(RETRACTED PAPER) The ripple effect of credit accessibility on the technical efficiency of maize farmers in Ghana

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Abstract

The purpose of this study is to examine the impact of access to credit on technical efficiency (TE) of maize farmers in a developing, Ghana. The study employed an instrumental variable approach and the stochastic frontier method for the estimation of the results. The study found that farmers who have access to agricultural credit stand the chance of increasing technical efficiency by a margin of 5%, which also influences the maize production than those who did not have access to credit. The average TE score of the farmers was 47.6%. The study also found out that factors like membership, gender, farmers' access to credit, age and social network determine farmers' possibility of accessing agricultural credit. The study finds out that returns to size in on the increases among the maize farmers and that significant improvement in efficiency can realize by increasing the level of input used in production. Also, factors such as farm size, labor, seeds, and fertilizer are the essential determinants of maize production output. Also, gender, extension, age, off-farm income, access to credit and membership were significant factors influencing TI. The paper contributes to the existing literature on agricultural credit on rural agricultural development. This paper also provides information to government policy-makers, practitioners and all other stakeholders in the maize sub-sectors and also will benefit small farmers outside the study area.

Keywords: Agricultural credit. Technical efficiency. Instrumental varables.

1. Introduction

1.1. Background of the study

Agriculture has been a significant contributor to the economy of several developing countries. In Ghana, the sector has remained one of the vital areas of the country's economy, contributing between 22% and 32% of the national GDP with an annual growth rate ranging between 1.7 and 7.4 (Ghana Statistical Service [GSS], 2017; Ghana Statistical Service, 2015). About 80% of the Northern Ghana population depends on subsistence farming with little productivity and agricultural income, mainly attributed to the relying on rain-fed farming under low agriculture input circumstances, which maize is one of the principal crops grown in the region (MoFA, 2011).

Maize is the most abundant staple crop in Ghana and contributes significantly to consumer diets and has occupied a planted area of about 1 million hectares and account for 50 to 60% of total cereal production. Besides, maize represents the second-largest commodity crop in the country after cocoa, and it is one of the most significant crops for Ghana's agricultural sector and food security (Baah Annor, 2018; MoFA, 2013). The massive mainstream of maize is produced by smallholder farmers under rainfed conditions, leading to yearly differences.

Small household farmers in Ghana account for a significant maize production of 70% and are mostly in the Brong Ahafo, Ashanti, Eastern, Northern, Upper East, and Upper West regions. However, overall maize production has remained relatively stable in the country in terms of the area yielded and quantity because of reliance on traditional farming; such that, under the conventional production methods and rainfed conditions, harvests are below their attainable levels; thus, the average maize yield is approximately 1.5 metric tons per hectare. However, a high yield of 5.0 to 5.5 metric tons per hectare and higher has been realized by farmers who enhance their farming operations through modern technology and technical efficiency such as; access to credit, increase use of agricultural inputs, change in technology (adoption of new technology), efficiency, irrigation, and new investment through better use of blend inputs in yielding high-quality production (Adolwa et al., 2019; Akudugu et al., 2016; Naab et al., 2017). Among the numerous factors influencing the performance of the agricultural sector in Ghana, agriculture credit has been a major undermining factor (Nunoo and Acheampong, 2014; Sulemana and Adjei, 2015).

Several researchers have concluded that agriculture credit is essential to support farmers in the rural areas ranging from short-term loans, medium-term loans, long-term loans, leasing, crop, and livestock insurance through formal and informal credit institutions as well as financial arrangements within the agricultural value chain (Asante-Addo et al., 2017; Chaifetz and Jagger, 2014). Other studies also stated that to fight against poverty across the developing countries, access to financial services, especially allotting credit to the agriculture sector, would help increase production and growth. (Akudugu et al., 2016; Berger and Nakata, 2013) The primary conclusion from these studies is that farm production and access to credit is vital in serving the deprived out of poverty. This has pushed many governments and non-governmental organizations to set up policies with the aim of improving the agriculture sector in developing countries.

Many interventions have been put in place by national governments and policymakers. For instance, in Ghana, the government through the Agricultural Development Bank (ADB), collateral registry, and soil health project has been set up to transfer capacity building, technology, credit facilities, and farmer’s welfare to support and improve farmer’s technical efficiency and to provide lower lending rates to farmers which the project intends to assist small household farmers’ access production inputs in enhancing technical efficiency (Anang et al., 2016; Sienso et al., 2014).

Furthermore, the government of Ghana has established Block Farm Credit Program (BFCP) through the Ministry of Food and Agriculture (MOFA) to fight against credit constraints. This program aims to exploit economies of scale and to ensure that farmers benefited from credit subsidy in the form of service mechanization through the Agricultural Mechanization Service Centre (AMSEC), seed improves certification, fertilizer subsidy program, extension, pesticides, and herbicides services (MoFA, 2013). Nevertheless, it will have a positive impact on technical efficiency that would increase farmers' productivity, improve farmers' income level, ensure food security, and generate employment among the rural poor, especially the youth. Some researchers also argued that the agriculture sector served as a critical driver of wealth creation, employment creation, and economic growth as a means of poverty reduction and provision of food security for the national economy (Sekabira and Qaim, 2017; Uduji et al., 2019). For example, some studies observed that the rapid growth of the continent of Asia is about the new economic industrialization, which has a direct relationship with the significant growth of the agricultural sector (e.g., Deng et al., 2019).

Despite the mechanisms that the government of Ghana has put in place to enhance the agriculture sector, there is still credit constraint facing most rural farmers in Ghana. The credit constraints may have a detrimental effect on the farmers; therefore, this research is to find out how access to credit may have affected farmers' technical efficiency.

1.2. Contribution of the study

All these past years, the country has been experiencing an annual domestic shortfall of maize production (MoFA, 2016). Again, humankind is competing with the livestock industry (mainly the poultry farm) in terms of maize consumption. Although there is no reliable data for maize utilized feeding animals, it is estimated that 85% of all maize grown is for human consumption. Besides, maize consumption is estimated to grow at a compound annual growth of 2.6% based on population growth and increasing per capita income (MoFA, 2013). The reduction in maize production has raised the concern of this research; thus, to find out if inadequate credit impact on the farmers' technical efficiency is the main factors influencing the production fall of maize productivity in recent years.

Several studies have analyzed technical efficiency of farmers using different methods such as Data Envelope Analysis (DEA) and the Stochastic Production Frontier (SPF) have been carried out (Abate et al., 2014; Cañete and Temanel, 2017; Coelli and Battese, 1996; Martey et al., 2019). Suggestions from these studies have given evidence that efficiency and productivity within the agricultural sector are vital and can be enhanced once credit instruments channeled to the requirements of agribusinesses and farmers. They also argued that credit constraint limits farmers from adopting better technologies. Difficulties in agriculture technology adoption have a great effect on the performance of farmers. Major identified causes of low adoption rates include supply-side constraints such as imperfect information and credit markets (Ankrah Twumasi et al., 2019; Shiferaw et al., 2017). Addressing the credit market imperfections can, therefore, serve as an important entry point for increasing the adoption of agricultural technologies, which is influenced by farmers' efficiency, hence, increasing productivity.

Nevertheless, the presumed positive connection between credit (formal and informal) and gains in technical efficiency have not widely been studied. This study fills this gap by adding to the existing literature of agriculture credit by using data collected from the Bolgatanga district in the Northern part of Ghana. The main object of the study is to analyze the effect of access to credit on maize farmers' technical efficiency. Contribution of the study, upon a thorough feasibility study on this research project, the researchers are aware that only a few studies are available. Also, the majority of available literature treated credit as an exogenous variable. This study empirically quantifies the impact of technical efficiency and credit accessibility in rural Ghana by taking into consideration the endogeneity issue of credit. Thus, the researchers account for the endogeneity of credit and technical efficiency through self-selected users in the econometric model by employing a two-stage assessment technique to address selection bias that accounts for observed and unobserved factors. The researchers provide policy implications and recommendations base on the findings.

2. Literature Review

Prior studies have analyzed Famers efficiency levels in different nations. According to the prior studies, this study will also control householder, household-level and other characteristics, which were considered to influence credit accessibilty and TE. For example, a study by (Wagan et al., 2019) in Pakistan revealed that rice farmers' efficiency, which helps in increasing productivity, is influenced by agriculture credit, age, gender, extension staff services, education and many others. Again, the impact of credit on technical efficiency among vegetable farmers in Swaziland was a related study by Masuku et al. (2014). The outcome of the study showed that other socio-economic variables, including credit are positively related to the technical efficiency of cabbage, tomato, and beetroot farmers. The result is in line with Duy (2015), who studied the effects of formal and informal credits on rice production efficiency of rural households in the Mekong Delta. Laha and Kuri (2012) examine the role of credit efficiency of West Bengal agriculture using disaggregated analysis for two groups: non-bank customers and bank customers. The results show that farmers who have access to formal credit are practicing efficient farming by directing credit to farm inputs than farm households with less or without access to credit.

In Ghana, there are prior studies of farmers' technical efficiency analysis (Abdulai et al., 2018; Donkoh, 2013). All these studies revealed that credit is essential in promoting farmers' efficiency, hence, improving agriculture productivity, profitability and household income. This study adds to existing studies of the agriculture credit market and its impact on rural development by accounting for the problem of endogeneity.

3. Methodology

3.1. Study area and data collection

The study area for the study is Bolgatanga in the Upper East region of Ghana. Bolgatanga Municipality has a total population of 131,550, accounting for 12.6% of the population of the Upper East Region. The Municipality has a male population of 62,783 (47.7%) and female populations of 68,767 (52%) of the total population. About 15,959 (59.8%) are agricultural households in the Municipality of which 10,631 (89.3%) households are in rural communities (Ghana Statistical Service, 2014). Its climate is described by one rainy season from May/June to September/October every year. The mean annual rainfall during the period is 800 mm and 1,100 mm. Due to the one seasonal rain-fall, the region often experiences long dry season from November to the middle of February, including cold, dry and dusty harmattan winds. The temperature during this period is between 14 degrees Celsius (low) at night and more than 35 degrees Celsius during the day.

The data used for this research are both primary and secondary. The primary data consist of the information gathered from targeted farmers from the Bolgatanga municipality of Ghana through questionnaires. In all, 600 questionnaires issued to the maize farmers; however, only 570 is used for the analysis of this study after proper assessment of the data received.

The study used a multistage sampling technique. In the first stage, one region in the Northern part of Ghana was selected. In the second stage, four (4) communities were randomly designated from the selected municipality, including Kumbosigo, Tindonmolgo, Kumbangre, and Gadoone. Finally, a simple random procedure was employed to select the respondents. About 20-30 households were selected randomly from each community based on the size of the community. Data collection from these rural farm households in Ghana accomplished using interview schedules and questionnaires. An in-depth interview was conducted because of the complex nature of the survey. Due to uncertainty, we had a pre-test of the questionnaire. The survey data questionnaire covered information on socioeconomic characteristics, access to agricultural credit, production year value of output, and other various variables that contribute to the purpose of the study. We edited and coded the data to ensure accuracy, validity, uniformity, consistency, and completeness employing Stata 14.

3.2. Empirical Analysis

This study examines the impact of access to agriculture credit on maize farmers' TE. Here, access to credit means whether a farmer was able to borrow from either formal or informal sources for agriculture production in the last 12 months. This paper employs a two-stage opinion method which is comparable to those distinct by Asante, (2014), Judith Beatrice Auma Oduol, (2011), and Ayed Mouelhi, (2009). In stage one, the probability of accessing agricultural credit is estimated, and scores of credits access are generated. We, therefore, combined the estimated scores of agricultural loans accessed with other variables and regressed the on the technical efficiency score to determine the direct effect of the farm loan. Following these steps eliminate the selection bias of agriculture loans received.

Due to the binary nature of the dependent variable (access to credit), the probit model is used to perform econometric analysis. Analyzing the determinants of access to credit, it is suggested that access depends on a latent variable that is unobservable and is denoted as AC*. AC* is influenced by X, i.e., observable characteristics of the farmers i denoted as independent vector X_i. Expressed as;

$$AC_i^* = \alpha' X_i + \varepsilon_i \qquad (1)$$

$$AC_i^* = \begin{cases} 1 \text{ if } AC_i^* > 0 \\ 0 \text{ if otherwise} \end{cases}$$

From the equation above, α is the estimable parameter vector of X_i, and that is the independent variable that influences the agricultural credit (AC_i^*). $\alpha' X_i$ is the index function that allows for the estimation of the probability of credit accessibility (Y = 1) in the function below;

$$AC_i = P(AC_i = 1|X_i) = P(AC_i^* \leq AC_i) = P(S_i \leq \alpha' X_i) = F(\alpha' X_i) \qquad (2)$$

Where S_i is the standard normal variable assumed to be N $(0,\sigma^2)$. F is the cumulative normal distribution function. Equation (2) is estimated using the maximum likelihood estimation.

The assumptions of the interaction between the factors affecting agricultural credit and its effect, the stochastic frontier production function would be introduced in stage 2. At this stage, the predicted probability of agricultural credit accessibility is involved. A Cobb-Douglas production function helps us explain the affiliation among production (output) and contribution (input).

$$\ln Y_i = \ln\lambda_0 + \sum_{b=1}^{5} \lambda_b \ln X_{bi} + v_i - \mu_i \qquad (3)$$

Where subscript i shows the ith farmer in the sample and b is the index of input (i = 1, 2, 3, 4, …N = 600); hence, Y_i represents the value of maize harvested by farmer i. X_{bi} is the input vector of farmer i. λ_b is the vector technology parameter, v_i is the random error assumed to be independently and identically distributed as, $N(0, \sigma_v^2)$ random variables and μ_i is the non-negative technical inefficiency effect that are assumed to be independently distributed among themselves and between the $v_i s$, so that μ_i is defined by the truncation (at zero) of the $N(\mu_i\ ,\sigma_v^2)$distribution. Where μ_i is further explained in the function below:

$$\mu_i = \beta_0 + \sum_{b=1}^{8} \beta_b D_{bi} + h \qquad (4)$$

Where D_b is a $(1xm)$ vector of explanatory variables associated with technical inefficiency (TI) effects; β_b is a $(mx1)$ vector of unknown parameter to be estimated. The parameter which indicates the impacts of D_b (which includes the estimated access to agriculture credit variable) on TI explains that a negative value suggests a positive influence on TE and vice versa. Agricultural credit might correlate with the error term in the equation 4; therefore, the authors' employed an instrumental variable approach in solving the endogeneity problem. Following (Ankrah Twumasi et al., 2019), social network (whether the farmer has a link with top officials in the community) was selected as an instrument. This instrument affects access to credit but not TI, so it is appropriate.

Here, the constant return to scale is the sum of the parameter coefficients, λ_i in the equation 5 should equivalent to one. For increasing return to scale, they should be > 1, while decreasing returns to scale, they should be < 1. See also (Jones, 2002; Langpap, 2004; Rios and Shively, 2005, 2006). The theoretical explanations of the returns are mathematically presented as:

$$\lambda_i = \frac{\delta Y|Y}{\delta X_i|X_i} \qquad (5)$$

Where λ_i represents the elasticity with respect to the input used and considered the most important property of the Cobb-Douglas production function.

4. Results and Discussion

4.1. Descriptive analysis

From Table 1, total value of output is GH¢405.138 and it achieved through the utilization of averagely, less than one (1) hectare of land, labor cost of GH¢34.112, fertilizer cost of GH¢21.556, cost of seed of GH¢ 57.819 and agro-chemical cost of production is GH¢39.511.

Concerning farmers, farm characteristics and other variables that influence inefficiency, it is indicated that the majority of the farmers are middle-aged; thus, 42 years of age. While an average of 7 members consistute a family, the average number of years of schooling are 6years. Besides, the statistic shows that about 21% of the farmers received extension services and about 56% are males. While a mean of 32% of the farmers has a link with community officials (social network), an average of 42% of farmers had access to credit and 22% of the farmers belong to an association. The results show that 39% approximately had access to irrigation. The farmer's average off-farm income is GH¢355.138.

Table 1: Description of variables, means and standard deviations (SD)

Variables	Descriptions	Mean	SD
Farm Income (output)	Total farm income for production years	405.138	217.379
Farmland size	Land area of cultivation (hectares)	0.780	3.006
Labor	Total labor operating cost incurred for one production year (in GH¢)	34.112	17.032
Fertilizer	Total fertilizer expenses incurred for one production year (in GH¢)	21.556	14.918
Seed	Total seed expenses incurred for one-year production (in GH¢)	57.819	26.062
Agrochemical	Total agrochemical used in liters	39.511	17.383
Gender	1 if the farmer is a male; 0 otherwise	0.560	0.445
Age	The age of the farmer (Number of years)	41.78	14.954
Level of Education of the farmer	Number of years spent in school by farmer	5.756	5.364
Irrigation	1 if the farmer have access to irrigation; 0 otherwise	0.385	0.546
Extension	1 if the farmer has access to extension service; 0 otherwise	0.212	0.343

Membership	1 if the farmer is an association member; 0 otherwise	0.221	0.425
Access to credit	1 if the farmer has borrowed from formal/informal lenders or both; 0 otherwise	0.416	0.471
Off-farm income	Annual off-farm income (in GH¢)	355.138	117.322
Household size	Number of family members	6.672	2.981
Social Network	Whether a farm has a link with a community official (Yes=1/otherwise=0)	0.321	0.442

Source: survey results. Note during the study period, USD1= GH¢5.4

Table 2: Difference between means of fishing activity input and financial status of credit constraint and unconstrained fishermen

Variables	Total	Access to Credit	Non-access to credit	p-value
Farmland size	0.780 (3.006)	1.083 (2.066)	1.066 (2.103)	0.5444
Labor	34.112 (17.032)	35.792 (14.419)	35.981 (14.837)	0.0559
Fertilizer	21.556 (14.918)	27.723 (15.331)	24.662 (14.137)	0.0014***
Seed	57.819 (26.062)	69.384 (24.418)	54.619 (22.528)	0.0001***
Agrochemical	39.511 (17.383)	44.711 (19.394)	38.094 (17.811)	0.0088**
Gender	0.560 (0.445)	0.571 (0.5211)	0.518 (0.493)	0.0684*
Age	41.78 (14.780)	39.822 (13.993)	45.901 (15.773)	0.0015***
Education	5.756 (3.364)	5.813 (3.033)	5.992 (3.971)	0.2118
Irrigation	0.385 (0.446)	0.419 (0.417)	0.382 (0.404)	0.0481**
Extension	0.212 (0.343)	0.274 (0.349)	0.269 (0.337)	0.1339
Membership	0.221 (0.425)	0.345 (0.425)	0.291 (0.419)	0.0072***
Off-farm income	755.138 (417.322)	1043.241 (601.772)	687.036 (577.033)	0.0007***
Household size	6.672 (2.981)	6.871 (2.952)	6.911 (2.987)	0.4601
Technical efficiency	0.476 (0.0167)	0.493 (1.117)	0.439 (1.103)	0.0002***

Source: survey results. *Asterisks *, ** and *** represent significant levels at 10%, 5% and 1% respectively. Standard errors in parentheses*

Table 2 presents the mean differences between access and non-access variables of credit of the study. The mean differences between access and non-access to credit are significant in terms of seed cost, fertilizer cost, and chemical cost. This means that farmers who have access to credit turn to employ modern technology on their farm activities, leading to high productivity than farmers who have no access to credit.

Also, there are statistically significant differences between these two groups of farmers for other control variables such as age, gender, irrigation, membership, and off-farm increase. Again, the study shows a significant variation in the technical efficiency of farmers who had access to credit and the farmers who did not have access to credit. Farm households who have access to credit were comparatively more efficient than farmers without access to credit. The mean difference comparison, however, does not control for confounding factors, which may result in misleading conclusions. Therefore, it is vital to employ an econometric approach to determine the impact of agricultural credit on the technical efficiency of maize farmers.

4.2. Empirical analysis

4.2.1. Factors influencing access to agricultural credit

The result in Table 3 is estimated using the probit model. Only the signs of the coefficients are Interpreted and not the magnitude. For example, the gender coefficient is positive at a 5% level of significance which means that the probability of male farmers having access to credit from lenders is higher than that of a female. This result is relevant among Africans because they think every household is headed by a male who has the right to control all the family resources; therefore, lenders prefer male to female. This result disagrees with Weber and Musshoff (2012) who found that the probability of accessing credit is highly independent of gender but similar to the study of (Atieno, 2001).

Again, age is insignificant, but its square is significant and has a negative relationship, suggesting that relative to elders, young farmers are more likely to secure credit. This result contradicts Tadesse (2014) who found the significant and positive relationship among age, credit access and age squared. Education showed a positive correlation with access to credit. This implies that educated farmers are more likely to have access to credit. Educated farmers may have acquired the financial knowledge and also understands payment policies compared to the uneducated (Ankrah Twumasi et al., 2019; Chandio et al., 2017). The 10% significant level and positive relationship between access to credit and membership indicates that members of an association have a high likelihood of accessing credit than their counterparts. This result is also similar to Akudugu et al (2009) who found that group memberships increase the probability of getting access to credit in Ghana. Social network (instrumental variable) has a positive coefficient, suggesting that knowing a top official in the community increases the possibility of a farmer to receive credit so they borrow.

Table 3: Factors affecting access to agricultural credit

Variables	Coefficient	Robust SE	Z
Farm land size	-0.0042221	0.0186346	-0.23
Gender	0.3284486	0.1487068	2.21**
Age of the farmer	0.006857	0.0096676	0.71
Age square	-0.0001847	0.0001047	-1.76*
Education	0.0323595	0.0093325	3.47***
Extension	-0.2239864	0.1238716	-1.81
Membership	0.2401831	0.1455278	1.65*
Social Network	0.6217361	0.1445002	4.30***
Constant	-0.4753776	0.2687007	-1.77*

Wald x^2 (10) = 94.28 Prob > x^2 = 0.0000 Log likelihood = -332.85085

Pseudo R^2 = 0.1511 Observations = 600

Note:

*** = 1% significant level

** = 5% significant level

* = 10% significant level

Source: survey results. *Asterisks *, ** and *** represent significant levels at 10%, 5% and 1% respectively.*

4.2.2. Technical Efficiency Determinants

In table 4, the study estimates the maximum likelihood. The function coefficient that measures the percentage change in output when all inputs involved in the model changed in the same percentage is about 1.53, suggesting an increasing return to scale. Among the five inputs variables, four estimated parameters were significant; thus, fertilizer cost, seed cost, farm size, and labor. Aside from farm size with a 10% significant level, the remaining were all significant at 1%. The data, therefore, recommended that the value of productivity could be high when households increase the quantity of seed, labor, fertilizer and, land. It means that if the land used for maize farming having the amount of labor, fertilizer and, the seed being increased by 1% each, then the production means of maize is estimated to increase by 0.20783, 0.70100, 0.39917 and 0.22367 level respectively. The outcome is in line with Coelli and Battese (1996), and Ogundari (2008).

The parameter $\gamma = \sigma_{\mu}^{2} / \sigma^{2}$ in the technical efficiency model is significant at 5% with a value of 0.937, indicating that inefficiency is highly significant between the households. Gender, extension, age, off-farm income, access to credit an,d membership were significant factors influencing TI. Extension is significant and negative, meaning its effect improves technical efficiency. Thus, farmers with access to extension services are more efficient than those without access to extension service. The outcome supports the principle that if human capital is high, it will empower rural households to improve the use of resources in achieving a high level of production (Solís et al., 2009).

Besides, gender presents positive and statistically significant effects on TE. These results of gender proposed that the efficiency of male-headed farmers over female-headed. The crucial roles performed by females in the domestic and economic life of society affect their technical efficiency negatively. This comprised the unmeasured non-economic activities (including cleaning, cooking, child care, etc.) performed by females in the household. Also, some customs, social norms, traditions, and religious beliefs have limits on women's activities both on-farm and off-farm so, therefore, affect their ability to access and use new technology and information. This finding is in line with Solís et al. (2009) on technical efficiency and soil conservation in El Salvador and Honduras where household's female-headed showed lower technical efficiency compared to that of a household headed by a male. The goal of the study is to assess the relationship between efficiency and agricultural credit.

After dealing with the endogeneity problem, the credit accessibility coefficient is negative. This discloses a positive relationship between technical efficiency and agricultural credit. The outcome supports the theory that access to agricultural credit empowers farmers to pay for new technologies and assume long-term investment that enhances productivity. This result is consistent with (Dong et al., 2012; Lin et al., 2019).

Also, age which serves as a proxy for farmers' experience, depicts a negative effect on technical efficiency at 1 % level of significance. This result is impressive because acquiring more knowledge in farming might improve efficiently (Läpple, 2010; Oladejo et al., 2011) but without proper health due to old age, knowledge becomes meaningless. This result confirms the study of (Danquah et al., 2019). Membership and off-farm income were all positive and significant. As one off-farm income increases, barriers that limit efficiency due to insufficient funds are dealt with, thereby increasing efficiency. Again, being a member of an association means that the farmer acquires skills and knowledge from other members of the union. Also, in times of financial or other help, association member come to assist; thus, improving farmers' efficiency (Francesconi, 2014).

4.3. Technical efficiency determinants

Table 4: Maximum likelihood estimation of production and inefficiency function of maize farmers

Variables	Coefficient	Robust SE	Z
Output model			
Lnfarm size	0.20783	0.11859	1.75*
lnlabor cost	0.70100	0.04629	15.34***
lnfertilizer cost	0.39917	0.06788	5.88***
Lnseed cost	0.22367	0.04185	5.34***
lnchemical cost	-0.04158	0.08895	-0.47
Constant	2.74010	0.06030	4.05***
Inefficiency model			
Gender	-0.72615	0.24663	-2.94***
Age	0.01569	0.00504	3.11***
Education	0.01495	0.01462	1.02
Off-farm income	-0.290	0.033	-0.51***
Irrigation	-0.13957	0.15963	-0.87
Extension	-0.33881	0.15937	-2.13**
Household size	-0.34541	0.02817	-1.19
Membership	-0.06117	0.18260	-0.33**
Access to credit	-1.58338	0.22559	-7.02***
Constant	1.62500	0.23610	3.03***
Variance Parameters			
$\sigma^2 = \sigma_v^2 + \sigma_\mu^2$	0.659	0.086*	
$\gamma = \sigma_\mu^2 / \sigma^2$	0.937	0.018*	
σ_μ^2	0.618	0.086*	
σ_v^2	0.014	0.010*	
Technical Efficiency Mean	0.476		
Coefficient function	1.532		
Log probability	-1099.7104		

Source: survey results. *Asterisks *, ** and *** represent significant levels at 10%, 5% and 1% respectively.*

4.5. Maize farmers level of technical efficiency

Table 5 presents the maize farmers' level of technical efficiency distributions. The results of the table show that farmers' maximum TE is 0.98 and the minimum TE is 0.44. The average TE is approximately 0.48. This indicates that maize farmers in the study area have room to improve their output by 52% using the same level of inputs.

Also, the wide scope of technical efficiency values shows a vast difference in presentation across farms. For instance, the outcome indicates that 43% of the farmers have technical efficiency of less than 50% followed by 16% of the population whose efficiency ranges from 71% to 80%. Again, the outcome indicates that less than 4% of the farmers are growing maize with technical efficiency, thus, from 91% to 100%.

Table 5: Maize farmers level of technical efficiency distribution in Bolgatanga

Range of technical efficiency	Frequency	Percentage (%)
≤ 0.5	260	43.3
0.51-0.60	73	12.2
0.61-0.70	90	15.0
0.71-0.80	97	16.2
0.81-0.90	60	10.0
0.91-1.00	20	3.3
Total	600	100
Mean	0.476	
Max	0.98	
Min	0.44	

Source: survey results

5. Conclusion and Policy Implications

In order to examine the impact of agricultural credit on the technical efficiency of maize farmers in Ghana, the study used data obtained from Bolgatanga Municipality. Using the econometric approach, the study revealed the fooling conclusions;

The study revealed that there are significant differences between farmers with access to credit and those without access to credit in terms of the variables used in this study. Precisely, the TE of those with access to credit was 49% and those without credit were 44%; thus, there is a significant difference among the farmers.

Access to credit is likely to increase the TE of the farmers by 5%. The average TE score of the farmers was 47.6%. The study also found out that factors like membership, gender, farmers' access to credit, age and social networkdetermine farmers' possibility of accessing agricultural credit. The study finds out that returns to size in on the increases among the maize farmers and that significant improvement in efficiency can realize by increasing the level of input used in production. Also, factors such as farm size, labor, seeds, and fertilizer are the essential determinants of maize production output. Also, gender, extension, age, off-farm income, access to credit and membership were significant factors influencing TI

Some policy implications were spelled out. For example, in order to enhance farmers' access to resources, the study recommended that there should be a reduction of the small market for the high pricing of natural resources such as land so that farmers can improve both efficiency and productivity. Also, for access to agricultural credit (variable of interest), investors are required to streamline loan application procedures, provide intensive education on loan procedures to farmers and to promote flexibility on collateral security demanded by financial institutions to improve farmers' access to credit.

Moreover, the study also recommended that quality of access to extension (human capital), mass extension methods should be encouraged and emphasized in other to facilitate the education of farmers on the current technology way of farming since extension officers in the region are limited. It could be done via the radio mass communication, farmers' membership groups and televisions to enable the education of farmers to enhance technical efficiency and productivity.

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