes to the policy discourse in Ghana by empirically testing whether the vision of enhancing farmers' access to credit would transmit into higher productivity and whether higher productivity would trickle down to market participation. In this regard, this article has wide currency for policy engagement in Ghana, and other developing economies with similar characteristics.

We achieve the objectives of the study by using a nationally representative secondary dataset, the Ghana Living Standards Survey Round 6 (GLSS6) collected in 2012/2013 by the Ghana Statistical Service (GSS). We focus on maize farmers because it is the most widely produced staple in Ghana and has sufficient observations than any other crop in the dataset.

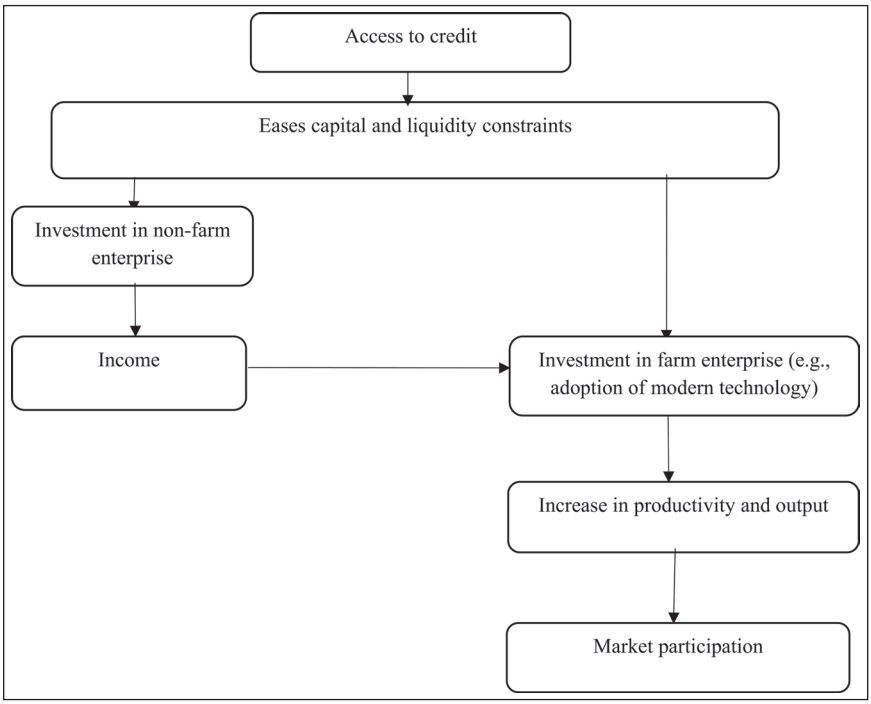
The rest of the article is organized as follows. The next section presents the methodology used to achieve the objectives of the study. Next, the results and corresponding discussions are presented, and the last section concludes and provides policy recommendations.

2. Methodology

2.1 Conceptual Framework

The conceptual framework underlying the main hypothesis of this study is presented in Figure 1. The figure provides the transmission mechanism of credit to productivity and productivity to market participation. It shows that the principal role of credit is the reduction of capital and liquidity constraints (see Misra et al., 2016). Thus, when farmers have access to credit, they become liquid to make investment decisions. Feder, Lau, Lin, and Luo (1990) noted the role of credit in easing liquidity constraints in Chinese agriculture through the observation that credit meets the cash needs of farmers. Misra et al. (2016) noted that credit influences output growth through making working capital available and smoothing consumption. When the capital and liquidity constraints are eased, farmers have two channels of investments—direct and indirect channels. The direct channel is the investment of the credit in farm enterprises. Thus, farmers make investments in modern technology (see Misra et al., 2016; Narayanan, 2016). The indirect channel is where farmers invest

Figure 1 Credit and Productivity Pathways to Market Participation



Source: The Authors.

credit in non-farm enterprises, which yield extra income. This income from non-farm enterprises can be used in purchasing modern technology. The combined effect of the direct and indirect channels of investments is an increase in productivity and output.

The link between credit and productivity has been established by studies such as Duong and Izumida (2002) and Lawal et al. (2009). Similarly, Foltz (2004) and Akudugu et al. (2012) observed that cash constraints limit farmers' technology adoption such as the use of improved inputs. Productivity and output gains help farmers to have marketable surplus with which they can then engage the market to dispose for income.

2.2 Econometric Model and Estimation

In this article, we define access to credit as farmers who applied for credit, the credit application approved and the farmer received the credit in the 2012–2013 production season. This conceptualization implies that farmers

who applied and did not receive the credit and those who did not apply at all are not considered as having access. Productivity is defined as yield of maize (that is, output per hectare of land cultivated to maize) in the 2012–2013 production season. Market participation is conceptualized as a farmer who sold a certain proportion of maize in the 2012–2013 production season. The interest is specifically on the decision to sell (market participation) and not on the quantity sold (level of commercialisation). Therefore, credit is a dummy variable, 1 representing a farmer who secured credit and 0 otherwise; market participation is a dummy variable, 1 representing a farmer who sold maize; and productivity is a continuous variable.

If we denote credit as CDT, productivity as PDT and market participation as MKP, and following the objective of this article, the following empirical models are to be estimated:

$$\mathrm{CDT}_i = \alpha_0 + \alpha_1 X_i + \epsilon_{1i} \tag{1}$$

$$\mathrm{PDT}_i = \beta_0 + \beta_1 X_i + \delta \mathrm{CDT}_i + \epsilon_{2i} \tag{2}$$

$$\mathrm{MKP}_i = \gamma_0 + \gamma_1 X_i + \eta \mathrm{PDT}_i + \epsilon_{3i} \tag{3}$$

where X_i represents a vector of socioeconomic characteristics associated with a farmer hypothesised to influence credit, productivity and market participation, ϵ_1, ϵ_2 and ϵ_3 are the respective random error terms, α, β, γ, δ and η are parameters to be estimated. The parameters δ and η are respectively the effect of credit on productivity and the effect of productivity on market participation. Since credit is received in the same season as productivity and market participation, we do not expect the latter variables to influence credit (i.e., appear as explanatory variables in Equation (1)). The definitions, measurements and summary statistics of the variables used in the models are presented in Table 1.

As indicated earlier, the estimation of Equations (1)–(3) as standalone models, as in previous studies, will yield biased and inconsistent estimates due to potential issues of selection and endogeneity. The rationale for including credit in Equation (2) is that credit is expected to ease liquidity constraints and propel investments in farm enterprises through adoption of modern technology leading to productivity and output growth. This pathway has grounding in some empirical studies (see, for example, Duong & Izumida, 2002; Feder et al., 1990; Lawal et al., 2009; Misra et al., 2016; Narayanan, 2016). The inclusion of productivity in Equation (3) is also based on the argument that productivity increases output and offers farmers the opportunity to generate surpluses to sell.

Table 1 Variable, Measurements and Summary Statistics

Variable	*Measurement*	*Mean*	*SD*
Outcome variables			
Access to credit	Dummy: 1 = if yes; 0 = otherwise	0.079	0.270
Yield of maize	Output (kg) per farm size (ha)	492.3	588.0
Sold maize	Dummy: 1 = if yes; 0 = otherwise	0.520	0.500
Explanatory variables			
Age of farmer	Number of years	47.20	15.24
Male farmer	Dummy: 1 = if male; 0 = otherwise	0.872	0.334
Years of education	Number of years	3.834	4.788
Household size	Number of people	5.501	3.161
Remittance	Dummy: 1 = if yes; 0 = otherwise	0.307	0.461
Ownership of radio and phone	Dummy: 1 = if yes; 0 = otherwise	0.847	0.360
Membership of cooperatives	Dummy: 1 = if member; 0 = otherwise	0.239	0.426
Motorable road to community	Dummy: 1 = if yes; 0 = otherwise	0.786	0.410
Access to public transport	Dummy: 1 = if yes; 0 = otherwise	0.367	0.482
Bank in community	Dummy: 1 = if yes; 0 = otherwise	0.042	0.201
Major economic activity in community	Dummy: 1 = if farming; 0 = otherwise	0.804	0.397
Market in community	Dummy: 1 = if yes; 0 = otherwise	0.610	0.488
Area of residence	Dummy: 1 = if rural; 0 = urban	0.838	0.369
Savannah zone	Dummy: 1 = if savannah; 0 = otherwise	0.680	0.466
Forest zone	Dummy: 1 = if forest; 0 = otherwise	0.278	0.448
Farm size	Hectares	1.237	1.408
Output	Kilograms	1117.6	2842.3
Number of times crops grown	Dummy: 1 = if twice; 0 = otherwise	0.293	0.455
Use of chemical fertiliser	Dummy: 1 = if yes; 0 = otherwise	0.860	0.347
Compliance with extension advice	Dummy: 1 = if yes; 0 = otherwise	0.779	0.415

Source: The authors.

To overcome these potential endogeneity and selectivity concerns, we propose to run Equations (1)–(3) as a structural system. However, there is a peculiar characteristic of Equations (1)–(3) that makes conventional structural equation models inapplicable. That is, the three equations are mixed: two binary models and one continuous model. At present, the most appropriate econometric model to implement this kind of a mixed structural model with different observations for the various models is the Conditional Mixed Process (CMP) model developed by Roodman (2011). The CMP framework performs a joint modelling of two or more equations, allows for cross-equation correlation of the error terms, permits mixing of these models in multi-equation systems and permits the individual models to vary by observations.

In the format of the CMP, Equations (1)–(3) are recast into the following:

$$y_1^* = \theta_1 + \varepsilon_1 \tag{4}$$

$$y_2^* = \theta_2 + \varepsilon_2 \tag{5}$$

$$y_3^* = \theta_3 + \varepsilon_3 \tag{6}$$

where $\theta_1 = \beta_1 X$, $\theta_2 = \beta_2 X + \delta y_1$, $\theta_3 = \beta_3 X + \eta y_2$

$$y = g(y^*) = (1\{y_1^* > 0\}, y_2^*, 1\{y_3^* > 0\})' \tag{7}$$

$$\epsilon = (\varepsilon_1, \varepsilon_2, \varepsilon_3)' \sim N(0, \Sigma) \text{ and } \Sigma = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{12} & 1 & \rho_{23} \\ \rho_{13} & \rho_{23} & 1 \end{bmatrix}$$

Here, y_1^*, y_2^* and y_3^* are, respectively, latent factors of credit, productivity and market participation, X is as defined before and ρ_{12} represents the correlation between the error terms of credit and productivity, ρ_{13} represents the correlation between the error terms of credit and market participation and ρ_{23} represents the correlation between the error terms of productivity and market participation. Assuming that $y_i = (0, y_{i2}, 0)'$ is observed, then a corresponding likelihood function can be specified as follows:

$$\begin{aligned} &L_i(\beta_1, \beta_2, \beta_3, \delta, \eta, \Sigma;\ y_i | x_i) \\ &= \int_{-\infty}^{-\theta_1} \int_{-\infty}^{-\theta_2} \int_{-\infty}^{-\theta_3} \phi_j \{(\varepsilon_1, y_{i2} - \theta_{i2}, \varepsilon_3)'; \Sigma\} d\varepsilon_1 d\varepsilon_2 d\varepsilon_3 \end{aligned} \tag{8}$$

2.3 Data, Variables and Descriptive Statistics

The GLSS6 household-level dataset collected by the GSS between October 2012 and October 2013 was used for this study. It consists of a stratified and nationally representative, random sample of 16,772 households in 1,200 enumeration areas. The household survey used a questionnaire adapted from the World Bank's Living Standards Measurement Survey. The study restricted the analysis to only maize farmers since maize was the basic crop cultivated in the 2012/2013 production season. This restriction leaves a sample size of 4,391. The main motivation for using the GLSS6 data for the study is the fact that it is one of the richest datasets on Ghana. Table 1 presents the measurements and summary statistics of specific variables used for estimations.

The results in the table show that access to credit in Ghana is low, as about 8 per cent of farmers had access. The mean yield is 493.3 kg/ha, the mean output is 1,117.6 kg and 52 per cent of the farmers sold their maize. The mean age is 47 years, suggesting farmers are still in their productive age. Most of the households (87.2%) are headed by male. Educational level of the farmers is low with average years of schooling of 3.8 years. The average household size is 6 people. Moreover, about 8 per cent complied with the advice of extension service.

Additional descriptive statistics of the amount of credit secured and the distribution of expenditure are presented in Table 2. The table shows four classes of credit amount spending among the sample of credit recipients. These are direct spending on agriculture (such as inputs, improvements and livestock), non-farm investments (such as expanding business and starting new business), spending to accumulate assets (such as purchasing building, improving house

Table 2 Credit Amount and Expenditure Distribution

Expenditure Type	*Frequency*	*Percentage*
Direct agriculture investment	144	41.38
Non-farm investment	53	15.23
Asset accumulation	84	24.14
Day-to-day expenditure	67	19.25
Total	348	100.00
Credit Amount	*Mean*	*SD*
Direct agriculture investment	552.92	829.71
Non-farm investment	1,388.31	1,747.01
Asset accumulation	1,529.66	1,937.82
Day-to-day expenditure	530.60	841.06
Overall	911.61	1,407.98

Source: The authors.

and purchasing property other than car) and day-to-day expenditures (such as paying debts, rental of apartment and other expenditures). Table 2 shows that majority of farmers (about 41%) spent on direct agricultural activities while the lowest number of farmers (about 15%) spent on non-farm activities. This observation points to the fact that few farmers diversify into non-farm activities. In terms of the credit amount, on average an amount of GHS911.61 is allocated to credit recipients by credit institutions. Disaggregating the credit amount into the various classes indicates that on average larger amount (GHS1529.66) is allocated to farmers who want to accumulate asset while the least amount is allocated to those who spend on day-to-day activities. We are unable to show whether these instances of spending on day-to-day activities were as a result of credit diversification.

3. Results and Discussions

Turning attention to the results on the econometric estimation of Equations (1)–(3) using the CMP modelling approach, we report the results in Table 3. Columns 1–3 respectively present the determinants of credit access, productivity and market participation. Given the complex survey nature of the GLSS dataset, survey estimation design was employed to cater for the fact that each sample household did not have equal chance of selection into the sample. Specifically, Stata's sampling weight (pweights) was used since it fits into the definition of weights used in the dataset. The significance of the *F*-statistic suggests that the model fits the data well.

We first discuss the results pertaining to the core objective of this article. The results show that structurally, credit positively affects productivity, and productivity positively affects market participation. The coefficient of credit in the productivity model is 959.8 and implies that farmers who have access to credit are more productive than those without credit. Specifically, credit recipients obtain 959.8 kg/ha more than their counterparts who do not receive credit. Giving that most farmers are smallholders, this magnitude is non-trivial. This finding provides empirical backing to assertions in Ghanaian policy documents that providing credit to farmers boosts their productivity. The positive effect of credit on productivity directly corroborates the findings of Chandio et al. (2018), Misra et al. (2016), and Sogo-Temi and Olubiyo (2004). For example, Chandio et al. (2018) found that access to short-term and long-term loans stimulate productivity of smallholder wheat farmers in Pakistan. Indirectly, the positive effect is also consistent with the findings of Ali et al. (2014) and Mukasa et al. (2017). These studies demonstrate that credit

Table 3 Determinants of Credit, Productivity and Market Participation

	(1)		(2)	(3)	
	Credit		Yield	Market Participation	
Variable	*Coeff.*	*ME*	*Coeff.*	*Coeff.*	*ME*
Access to credit			959.8***		
Yield				0.557***	0.203***
Socioeconomic characteristics					
Age of farmer	−0.005***	−0.001***	−0.939	−0.005***	−0.002**
Male farmer	−0.038	−0.009	109.6***	0.078	0.028
Years of education	0.010	0.002	3.311	−0.001	−0.001
Household size	0.004	0.001	9.084***	−0.015*	−0.005*
Remittance	0.216***	0.050***	−28.11	0.019	0.007
Ownership of radio and phone	0.037	0.008	123.6***	0.028***	0.010***
Membership of cooperatives	0.091	0.021	−67.27**	−0.021	−0.008
Community characteristics					
Motorable road to community	0.012	0.003	49.29**	0.035	0.013
Access to public transport	−0.044	−0.010	94.26***	0.081	0.030
Bank in community	0.281*	0.101*	128.0**	0.087	0.032
Major economic activity in community	0.083	0.019	−210.1***	0.048	0.017
Market in community				0.127***	0.036***
Geographic characteristics					
Area of residence	0.035	0.008	−0.049	0.102	0.033
Ecological zone (base: coastal)					
—Savannah zone	−0.199	−0.046	−0.276**	−0.422***	−0.100**
—Forest zone	−0.168	−0.049	0.265**	0.092	0.097

(Table 3 continued)

(Table 3 continued)

	(1)		(2)	(3)	
	Credit		Yield	Market Participation	
Variable	*Coeff.*	*ME*	*Coeff.*	*Coeff.*	*ME*
Production characteristics					
Farm size	−0.247***	−0.057***	−1.825		
Output	0.514***	0.003***			
Number of times crops grown			−25.38	0.167***	0.099***
Use of chemical fertiliser			54.87*		
Compliance with extension advice			47.90**		
Constant	−0.739***		94.06	0.087	
Observations			4,391		
F-statistic			3.59***		

Source: Produced by the authors using the GLSS6 Data.
Notes: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Survey weights used in estimations; ME is marginal effect.

constraints negatively affect productivity. The transmission mechanism of credit is stimulating reduction in capital and liquidity constraints and propelling investments in farm enterprises through adopting modern technology. This pathway is grounded in the literature. For example, Narayanan (2016), WoldeKidan et al. (2017), Misra et al. (2016), Lawal et al. (2009), and Duong and Izumida (2002) showed that credit enhances adoption of technology. Similarly, Akudugu et al. (2012) and Foltz (2004) found that credit constraints stifle technology adoption.

The marginal effect of productivity in the market participation model is 0.203, implying that productive farmers are more likely to sell their produce. Specifically, highly productive farmers are about 20 per cent more likely to sell their produce compared to their counterparts who are not as productive. Again, this finding provides sufficient evidence to assertions that productivity gains induce the selling of farm produce. The explanation for this observation is that the proportion of sale is heavily dependent on the marketed surplus ratio (which is dependent on the excess of output over household consumption). Therefore, an increase in productivity provides a surplus and thus increases agricultural commercialisation. This finding corroborates the findings of Rios et al. (2009) who observed that farm households who are more productive have higher market participation rates. Also, Abu et al. (2016) found that maize and groundnut farmers who have higher land productivity participate in the markets more than famers with low productivity. Moreover, Mekonnen (2017) indicated that the use of improved agricultural inputs has higher marketable surplus ratios.

We shift the discussion to other determinants of credit, productivity and market participation. The age coefficient is negative in the credit and market participation models. This means that older farmers are less likely to access credit (see also Chandio, Jiang, Wei, Rehman, & Liu, 2017; Sebopetji & Belete, 2009) and less likely to sell their produce. These findings are consistent with expectations. Though we find no evidence of productivity differentials between young and old farmers, credit institutions are more likely to allocate credit to younger farmers than older farmers (WoldeKidan et al., 2017). Larger households are more productive and have a lower probability of selling. Perhaps, larger households benefit from cheap labour and thus an increase in productivity. However, due to the large size, consumption reduces market participation (Olwande & Mathenge, 2012). The existence of a bank in the community increases the probability of accessing credit and boosts productivity, which emphasises the role of financial institutions in agricultural development. The presence of a bank in a community reduces transaction costs associated with accessing financial products, and increases financial inclusion in terms of savings, which in turn

stimulates access to credit and subsequently boosts productivity. Farmers in the savannah ecological zone are less productive and less likely to sell their output in the market compared to farmers in the coastal zone. Since farmers in the savannah zone are less productive, their engagement in the market is also adversely affected. In addition, farmers in savannah zone have relatively larger household sizes, with a statistically significant difference in average size. The results also imply that farmers in the savannah zone sell less, probably because maize is their staple food and, thus, they tend to consume more maize than sell it.

Use of fertiliser, compliance with extension advice, and ownership of a radio and phone positively influence productivity. Expectedly, the use of chemical fertiliser shifts the production frontier upwards leading to higher productivity. This result is consistent with that of Misra et al. (2016) and Onyenweaku and Okoye (2007), who clearly showed that fertiliser is a major input to higher farm productivity. Compliance with extension advice increases productivity because extension programmes provide farmers with information about modern technologies, which enhance productivity. This finding is corroborated by the finding of Siziba, Kefasi, Diagne, Fatunbi, and Adekunle (2011) who argued that access to extension services increases yield. The positive effect of radio and phone confirms the finding of Issahaku, Abu, and Nkegbe (2017) who observed that the use of mobile phones promote productivity of maize farmers in Ghana and argued that phones enhance access to information on inputs. In addition to the positive effect on productivity, ownership of radio and phone increases the probability of selling maize. Since phones and radio are sources of information, this finding corroborates the finding of studies that observed a positive effect of market information on market participation (see, for example, Abu et al., 2016; Abu, Osei-Asare, & Wayo, 2014; Siziba et al., 2011). Motorable roads and means of public transport boost productivity. The presence of good road infrastructure and public transport reduces the transaction costs to farmers in the search for productivity-enhancing inputs. This corroborates findings of Acheampong, Sayer, and Macgregor (2018) who reported that access to improved roads encourage the use of modern farm inputs and thus higher yields. We are unable to confirm or reject the inverse productivity–size relationship in this study. Though farm size has a negative coefficient in the productivity model (in line with the prediction of the inverse relationship), it is not statistically significant.

Further determinants of the outcomes are gender, output, farm size, cropping times, remittances, presence of market in community and membership in farmer association. Male farmers are more productive than female farmers. This finding meets a priori expectation since ownership of productive resources is

basically the preserve of males. This corroborates the finding of Adereti (2005). Output and remittance increase the probability of credit access. Large output serves as a proxy for collateral and credit worthiness to credit institutions. The finding on remittance corroborates observations that indicate that remittance stimulates financial inclusion (see Abu & Issahaku, 2017; Anzoategui, Demirguc-Kunt, & Peria, 2014). The estimated negative coefficient of membership of cooperatives is surprising since we expected that information is often shared among members of such groups, hence possibility that productivity will increase. However, it seems in Ghana such groups have lost their relevance and intended purposes, thus hindering the use of information shared by farmers to increase productivity. We also find that number of cropping times and presence of market in community positively affect market participation. Cultivating two times in a farming season increases the output, which subsequently increases marketable surplus. The positive effect of market in community supports the argument that physical infrastructure reduces transaction costs associated with marketing and information hence increasing the quantities sold (Abu & Issahaku, 2017).

4. Conclusion and Policy Implication

This article examined on one hand the impact of credit on productivity and the impact of productivity on market participation, and on the other hand the determinants of maize farmers' access to credit, productivity and market participation in Ghana. Contrary to popular practice in the literature, which estimates single equations for these three outcomes, this study jointly estimated these outcomes as a way of controlling for selectivity bias and unobserved endogeneity using the conditional recursive mixed process estimation technique. The estimation results show that credit positively impacts productivity and productivity in turn positively impacts market participation. Highlights of other determinants show that infrastructural and asset variables such as roads, public transport, radio and phone, and compliance with extension advice positively influence productivity. Further, the availability of markets and multiple cropping in a season boost the selling of maize. These findings imply that the transmission mechanism for transforming the subsistence nature of Ghanaian agriculture into a sector characterised by commercial agriculture is to enhance access to credit, which in turn would stimulate productivity and then productivity gains would enhance market engagements.

From this analytical implication, the policy implication is that the government of Ghana through its relevant institutions such as the MoFA and the Bank of Ghana should find workable measures to provide credit to farmers. Further,

MoFA should find ways of promoting and sustaining access to productivity-enhancing inputs and boosting infrastructural facilities in farm areas. Indeed, the government's current flagship programme in agriculture of 'Planting for Food and Jobs' makes it easy for farmers to access inputs at affordable prices, but what remains is to find ways to sustain the programme.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

References

Abu, B. M., & Issahaku, H. (2017). Financial inclusion and agricultural commercialization in Ghana: An empirical investigation. *Agricultural Finance Review*, *77*(4), 524–544.

Abu, B. M., Issahaku, H., & Nkegbe, P. K. (2016). Farmgate versus market centre sales: A multi-crop approach. *Journal of Agricultural and Food Economics*, *4*(21). doi:10.1186/s40100-016-0065-6

Abu, B. M., Osei-Asare, Y. B., & Wayo, S. (2014). Market participation of smallholder maize farmers in the Upper West region of Ghana. *African Journal of Agricultural Research*, *9*(31), 2427–2435.

Acheampong, E. O., Sayer, J., & Macgregor, C. J. (2018). Road improvement enhances smallholder productivity and reduces forest encroachment in Ghana. *Environmental Science and Policy*, *85*, 64–71.

Adereti, F. O. (2005). Rural women's access to and control over production resource: Implications for poverty alleviation among Osun State rural women. *Nigeria Journal of Human Ecology*, *18*(3), 225–230.

Akerlof, G. A. (1970). The market for lemons: Quality uncertainty and the market mechanism. *Quarterly Journal of Economics*, *84*(3), 488–500.

Akudugu, M. A., Egyir, I. S., & Mensah-Bonsu, A. (2009). Women farmers' access to credit from rural banks in Ghana. *Agricultural Finance Review*, *69*(3), 284–299.

Akudugu, M. A., Guo, E., & Dadzie, S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions? *Journal of Biology, Agriculture and Healthcare*, *2*(3), 1–13.

Ali, D. A., Deininger, K., & Duponchel, M. (2014). Credit constraints and agricultural productivity: Evidence from rural Rwanda. *The Journal of Development Studies*, *50*(5), 649–665.

Anzoategui, D., Demirguc-Kunt, A., & Peria, M. S. M. (2014). Remittances and financial inclusion: Evidence from El Salvador. *World Development*, *54*, 338–349.

Awotide, B. A., Abdoulaye, T., Alene, A., & Manyong, V. M. (2015, August). *Impact of access to credit on agricultural productivity: Evidence from smallholder cassava farmers in Nigeria*. Paper presented at the International Conference of Agricultural Economists, Milan.

Retrieved from http://ageconsearch.umn.edu/bitstream/210969/2/Awotide-Impact%20of%20Access%20to%20Credit%20on%20Agricultural%20Productivity-71.pdf

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from Eastern and Southern Africa. *Food Policy*, *33*(4), 299–317.

Barrett, C. B., Bellemare, M. F., & Hou, J. Y. (2010). Reconsidering conventional explanations of the inverse productivity–size relationship. *World Development*, *38*(1), 88–97.

Bellemare, M. F., & Barrett, C. B. (2006). An ordered tobit model of market participation: Evidence from Kenya and Ethiopia. *American Journal of Agricultural Economics*, *88*(2), 324–337.

Burke, W. J., Myers, R. J., & Jayne, T. S. (2015). A triple-hurdle model of production and market participation in Kenya's dairy market. *American Journal of Agricultural Economics*, *97*(4), 1227–1246.

Chandio, A. A., Jiang, Y., Wei, F., & Guangshun, X. (2018). Effects of agricultural credit on wheat productivity of small farms in Sindh, Pakistan. Are short-term loans better? *Agricultural Finance Review*, *78*(5), 592–610.

Chandio, A. A., Jiang, Y., Wei, F., Rehman, A., & Liu, D. (2017). Famers' access to credit: Does collateral matter or cash flow matter?—Evidence from Sindh, Pakistan. *Cogent Economics and Finance*, *5*(1), 1–13.

Dabone, A. J., Osei, B. A., & Petershie, B. E. (2014). Determinants of access to credit for cash crop production in Ghana: A case study of the cocoa industry. *Developing Country Studies*, *4*(14), 63–72.

Denkyirah, E. K., Aziz, A. A., Denkyirah, E. K., Nketiah, O. O., & Okoffo, E. D. (2016). Access to credit and constraint analysis: The case of smallholder rice farmers in Ghana. *Journal of Agricultural Studies*, *4*(2), 53–72.

Duong, P. B., & Izumida, Y. (2002). Rural development finance in Vietnam: A microeconometric analysis of household surveys. *World Development*, *30*(2), 319–335.

Etonihu, K. I., Rahman, S. A., & Usman, S. (2013). Determinants of access to agricultural credit among crop farmers in a farming community of Nasarawa State, Nigeria. *Journal of Development and Agricultural Economics*, *5*(5), 192–196.

Fafchamps, M., & Hill, R. V. (2005). Selling at the farmgate or traveling to market. *American Journal of Agricultural Economics*, *87*(3), 717–734.

Feder, G., Lau, L. J., Lin, J. Y., & Luo, X. (1990). The relationship between credit and productivity in Chinese agriculture: A microeconomic model of disequilibrium. *American Journal of Agricultural Economics*, *72*(5), 1151–1157.

Foltz, J. D. (2004). Credit market access and profitability in Tunisian agriculture. *European Review of Agricultural Economics*, *30*(3), 229–240.

Ghana Statistical Service. (2014). *Ghana Living Standards Survey Round 6* (GLSS6). Accra: GSS.

Goetz, S. J. (1992). A selectivity model of household food marketing behavior in Sub-Saharan Africa. *American Journal of Agricultural Economics*, *74*(2), 444–452.

Government of Ghana. (2010). *Medium term agricultural sector investment plan (METASIP)-2011–2015*. Ghana: Ministry of Food and Agriculture.

Holloway, G., Dorfman, J., & Ehui, S. (2001). Tobit estimation with unknown point of censoring with an application to milk-market participation in the Ethiopian highlands. *Canadian Journal of Agricultural Economics*, *49*(3), 293–311.

Holloway, G., Nicholson, C., Delgado, C., Ehui, S., & Staal, S. (2000). Agro-industrialization through institutional innovation: Transactions costs, cooperatives and milk-market development in the East African highlands. *Agricultural Economics*, *23*(3), 279–288.

Issahaku, H., Abu, B. M., & Nkegbe, P. K. (2017). Does the use of mobile phones by smallholder maize farmers affect productivity in Ghana? *Journal of African Business*, *19*(3), 302–322.

Key, N., Sadoulet, E., & de Janvry, A. (2000). Transactions costs and agricultural household supply response. *American Journal of Agricultural Economics*, *82*(2), 245–259.

Kimhi, A. (2003). Plot size and maize productivity in Zambia: The inverse relationship revisited (Discussion Paper No. 10.03). Jerusalem: Hebrew University of Jerusalem.

Kumar, A., Mishra, A. K., Saroj, S., & Joshi, P. K. (2017). Institutional versus non-institutional credit to agricultural households in India: Evidence on impact from a national farmers' survey. *Economic Systems, 41*(3), 420–432.

Larson, D. F., Otsuka, K., Matsumoto, T., & Kilic, T. (2012). Should African rural development strategies depend on smallholder farms? An exploration of the inverse productivity hypothesis (Policy Research Working Paper No. 6190). Washington, DC: The World Bank.

Lawal, J. O., Omonona, B. T., Ajani, O. I. Y., & Oni, O. A. (2009). Determinants of constraints to credit access among cocoa farming households in Osun State. *Pakistan Journal of Social Sciences*, *6*(3), 159–163.

Makhura, M. N., Kirsten, J., & Delgado, C. (2001). *Transaction costs and smallholder participation in the maize market in the Northern Province of South Africa*. Paper presented at the Seventh Eastern and Southern Africa Regional Maize Conference, Pretoria, pp. 463–467.

Mazumdar, D. (1965). Size of farm and productivity: A problem of Indian peasant agriculture. *Economica*, *32*(126), 161–173.

Mekonnen, M. T. (2017). *Impact of agricultural technology adoption on market participation in the rural social network system* (MERIT Working Papers 008). UNU-MERIT

Misra, R., Chavan, P., & Verma, R. (2016). Agricultural credit in India in the 2000s: Growth, distribution and linkages with productivity. *Margin-The Journal of Applied Economic Research*, *10*(2), 169–197.

Mukasa, A. N., Simpasa, A. M., & Salami, A. O. (2017). Credit constraints and farm productivity: Micro-level evidence from smallholder farmers in Ethiopia (Working Paper Series No. 247). Abidjan: African Development Bank.

Narayanan, S. (2016). The productivity of agricultural credit in India. *Agricultural Economics, 47*(4), 309–409.

Olwande, J., & Mathenge, M. (2012). *Market participation among poor rural households in Kenya*. Paper presented at the International Association of Agricultural Economists Triennial Conference, Foz do Iguaçu.

Onyenweaku, C. E., & Okoye, B. C. (2007). Technical efficiency of small-holder cocoyam farmers in Anambra State, Nigeria: A translog stochastic frontier production function approach. *International Journal of Agriculture and Rural Development*, *9*(1), 1–6.

Rehman, A., Chandio, A. A., Hussain, I., & Jingdong, L. (2017). Is credit the devil in agriculture? The role of credit in Pakistan's agricultural sector. *The Journal of Finance and Data Science*, *3*(1–4), 38–44.

Rios, A. R., Shively, G. E., & Masters, W. A. (2009, August). *Farm productivity and household market participation: Evidence from LSMS Data*. Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing.

Roodman, D. (2011). Fitting fully observed recursive mixed-process models with cmp. *The Stata Journal*, *11*(2), 159–206.

Sadoulet, E., de Janvry, A., & Benjamin, C. (1998). Household behavior with imperfect labour markets. *Industrial Relations*, *37*(1), 85–108.

Sebopetji, T., & Belete A. (2009). An application of probit analysis to factors affecting small-scale farmers' decision to take credit: A case study of the greater Letaba local municipality in South Africa. *African Journal of Agricultural Research*, *4*(8), 718–723.

Sekyi, S., Abu, B. M., & Nkegbe, P. K. (2017). Farm credit access, credit constraint and productivity in Ghana: Empirical evidence from Northern Savannah ecological zone. *Agricultural Finance Review*, *77*(4), 446–462.

Siziba, S., Kefasi, N., Diagne, A., Fatunbi, A. O., & Adekunle, A. A. (2011). Determinants of cereal market participation by Sub-Saharan Africa smallholder farmers. *Journal of Agriculture and Environment Studies*, *2*(1), 180–193.

Sogo-Temi, J. S., & Olubiyo, S. O. (2004). The role of agricultural credit in the development of agricultural sector: The Nigerian case. *African Review of Money Finance and Banking*, 101–116.

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

Wiebe, K. D., Soule, M. J., & Schimmelpfennig, D. E. (2001). Agricultural productivity for sustainable food security in Sub-Saharan Africa. Rome: FAO Corporate Document Repository. Retrieved from www.fao.org/docrep/003/X9447E/x9447e06.htm

WoldeKidan, H., Hadush, G., & Gerezihar, K. (2017). Impacts of credit constraint on smallholder farmer's technology adoption in Ethiopia: In case of South Ethiopia. *Journal of Land and Rural Studies*, *5*(2), 110–119.