



## Empirical impact of financial service access on farmers income in Ghana

Anthony Siaw<sup>1</sup>  Martinson Ankrah Twumasi<sup>1</sup>  Wonder Agbenyo<sup>1</sup>   
Evans Brako Ntiamoah<sup>2</sup>  Gideon Amo-Ntim<sup>3</sup> Yuansheng Jiang<sup>1\*</sup>

<sup>1</sup>College of Economics, Sichuan Agricultural University, Chengdu, China. E-mail: [yjiang@sicau.edu.cn](mailto:yjiang@sicau.edu.cn). \*Corresponding author.

<sup>2</sup>College of Management, Sichuan Agricultural University, Chengdu, China.

<sup>3</sup>Department of Economics, Ohio University, 45701, Athens, Ohio, United States of America.

**ABSTRACT:** The impact of access to financial services (AFS) and access to informal financial services (AIFS) on farmer income is examined in this study. After a multi-stage random sampling procedure, the study used a sample size of 478 people from two regions in Ghana. The endogenous treatment regression (ETR) model was used to account for selection bias while the unconditional quantile regression (UQR) model was used for a heterogenous analysis. The findings showed that education, financial literacy, IT access, farm size, and distance were all factors of access to financial services. Similarly, the findings revealed a positive and statistically significant link between household income and access to formal financial services. Similarly, there was a positive and significant association between access to informal financial services and household income. The findings showed that access to formal and informal financial services has different effects on household income. As a result, the effects of access to financial services on income varied by quantile. Based on the findings of the study, we developed policies to boost financial services accessibility as a means of increasing household income.

**Key words:** financial service accessibility, farmers income, unconditional quantile regression model, endogenous switching regression model, Ghana.

## Impacto empírico do acesso a serviços financeiros na renda dos agricultores em Gana

**RESUMO:** O impacto do acesso a serviços financeiros (AFS) e acesso a serviços financeiros informais (AIFS) na renda do agricultor é examinado neste estudo. Após um procedimento de amostragem aleatória em vários estágios, o estudo utilizou uma amostra de 478 pessoas de duas regiões de Gana. O modelo de regressão de tratamento endógeno (ETR) foi usado para explicar o viés de seleção, enquanto o modelo de regressão quantílica incondicional (UQR) foi usado para uma análise heterogênea. Os resultados mostram que educação, alfabetização financeira, acesso a TI, tamanho da fazenda e distância foram fatores de acesso a serviços financeiros. Da mesma forma, os resultados revelaram uma ligação positiva e estatisticamente significativa entre a renda familiar e o acesso a serviços financeiros formais. Da mesma forma, houve associação positiva e significativa entre acesso a serviços financeiros informais e renda familiar. Os resultados mostram que o acesso a serviços financeiros formais e informais tem efeitos diferentes na renda familiar. Como resultado, os efeitos do acesso a serviços financeiros sobre a renda variaram por quantil. Com base nos resultados do estudo, desenvolvemos políticas para aumentar a acessibilidade dos serviços financeiros como forma de aumentar a renda familiar.

**Palavras-chave:** acessibilidade de serviços financeiros, renda dos agricultores, modelo de regressão quantílica incondicional, modelo de regressão de comutação endógena, Gana.

## INTRODUCTION

Access to financial services (AFS) is thought to boost household welfare through increasing income and increasing asset accumulation (BOJNEC & FERTO, 2016). According to BOSTEDT et al., (2021) and ANKRAH TWUMASI et al., (2022), access to and usage of financial services by households results in a positive shift in income and finally allows the poor to escape poverty traps. According to KINGU (2019) and BOJNEC & KNIFIC (2021), increased revenue allows for investments in human capital and health, which boosts productivity and economic growth. AGBENYO et al., (2019), in their contribution

to the access to finance debate, established that understanding finance's function in the endogenous growth theory portrays that the agriculture sector's growth is dependent on access to financing. Access to financial services is also an essential to rural development, according to ABRAHAM & FONTA (2018) and FERTÓ et al., (2021). It will also increase incomes through productive investment, assist in the creation of employment opportunities, facilitate investments in health and education, and reduce the poor's vulnerability by assisting them in smoothing their income patterns over time (ASANTE-ADDO et al., 2017; BECK; DEMIRGUC-KUNT; HONOHAN, 2009; ISAGA, 2018). As a result, absence of banking services can exacerbate poverty among rural residents.

According to CLAESSENS (2006), access to credit is influenced by the availability of a supply of reasonable quality financial services at reasonable costs, whereas use of financial services is defined as the actual consumption of financial services. The information era has made it more convenient to make available financial services to communities that lack access. With or without a physical presence, financial services can be accessed with a click of a button (TCHAMYOU et al., 2019). Financial innovations, according to CHANDIO et al., (2021), HUSSAIN & THAPA (2016) and ABRAHAM & FONTA (2018), are targeted at boosting farmers' access to financial services. However, research on whether various financial services serve primarily impoverished and financially disadvantaged farmers is limited (BECK et al., 2015; BECK & CULL, 2014)

Agricultural producers in most developing countries, particularly those in low-income countries like Ghana, face a variety of challenges, including low productivity, limited access to commercial facilities for their farm products, and, most importantly, access to finance. While agriculture remains an important economic activity in Africa, employing roughly 55% of the population, the agricultural sector receives just around 1% of bank lending (AGBENYO et al., 2019). According to Findex data, only 4.7% of adults in rural areas in developing countries have access to formal financial institutions' loans, and only 5.9% have a bank account. Accessing financial services, an income booster, directly influences rural Ghana's livelihoods (SIAW et al., 2020). However, rural Ghanaians are said to have limited access to financial services. Inadequate access to basic social amenities and agricultural production continues to be a systemic concern in Ghana's rural communities (ANANG et al., 2016).

Despite various studies on financial access, the level of accessibility to financial services in most developing countries remains a major concern, particularly for individuals living in rural areas. Limited access to production, credit to buy and use farm inputs, and payment for non-family farm labor and other farm maintenance costs are all common examples of the problem (CHANDIO et al., 2018; SIAW et al., 2020). Farm productivity on smallholder farms is often low, despite available technologies for increasing yields, because smallholder farmers cannot afford yield-enhancing inputs. Conversely, smallholder farmers have difficulty obtaining post-harvest loans, resulting in severe household liquidity constraints, forcing them to sell most of their produce during harvest when prices are severely

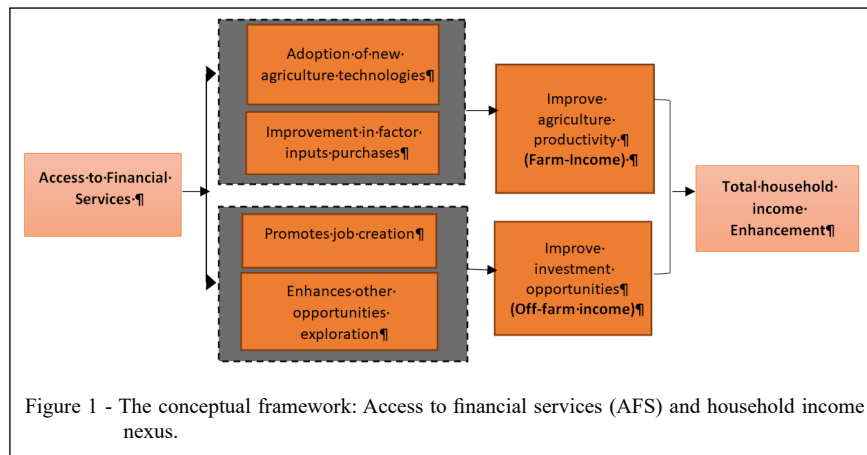
low. Financial constraints also hinder them from conditioning produce to reach premium market grade standards (CHANDIO & JIANG, 2018). They miss out on possibilities to increase household income this way. Furthermore, because few financial institutions provide such services in rural areas, smallholders have limited access to institutional savings facilities. This analysis is based on insufficient empirical information on whether access to financial services can affect farmers' income (SIAW et al., 2017; TWUMASI et al., 2020, 2021).

The study's main has two main aims. First, we assessed the effects of financial services accessibility on household income. Second, we examined the heterogeneous impact of financial services accessibility on household income based on household income quantiles. The following are the contributions of this research. First, using Ghana as a case study, we can see how AFS can affect farmers' income in a country where farming is a prominent occupation yet farmers' earnings are always dropping. Second, we use three metrics to assess AFS: access to credit, savings, and insurance. Compared to certain studies that just employ a portion or one of these variables to measure AFS, our measurement is more comprehensive. As a result, our findings may help us better understand the impact of AFS on household income. Finally, we examined the impact of formal and informal financial services access. The impact of these two financial services on household income may differ. However, most studies only focus on one section instead of both. Thus, in this study we compared how formal and informal financial services access affect household income differently.

#### *Analytical framework and hypotheses development*

Studies have confirmed an improvement in the lives of many individuals and households in most developing nations through access to financial services (AFS) (ADJEI et al., 2009; CHAUVET & JACOLIN, 2017). Nonetheless, rural households, which farmers dominate, face difficulty in raising their welfare due to a lack of financial services (income) (CHURCHILL & MARISSETTY, 2019). This study posits that the income of rural households influences their access to financial services (e.g., owning a bank account or having access to obtain insurance and credit). Figure 1 shows the path system through which AFS influences income.

The first path demonstrated how households with AFS can boost their farm inputs (e.g., machinery, manpower, fertilizer, and improved seeds) by leveraging their credit market



advantages (finance services). Farmers could also adopt modern agricultural technologies if there is no constraint to credit access (e.g., access to loans) as explained by BOJNEC & FERTŐ, (2013), DU et al. (2019) and ANKRAH TWUMASI et al. (2020) that credit unavailability hinders farmers from increasing production inputs and thus discourages them from enhancing productivity. AFS influences agricultural input variables, which causes the decrease of uncertainties and risks related to agricultural production and sale, resulting in increased productivity and, as a result, a positive impact on household income through farm income improvement (MA & WANG, 2020). Farmers' capacity to increase their engagement in agricultural production reduces as risks and uncertainties become difficult to manage (CABRERA et al., 2009).

AFS provides a channel for financial service users to seek work and other prospects; therefore, increasing household income through off-farm income improvement as depicted in the second pathway by the figure 1. Governments, non-governmental organizations (NGOs), and policymakers are encouraged to acknowledge financial inclusion as one of the measures to improving business formation (entrepreneurship development), which has the potential to generate off-farm income, particularly for rural households.

Financial services have also helped poor people invest in additional income-generating options such as education, bonds, treasury bills, rented structures, and insurance policies (CHURCHILL & MARISSETY, 2019; KUMARI & FERDOUS AZAM, 2019).

Pursuing these investment avenues can boost household income by generating other forms of income (off-farm income). As a result, it is expected that AFS will improve rural household agricultural and non-agricultural income, resulting in an increase in total household income.

Availability of credit has a quantile effect on household income, which shows the proportional growth in household income. In a study done in China, MA & WANG (2020) discovered that the magnitude effect of Internet use on household well-being was greater at the 75th quantile than at the 25th quantile. This study proposed two hypotheses on how access to financial services affects the income of rural households based on this theoretical framework.

H1: There is a direct relationship between household income and access to financial services.

H2: A heterogeneous positive relationship exists between household income and access to financial services.

## MATERIALS AND METHODS

### Data source

#### Method of data collection and variables explanations

The data used in this study were collected from a rural household survey conducted in Ghana from January to April 2020. A multi-stage sampling strategy was used to collect data from 478 farmers in two regions for this study. The two (2) regions chosen in the first stage were the Eastern region in southern Ghana and the Brong Ahafo region in central Ghana. In the second stage, one district from each designated region was picked at random. Kintampo north district in the Brong Ahafo region and Brim central district in the Eastern region were among them. Kintampo,

Babatokuma, and Benkrom in the Kintampo North District and Manso, Asuboa, and Nkwanta in the Brim Central District were the three (3) settlements chosen at random from each designated district in the third stage. Finally, the respondents were chosen using a basic random technique. A total of 10–20 rural homes were chosen at random from each village. The sample size was obtained using CALDERON & GONZALES (2011) sample selection approach.

All household farmers in Ghana's two regions make up the target demographic for this exercise. According to the 2010 population census, there are 13,606,109 rural household farmers in Ghana, accounting for 56.2 percent of the total population. The study's target population is anticipated to be 13,606,109 people. CALDERON & GONZALES (2011) suggested that the sample size be calculated using the formula below.

$$n = \frac{N}{(1 + N(\alpha)^2)}$$

Where  $N$  denotes the total number of farm families in the study;  $n$  denotes the sample size to be calculated; and  $(\alpha)$  is the preferred margin of error. According to the 2010 population and housing census numbers, the targeted population is anticipated to be 13,606,109 agricultural households, with a 0.05 error margin (that is 5 percent). The sample size for this investigation is calculated using these figures:

$$n = \frac{13,606,109}{1 + 13,606,109 (0.05)^2}$$

$$n = \frac{13,606,109}{1 + 34,015.273}$$

$$n = \frac{13,606,109}{34,016.273}$$

$$n = 399.99$$

$$\therefore n = 400$$

Due to non-responses, we increased the sample size to 500 but after screening, a total sample size 478 were made available for the study's analysis.

Interviews and questionnaires were used to obtain data from these rural agricultural households in Ghana. Due to the questionnaire's complexity, an in-depth interview was undertaken. A pre-test of the questionnaire was conducted to eliminate any doubts. The survey data questionnaires included questions about socioeconomic characteristics, Internet use, and other variables relevant to the study's goal.

AFS (formal services) denotes the presence of at least one of the three signs in the response (access to credit, savings and insurance). The respondent is

considered to have formal financial services if he or she answers "yes" to the question "Did you access any of these three financial services in the last 12 months?" Similarly, if the respondent says yes to the question "Did you use any informal financial services (save with friends or relatives/get credit from relatives or friends) in the last 12 months?" he or she is judged to have used informal financial services. Household income is calculated using a combination of off-farm and farm earnings. Wages/salaries, rent, remittances, pensions, and dividends are all examples of off-farm income. After following other literature (e.g., ANKRAH TWUMASI et al., 2021; MA et al., 2018; SIAW et al., 2020) and our available data, some other variables (e.g., age, gender, education, farming experience, distance from farmers' resident to the nearest financial institution, financial literacy and household size) were added as control variables to establish consistency in our estimation (The definitions of the other control variables may be found in Table 1). STATA 15 was used to edit and code the data to guarantee accuracy, validity, uniformity, consistency, and completeness.

#### *Empirical model specification*

The focus of this study is on the relationship between financial services accessibility and household income (farm, off-farm and total income). It's worth noting that this study calculated the influence of access to informal financial services on household income; thus, where the term "financial services" appears in the method's description, it refers to both formal and informal financial services. Because using financial services is voluntary, the fundamental variable (financial services accessibility) is possibly endogenous. As a result, households decide whether or not to use financial services (HÜBLER & HARTJE, 2016). Inconsistency in the study's estimates would result if the endogeneity issue of access to financial services was not addressed. Endogenous treatment regression (ETR), propensity score matching (PSM) method, regression adjustment (RA) estimator, inverse-probability weighting (IPW) estimator, augmented inverse-probability weighting (AIPW) estimator, and inverse probability-weighted adjusted regression (IPWRA) estimator are among the best tools for dealing with endogeneity in cross-sectional data analyses. These econometrics tools are especially useful when estimating the effect of a dichotomous endogenous variable on outcome variables of interest (LIU et al., 2019; KHANAL et al., 2015; OGUTU et al., 2014). However, we chose ETR since it is the best of these models. The rationale

Table 1 - Variable measurement and a priori expectations.

Variables	Measurement
Access to financial services	1 if the respondent had access to financial services; 0 otherwise
Access to informal financial services	1 if the respondent had access to informal financial service; 0 otherwise
Farm income (GH¢)	Amount of annual farm income (GH¢1000/capita)
Off-farm income (GH¢)	Amount of annual farm income (GH¢1000/capita)
Household income (GH¢)	Amount of total household income (GH¢1000/capita)
Age	Age of the respondent
Gender	1 if respondent is a male; 0 otherwise
Education	Years of schoolings
Household size	Number of members in a household (number)
Financial Literacy	Financial literacy scores
Membership	1 if respondent joins an association; 0 otherwise
Access to IT	1 if the respondent has access to IT (Television, radio and Internet); 0 otherwise
Distance	1 if respondent had a relative with a chronic disease; 0 otherwise
Farm experience	Years of farming experience (years)
Farm size	Respondent farm size (in acres)
Eastern	1 if respondent resides in Eastern region; 0 otherwise
Brong Ahafo (BA)	1 if respondent resides in BA region; 0 otherwise
Distance	The distance from the respondent house to the nearest financial institution
Social network	1 if respondent relates to someone who can provide loan to him/her; 0 otherwise

for this is that the ETR model can handle selection bias caused by both observed and unobserved factors at the same time, but other models (e.g., PSM, RA, IPWRA, IPW, and AIPW) can't (MA & ABDULAI, 2016; TESFAYE & TIRIVAYI, 2018). Again, the ETR can assess the treatment variable's direct effect on the outcome variables (MA & ABDULAI, 2016). As a result, the author claims that utilizing the ETR model is beneficial to the study.

Another goal of the research is to better understand the potential heterogeneity of the influence of financial services on dependent variables from a policy standpoint, because ETR estimation only finds a homogeneous impact of financial services on outcome variables. A quantile regression model was utilized to continue the heterogeneous analysis. An unconditional quantile regression (UQR) model is used to investigate the diverse influence of access to financial services on household income distributions on outcomes of interest, as proposed by (BALTAGI & GHOSH, 2017; MA et al., 2019).

#### ETR model

In two stages, the ETR model is specified and calculated. In stage one, a household's decision to use financial services is specified using a traditional binary choice model. At this point, the attributes that

are associated with accessing to financial services decisions, such as farmers and farm attributes, are identified. The outcome equation is then constructed in stage two to relate the features associated with household income while adjusting for potential endogeneity associated with financial services access. The equations for the two stages are as follows:

First stage:

$$T_i^* = \delta X_i + C_i + \varepsilon_i, \quad T_i = \begin{cases} 1 & \text{if } T_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

$$\text{Second stage: } Y_i = \alpha T_i + \beta X_i + \mu_i \quad (2)$$

Where  $T_i^*$  is a latent variable that specifies the utility difference between accessing financial services and not accessing financial services in household  $i$ ;  $T_i$  is a dichotomous variable, with  $T_i = 1$  meaning usage of financial services and  $T_i = 0$  implying non-use of financial services.  $Y_i$  represents the dependent variables (farm, off-farm, and total household income);  $X_i$  is a vector of household head, household, and farm-level characteristics (e.g., household head's age and education, household size, and farm size) that are expected to influence the decision to access financial services and income level distributions;  $\delta$ ,  $C$ ,  $\alpha$ ,  $\beta$  are parameters to be estimated. Specifically, the direct/homogenous influence of financial services accessibility on household incomes is captured  $\alpha$ . The terms  $\varepsilon_i$  and  $\mu_i$  are mistake terms.  $I_i$  is the instrumental variable (IV) used in the ETR model's estimation procedure. The variable social

network (whether the respondent is related to someone who can provide a loan to him/her) is the instrument for access to informal financial services, while distance (distance from the respondent's house to the nearest financial institution) is the instrument for access to formal financial services. These IVs are projected to have an impact on the respondent's decision to use (informal) financial services, but not on household income.

Equations (1) and (2) can be estimated together using a maximum likelihood estimator, yielding a correlation of  $\rho_{\varepsilon_i \mu_i} \neq 0$  between the two error factors. The presence (absence) of the endogeneity problem associated to access to (informal) financial services would be shown by the statistically significant (insignificant) coefficient of  $\rho_{\varepsilon_i \mu_i}$  (HÜBLER & HARTJE, 2016). Furthermore, this paper presents the results of a Wald test to see if the estimated correlations between treatment assignment and prospective outcome models are different from zero, with the null hypothesis being that they are both zero.

#### *Unconditional Quantile Regression (UQR) model*

Because the ETR model only works with a mean-based/homogenous estimation of the impacts of access to financial services on household incomes, the UQR is also used to analyze the heterogeneous implications of access to financial services on household incomes. A UQR model can be estimated using the recentred influence function (RIF) as a simple OLS regression on a transformed dependent variable (BALTAGI & GHOSH, 2017; MISHRA et al., 2015). The following is the equation:

$$\text{RIF}(Y_i; Q_r, F_Y) = \omega T_i + \phi X_i + \rho_i \quad (3)$$

The  $r^{\text{th}}$  quantile of the outcome cumulative distribution is denoted by  $Q_r$ .  $F_Y$ ,  $T_i$ , and  $X_i$  are the same specifications as in equation (1);  $\omega$  and  $\phi$  are to be estimated parameters; and  $\rho_i$  is an error term. The RIF in equation (3), for example, is defined as:

$$\text{RIF}(Y_i; Q_r, F_Y) = Q_r + \frac{r - I(Y_i \leq Q_r)}{f_Y(Q_r)} \quad (4)$$

The indicator function is  $I(\cdot)$ , and the probability distribution function of variable  $Y_i$  is  $f_Y$ . In the estimation of equation (3), the potential endogeneity issue related to access to financial (informal) services might be neglected in order to obtain consistent results. The correlation coefficients of the error terms between equations (1) and (2) following ETR model estimation that is,  $\rho_{\varepsilon_i \mu_i}$ , can be linked to this worry. The coefficient of  $\rho_{\varepsilon_i \mu_i}$  in the ETR model, in particular, is not statistically significant, showing that there is no endogeneity problem associated with the access to financial

(informal) services variable. In that circumstance, the researcher might use the access to financial (informal) services variable as an exogenous variable in the UQR model estimation.

## RESULTS

### *Descriptive statistics*

The respondents' descriptive data are presented in table 2 below. Approximately 42% and 45% of respondents respectively have access to formal and informal financial services. Farm income, off-farm income, and household income per capita are GH2.05, GH2.43, and GH4.49, respectively, on an annual basis. The respondents' average age, years of schooling, and years of farming experience are 42, 7, and 14 years, respectively. While 70% of the respondents are male, 44% and 81% of the respondents, respectively, are members of farm associations and IT users. The average household size is five people, and the average farm size is 3.34 acres. Respondents from the Eastern and Brong Ahafo regions account for 46 percent and 54 percent of the total. The average distance between the respondent's home and the nearest financial institution was 1.34 kilometers, according to the findings. While the average financial literacy score is 1.14, over half of the respondents (43%) know someone who can help them get a loan.

### *Difference between the means of access to Financial Services and Non-access to financial services*

Table 3 presents the means differences between rural farmers who have access and rural farmers who do not or lack access to financial services. The mean differences between those who have access and those who do not have access were significant in terms of gender, education, financial literacy, access to IT, distance and social network variables. Those with a higher level of education, for example, are more likely to have access to financial services than those with less or no formal education. In addition, the chart reveals that individuals who have access to financial services have higher farm income, off-farm income, and total household income than those who do not. This suggested that persons with access to financial services have a higher income than those without. The mean difference comparison, on the other hand, does not account for confounding circumstances, which could lead to erroneous conclusions. As a result, using an econometric technique to assess the impact of financial services access is critical.

Table 2 - Distribution of household samples by area.

Variables	Mean	Std. Dev.	Min	Max
Access to financial services (AFS)	0.42	0.50	0	1
Access to informal financial services (AIFS)	0.45	0.49	0	1
Farm Income	2.05	0.87	1.24	3.98
Off-farm Income	2.43	1.05	1.41	4.85
Total household Income	4.49	2.76	2.65	8.83
Age	41.72	12.20	30	64
Gender	0.70	0.46	0	1
Education	7.48	5.49	0	16
Household size	5.36	1.30	1	9
Financial Literacy	1.14	0.94	0	3
Membership	0.44	0.50	0	1
Access to IT	0.81	0.56	0	1
Farm experience	13.65	7.84	2	32
Farm size	3.34	1.87	1	11
Eastern	0.46	0.51	0	1
Brong Ahafo	0.54	0.49	0	1
Distance	1.34	0.47	0	1
Social network	0.43	0.46	0	1

Source: Survey results.

### Empirical analysis

The household income impact of access to financial and informal services is empirically shown below (Table 4 and 5). The use of the ETR model make it possible to calculate equations (1) and (2) jointly. As displayed in the lower part of both tables, it can be seen that the  $\rho_{\mu\epsilon}$  coefficients are statistically insignificant and negative. This means there isn't any selection bias due to unobserved traits (MA

et al., 2018). The null hypothesis, that there is no association between household incomes and access to financial and informal services, cannot be rejected because the Wald test values are not significant. This finding also implies that the focal variables, access to financial and informal services, can serve as exogenous variables in the UQR estimation. The interpretations of the results of the ETR model are shown below.

Table 3 - Differences in access to financial services and access to non-financial services (key variables).

Variables	Access to Financial Services (AFS)	Non- Access to Financial Services (NAFS)	-----Diff.-----
Farm Income	2.45 (1.04)	1.74 (0.71)	0.71***
Off-farm Income	3.12 (1.52)	1.78 (0.58)	1.34***
Total household Income	5.43 (2.06)	3.71 (1.17)	1.72***
Age	41.14 (7.23)	42.45 (8.04)	1.31
Gender	0.83 (0.08)	0.54 (0.06)	0.29***
Education	9.32 (3.21)	5.46 (2.83)	3.86***
Household size	5.19 (3.98)	5.68 (3.04)	0.49
Financial Literacy	1.89 (0.43)	0.63 (0.32)	1.26**
Membership	0.46 (0.06)	0.41 (0.03)	0.05
Access to IT	0.89 (0.07)	0.83 (0.05)	0.06*
Farm experience	14.17 (0.77.)	13.24 (0.73)	0.93
Farm size	4.21 (2.32)	2.52 (1.21)	1.69
Distance	1.68 (0.75)	1.02 (0.62)	0.66*
Social network	0.57 (0.08)	0.33 (0.05)	0.24**

Source: Survey results.

Table 4 - Effect of Formal Financial Services Access on Household Incomes (ETR model).

Variables	Access to Financial Services	Total Household Income	Access to Financial Services	Farm Income	Access to Financial Services	Off-farm Income
Access to formal financial Services		0.239** (0.098)		0.269*** (0.099)		0.454*** (0.096)
Age	-0.004 (0.230)	-0.031 (0.333)	-0.006 (0.233)	-0.003 (0.522)	-0.008 (0.231)	-0.005 (0.820)
Gender	-0.085 (0.591)	-0.006 (0.553)	-0.088 (0.593)	-0.013 (0.244)	-0.090 (0.596)	-0.075 (0.231)
Education	0.160*** (0.033)	0.188* (0.088)	0.164*** (0.035)	0.478*** (0.059)	0.166*** (0.036)	0.239** (0.099)
Household size	-0.070 (0.282)	0.007 (0.183)	-0.072 (0.284)	0.014 (0.630)	-0.074 (0.286)	-0.049 (0.250)
Financial Literacy	0.451*** (0.092)	0.290*** (0.065)	0.455*** (0.094)	0.237** (0.088)	0.458*** (0.096)	0.257*** (0.087)
Membership	0.030 (0.173)	0.315*** (0.023)	0.032 (0.177)	0.225*** (0.024)	0.035 (0.175)	-0.162 (0.682)
Access to IT	0.100* (0.040)	0.150*** (0.066)	0.102* (0.044)	0.127*** (0.012)	0.106* (0.043)	0.097* (0.044)
Farm experience	-0.010 (0.818)	-0.000 (0.028)	-0.012 (0.820)	-0.004 (0.685)	-0.015 (0.819)	0.009 (0.408)
Farm size	0.270*** (0.050)	0.442*** (0.058)	0.272*** (0.052)	-0.003 (0.933)	0.276*** (0.053)	0.218** (0.078)
Eastern	-0.270*** (0.050)	0.442*** (0.058)	-0.272*** (0.052)	-0.003 (0.933)	-0.276*** (0.053)	0.218** (0.078)
Distance	-0.218*** (0.093)		-0.220*** (0.097)		-0.223*** (0.095)	
_cons	-2.121** (0.648)	1.283*** (0.244)	-2.128** (0.644)	1.489*** (0.689)	-2.125** (0.648)	3.503*** (0.985)
$\rho_{\mu\epsilon}$	-0.311 (0.342)		-0.273 (0.199)		-0.136 (0.95)	
Wald X <sup>2</sup>	-----89.45-----		-----26.11-----		-----38.34-----	
Log pseudo	-----633.615-----		-----431.809-----		-----444.755-----	

Source: \*, \*\*, and \*\*\* in the survey results indicate statistical significance at 10%, 5%, and 1% alpha levels, respectively. All figures in brackets represent robust standard errors. The reference region is Brong Ahafo.

#### Determinants of access to formal and Informal financial services

Table 4 shows the factors that influence access to formal financial services in columns 2, 4, and 6. Because the findings are nearly identical, the interpretation is based on column 2. The data show that education variable has a positive sign, meaning that educated rural residents have more access to financial services. One possible reason is that enlightenment is achieved through greater education, which has financial rewards. The findings

of ANKRAH TWUMASI et al. (2020) and SIAW et al. (2020) are supported by this result.

The financial literacy variable has a statistically significant positive impact on access to financial services, implying that those who are financially literate have a greater chance of receiving financial services. The findings agree with KHAN & SURISSETTI (2021) study, which reported that financial knowledge boosts people's confidence in participating in the financial sector. Similarly, the positive and significant correlation for the access to

Table 5 - Impact of Access to Informal Financial Services on Household Incomes (ETR model).

Variables	Access to informal financial service	Household Income	Access to informal financial service	Farm Income	Access to informal financial service	Off-farm Income
Access to informal financial Services		0.135*** (0.048)		0.159*** (0.056)		0.254** (0.076)
Social network (IV)	0.076** (0.020)		0.081** (0.022)		0.079** (0.020)	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Regional Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.121** (0.048)	0.283*** (0.044)	-0.696 (0.159)	0.489*** (0.089)	-0.754*** (0.061)	0.503*** (0.085)
$\rho_{\mu\epsilon}$	-0.157 (0.142)		-0.328 (0.142)		-0.185 (0.106)	
Wald X <sup>2</sup>	-----114.45-----		-----76.59-----		-----83.35-----	
Log pseudo	-----1103.314-----		-----984.932-----		-----504.081-----	

Source: \*, \*\*, and \*\*\* in the survey results indicate statistical significance at 10%, 5%, and 1% alpha levels, respectively. All figures in brackets represent robust standard errors.



IT variable indicates that households having access to IT are more likely to use financial services. Users of IT gadgets can usually use the information they supply to gain financial skills and knowledge.

The farm size variable shows a statistically significant and positive influence on access to financing, showing that households with a greater farm size are more likely to use financial services. All other things being equal, large farm sizes are strongly linked to high production, resulting in increased revenue, making farmers creditworthy and more inclined to participate in the credit market (KHAN & SURISSETTI (2021). Residents of the Eastern area are more likely to have access to financial services than those in the Brong Ahafo (reference region). According to the findings, farmers' desire and ability to utilize financial services is influenced by regional heterogeneities (e.g., regional infrastructures and institutional finance arrangements).

Also, our findings demonstrated that the IV variable (distance) has a negative and statistically significant effect on access to financial services. This research implied that the farther a household is from secure financial services, the less likely it is to use them. This finding is consistent with the findings of the AWAWORYI CHURCHILL et al., (2020) study, which reported that people who live near a financial institution are more likely to use financial services due to lower transaction costs (e.g., transportation costs) and convenient accessibility.

In addition, table 5 shows the study's findings on the drivers of access to informal financial services and their impact on household income. As a result, the factors influencing access to informal financial services are presented. Only the social network (IV) variable outcome was provided and discussed for brevity seek. The social network variable is positive and statistically significant, indicating that respondents with relatives who can make loans are more likely to use informal financial services.

#### *Determinants of household income (access to financial and Informal financial services perspective)*

Tables 4 and 5 also include the elements that influenced household income. It's critical to look at the factors that influence household income from the standpoint of access to formal and informal financial services. This ensures that the respondents' income levels are affected by the unique role of access to formal and informal financial services. Access to formal and informal financial services positively impacts rural household earnings, as shown in table 4 and 5, respectively. The other control variables, such

as education, financial literacy, membership, access to IT, and farm size, significantly impact farm, non-farm, and total household income.

#### *Heterogenous impact of financial services access on total household, farm and off-farm income*

This section to determined the impact of financial services access on rural families in Ghana (Table 6). According to THORNTON & INNES (1989), the proportionate impacts of discrete variables on household income, such as access to financial (informal) services, are calculated where the variable's coefficient is the  $\alpha_i$ . According to the quantile regression estimates, the coefficients of access to formal and informal financial services are positive and significant. Access to formal and informal financial services positively influences household, farm, and off-farm earnings at each quantile level; hence, the coefficient values grow as the quantiles increase. This means that the farmers in the highest quantile gained more form accessing financial (informal) services. For example, access to financial services can increase household income at 50<sup>th</sup> quantile by 53%, i.e.  $[\exp(0.426) - 1]$ , while access to informal financial services can increase household income at 50th quantile by 14%. This can be attributed to the fact that most informal financial systems do not provide intense financial service or (if any) to their customers; hence farmers who patronize these forms of financial systems turn to have less influence on their income levels. The research results are not in conformity with TURVEY et al., (2010) study, which revealed that, relative to formal credit, informal credit has greater impact on household welfare. However, LIN et al. (2019) study, which showed that informal financial accessibility has less impact on household well-being supports this study.

Concerning the other control variables, the quantile regression estimates indicated that older farmer can increase their household income by 12% and 14% at 50th and 90th quantiles, respectively. Gender has significant impact on farmers' off-farm income in Ghana at 25th quantile. Meanwhile, education and financial literacy significantly impacted household income by 22% and 34% at 90th quantiles, respectively. Financial literacy as well as education play an important role in household income improvement.

Being a member of a farm-based association; conversely, has a direct and proportionate effect on a farmer's household and farm income. This means that farmers who are members of farm-based groups have access to information that can help

Table 6 - Quantile regression analysis of the impact of financial services on farmer income.

	-----Household Income-----				-----Farm Income-----				-----Off-farm Income-----			
	25th	50th	75th	90th	25th	50th	75th	90th	25th	50th	75th	90th
AFS	0.261*** (0.039)	0.426*** (0.043)	0.167 (0.419)	0.170 (0.098)	0.111 (0.091)	0.098 (0.071)	0.223** (0.090)	0.347** (0.133)	0.095 (0.083)	0.094 (0.077)	0.144* (0.072)	0.216 (0.146)
AIFS	0.021 (0.206)	0.135* (0.058)	0.243 (0.166)	0.024 (0.150)	0.030 (0.099)	0.119 (0.077)	0.165* (0.089)	0.234** (0.105)	0.143* (0.062)	0.067 (0.086)	0.064 (0.083)	0.136 (0.163)
Age	0.005 (0.498)	0.116** (0.048)	0.015 (0.252)	0.136* (0.072)	(0.005) (0.008)	-0.002 (0.007)	-0.001 (0.007)	0.005 (0.101)	0.004 (0.008)	0.001 (0.007)	0.010 (0.007)	0.014 (0.014)
Gender	-0.099 (-0.976)	0.085 (-0.498)	0.102 (0.262)	0.113 (-0.708)	-0.022 (0.081)	0.070 (0.063)	0.007 (0.072)	0.014 (0.094)	0.155* (0.074)	0.014 (0.069)	-0.021 (0.067)	-0.095 (0.130)
Education	0.024 (0.388)	0.058 (0.231)	0.068 (0.928)	0.195*** (0.015)	0.025 (0.050)	0.045 (0.039)	0.084* (0.045)	0.133** (0.049)	0.003 (0.045)	0.006 (0.044)	0.027 (0.042)	0.049 (0.083)
Household size	-0.022 (0.629)	-0.029 (0.083)	-0.007 (0.173)	-0.039 (0.694)	(-0.013) (0.029)	-0.012 (0.023)	0.012 (0.026)	0.027 (0.034)	-0.059* (0.027)	-0.045* (0.025)	-0.057* (0.024)	-0.099* (0.048)
Financial literacy	0.085 (0.730)	0.043 (0.493)	0.208 (0.494)	0.289** (0.116)	0.004 (0.093)	0.032 (0.073)	0.038 (0.083)	0.151 (0.108)	0.125 (0.086)	0.021 (0.080)	0.008 (0.078)	0.105 (0.152)
Farm membership	0.334** (0.230)	0.208*** (0.043)	0.169 (0.417)	0.012 (0.078)	0.183* (0.084)	0.166** (0.066)	0.151* (0.076)	0.220* (0.098)	-0.020 (0.088)	-0.069 (0.073)	-0.175 (0.099)	-0.054 (0.135)
Access to IT	0.371*** (0.097)	0.245* (0.123)	0.031 (0.226)	0.064 (0.361)	(0.015) (0.092)	0.015 (0.072)	0.096 (0.083)	0.150 (0.107)	0.257** (0.064)	0.254*** (0.079)	0.234** (0.087)	0.129 (0.150)
Farm Experience	-0.006 (0.637)	-0.010 (0.435)	-0.091* (0.043)	-0.021 (0.417)	(-0.003) (0.008)	0.001 (0.006)	0.001 (0.007)	-0.006 (0.009)	0.001 (0.007)	0.012* (0.006)	0.003 (0.006)	0.010 (0.013)
Farm size	0.013* (0.007)	0.143*** (0.020)	0.131*** (0.017)	0.259*** (0.090)	0.011 (0.076)	0.114* (0.054)	0.142** (0.055)	0.010 (0.056)	-0.006 (0.005)	0.023 (0.045)	0.013 (0.016)	0.024 (0.019)
Constant	3.524*** (0.975)	4.510*** (2.367)	4.723*** (1.565)	3.890*** (0.470)	2.899*** (0.586)	4.260*** (1.659)	2.840** (1.096)	2.229** (0.881)	4.579** (1.791)	4.618*** (1.688)	4.735* (1.896)	4.209** (1.547)

*SD* statistics in parentheses \*  $P < 0.1$ , \*\*  $P < 0.05$ , \*\*\*  $P < 0.01$ . Note: Dependent Variable Income Quantile. AFS = access to financial services. AIFS = Access to informal financial services.

the farm thrive. This is due to the fact that farm-based associations benefit from a variety of resources, including extension services and interest-free loans. Financial institutions are also happy to provide such organizations with financial services. The farmer's home income and farm income are likely to rise as a result of this.

In addition, farmers' total household income at the 50th quantile and off-farm income at the 75th quantile had a positive association with IT access. As a result, access to technology is anticipated to boost farmers' off-farm and household incomes. This is due to the financial incentives associated to IT data. According to LENG et al., (2020), IT helps rural households diversify their revenues, hence enhancing household wellbeing.

In another example, at 0.75 quantiles, farm experience has a negative impact on household income. This means that an increase in farmers' experience leads to a corresponding fall in household income at the 75th quantile. This is most likely due to the belief that experienced farmers will be hesitant

to adopt new technologies that will reduce total output and, as a result, household income. At the 0.50 quantiles; however, farm experience showed a positive significant impact on off-farm income. This could also be explained by the fact that a seasoned farmer may devote less time to the farm and more time to off-farm activities that boost his or her income.

Farmers' household and farm income are directly proportional to the size of their farms. A percentage increase in the farm size of rural farmers is likely to increase their household income by 29% at 90th quantile and farm income by 15% at 75th quantile. This is true as farmers with large-scale farms can enjoy farm inputs, marketing, and distribution incentives, which boost their productivity and thereby increase their incomes.

## DISCUSSION

Improving the financial standing of farmers is crucial for sustainable agriculture since

it may empower them to invest in their farming activities rather than off-farm jobs. Given this, the study examined how access to formal and informal financial services can promote farmers' income. The positive and significant coefficient of the main core variables, access to formal and informal financial services, in tables 4 and 5 infers that households with access to financial services have a higher propensity to grow farm, non-farm, and total household income. However, the impact of formal financial services on the household incomes are more profound compared to informal services. Financial services, including insurance (farm or farm/house equipment), credit accessibility and savings, are great elements to promote agricultural growth, and they also help farmers to achieve their farming expectations (ANKRAH TWUMASI et al., 2020; ANKRAH TWUMASI et al., 2022; SIAW et al., 2020).

In addition, the research showed that being a member of farm associations positively influences total household and farm income, whereas this membership does not necessarily guarantee a higher off-farm income. This implies that farmers who are members of farm organizations can increase their total household income by 31.5% and 22.5% on farm income. At a 1% significance level, this result is statistically significant. The findings are consistent with those of DEMIRGUC-KUNT et al., (2018), SIAW; et al., (2020) and LIN et al., (2019).

Access to information technology increased total household, farm, and off-farm income. The positive coefficient indicates that access to information technology will benefit farmers' income levels (Household, farm and off-farm income). Thus, a unit increase in usage or access to IT will increase household income levels. Financial literacy also emerged to impact rural household income levels positively. The results suggested that respondents with higher financial literacy will increase their farm, off-farm and total household income. This implies that financial literacy is positively related to the respondent's income. Thus, decision making among respondents will depend on their knowledge of financial management or investment analysis. This discovery is likewise consistent with WACHIRA (2012) findings. Farm size significantly impacted total household income and off-farm income, but there was a statistically insignificant negative association between farm size and farm income. The positive indication is significant because farmers with big agricultural holdings have more assets and income from their farms than small-acre farmers. Education had a considerable beneficial impact on

overall household income, farm revenue, and off-farm income. This implies that as the educational level of a household increases, their income levels are likely to increase. The results confirmed AWAWORYI CHURCHILL et al., (2020) findings.

The policy implications attached to these findings are as follows. First, the government can, for example, simplify the requirements for starting microfinance in rural areas to entice investors into the sector and make formal financial services more accessible for farmers. Furthermore, because the distance between a farmer's home and the nearest financial institution encourages financial exclusion, policymakers should prioritize requisite infrastructures such as a proper road network and IT development, particularly in rural areas, to attract financial institutions to rural areas.

The following are the study's limitations. First, we only used two regions for this study, thus the sample size may be tiny. Larger sample sizes may be considered in future investigations. Second, while the study focuses on rural (farmer) households, other population segments, such as business owners and traders, exist in the country. Future research could look into how AFS affects these people as well.

## CONCLUSION

The conclusion of the study is presented in this section. The mean differences between those who have access and those who do not were significant in terms of gender, education, financial literacy, access to IT, distance and social network variables.

Access to financial services was also influenced by factors such as education, financial literacy, IT access, farm size, and distance. Similarly, the findings revealed a favorable and statistically significant link between financial services availability and household income. Similarly, there was a positive and significant association between access to informal financial services and household income. The findings showed that access to financial services has a diverse impact on household income. As a result, the effects of access to financial services on income varied by quantile. Financial availability is critical for poverty alleviation, necessitating the establishment of policies that enhance rural households' access to financial services to increase income.

## DECLARATION OF CONFLICT OF INTEREST

We have no conflict of interest to declare.

## AUTHORS' CONTRIBUTIONS

All authors contributed equally.

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