The Impact of Finance on Welfare of Smallholder Farm Household in Ghana

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Abstract:

This study estimates the effect of access to finance on smallholder farmer's welfare in the Northern Region of Ghana. Using field survey data, we compared the average difference in welfare between farmers with access to finance and non-equivalent control groups. By adopting Propensity Score Matching (PSM) and Propensity Score Weighting (PSW) to control selection bias, the results of the econometric estimation indicate that access to finance has a positive and significant effect on the welfare of smallholder farmers. The result provides evidence that smallholder farmers' participation in financial services must be promoted. Thus, policy towards extending finance to smallholder farmers must be adopted.

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ABSTRACT

This study estimates the effect of access to finance on smallholder farmer's welfare in the Northern Region of Ghana. Using field survey data, we compared the average difference in welfare between farmers with access to finance and non-equivalent control groups. By adopting Propensity Score Matching (PSM) and Propensity Score Weighting (PSW) to control selection bias, the results of the econometric estimation indicate that access to finance has a positive and significant effect on the welfare of smallholder farmers. The result provides evidence that smallholder farmers' participation in financial services must be promoted. Thus, policy towards extending finance to smallholder farmers must be adopted.

Keywords: Finance, Welfare, Propensity Score Matching(PSM) and Ghana

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1.1. INTRODUCTION

There is a consensus, based on economic theory, that access to finance has a positive impact on household welfare. By improving and extending access to finance, households can smoothen consumption and reduce exposure to risk. Finance also offers households the opportunity to invest in high-risk investments that ultimately culminate in improving household welfare (Eswaran & Kotwal, 1990; Karlan & Zinman, 2010). Similarly, Ledgerwood (2013) argues that access to finance improves household welfare through investment in health and education, household assets, and enhanced productivity, and that access to finance serves as a buffer against any future shock or risk. In a nutshell, Beck and Demirgüc-Kunt (2008) and Hudon (2009) described the critical role of access to finance as an ingredient needed to improve welfare of households in an economy. Indeed, Mahajan (2005) argues that although finance is relevant, it must be combined with other factors to improve the livelihood of households. In other words, access to finance is not the only means of ensuring improvement in welfare.

Even so, not many studies exist on the welfare impact of finance for smallholder farmers. The few studies that exist (Pitt & Khandker, 1998; Quach, Mullineux & Murinde, 2005; Kotir & Obeng-Odoom, 2009; Richard, Job & Wambua, 2015; Adebowale & Dimova, 2017) dwell on the household welfare impact of finance and not specifically on smallholder farmers. There is therefore relatively little empirical evidence on the welfare impact of finance on smallholder farmers. This perhaps also explains the absence of finance in agricultural development policies aimed at improving the welfare of smallholder farmers. It is imperative to note that in developing countries, especially in Africa, a main channel – income generation from production – through which finance enhances welfare is rooted in agriculture, particularly in smallholder farming. Most household economic activity in Africa is structured around agriculture and smallholder farming. Therefore, smallholder farming is the main production channel through which finance augments production to generate extra income and enhance welfare. This confirms the relevance of studying the finance–welfare link from a smallholder farmer point of view. Another weakness of most studies is the use of one-dimensional welfare measures such as income and consumption. These gaps create the opportunity for further empirical studies. This essay therefore provides new evidence on the effect of finance on the welfare of smallholder farmer households using the case of Ghana.

In Ghana numerous agricultural policies have been implemented to enhance welfare (Nyanteng & Seini, 2000); however, these seem to be devoid of financing strategies. Although a plethora of financial sector initiatives and policies have also been implemented, most of them have little explicit attention to

agriculture, aside from a few[2] that mention the possible benefits to agriculture. In addition, despite the numerous policies that have been formulated within the agricultural and financial sector, there is little evidence of whether these policies have positively impacted on farm households' welfare. This makes the case of Ghana an interesting one to study for the impact of finance on smallholder farmers' welfare. Furthermore, the implementation of the DANIDA AVCF project 2011–2015 (with a finance-linked welfare goal) in the Northern Region of Ghana provides a unique case for study.

The rest of the paper is organised in six sections as follows: section 2 presents the overview of agricultural finance and welfare in Ghana. Section 3 discusses the theoretical frameworks that highlight the role of access to finance on welfare and provide a review of empirical literature. Section 4 describes the data and presents the econometric model and estimation techniques for the analysis. The results and key empirical findings are discussed in section 5, with a conclusion in section 6.

1.2. AN OVERVIEW OF AGRICULTURAL FINANCE AND WELFARE IN GHANA

Ghana's financial system has transformed over time through the introduction of financial policy reforms that the country embarked on from the 1980s. The reforms were part of the ERP and SAP that became necessary because of the financial crisis and low economic growth that Ghana was confronted with from 1976–1983 (Antwi-Asare & Addison, 2000). The two major reforms that took place from the 1980s were the FINSAP, which was implemented in 1988–2000, and the FINSSIP, also implemented in 2001–2008. Both programs focused on deepening the financial sector by broadening financial services through restructuring the public sector financial institutions and improving the legal and regulatory framework and financial liberalisation (Brownbridge & Gockel, 1998; Sowa, 2002; Biekpe, 2011). The most explicit reference to financing agriculture was prior to the introduction of these reforms, where there was direct state control of the financial sector leading to the provision of preferential lending rates to priority sectors including agriculture (Brownbridge & Gockel, 1998; Quartey & Afful-Mensah, 2013).

Table 1 below presents allocation of credit to the agricultural sector by the DMBs and specifically by the ADB. The rationale for the selection of ADB is that its core mandate is to specifically extend finance to the productive actors within the agricultural sector in Ghana. Overall (from Table 1), credit to the agricultural sector by commercial banks has been consistently declining. Although credit from ADB to

[2] See Brownbridge and Gockel (1998), Quartey and Afful-Mensah (2013) and Asante and Owusu (2013).

the agricultural sector is higher than that of commercial banks, just about a third of the portfolio of the ADB goes to agriculture. This further conforms the neglect on agricultural finance.

Table 1: Allocation of Credit by Deposit Money Banks (DMBs) and the Agricultural Development Bank (ADB) to the Agriculture Sector, 1993–2015 (%)

YEAR	DMBs (%)	YEAR	DMBs (%)	ADB (%)
1993	8.6	2004	7.7	
1994	8.5	2005	6.7	
1995	9.7	2006	5.4	
1996	10.8	2007	4.9	
1997	12	2008	4.3	24.33
1998	12.2	2009	4.74	24.09
1999	11.8	2010	6.13	28.97
2000	9.6	2011	5.74	27.40
2001	9.6	2012	5.11	29.00
2002	9.4	2013	4.09	27.20
2003	9.4	2014	3.64	32.00
		2015	3.84	35.00

Source: Bank of Ghana and Agricultural Development Bank Annual Reports.

With respect to welfare, the Government of Ghana has implemented several policies. The Ghana Vision 2020 was launched in 1995 with its policy goal of improving the welfare of Ghanaians (Aryeetey & Codjoe, 2005). A five-year Medium-Term Development Plan (MTDP) slated for 1996–2000 and aimed at improving welfare and social well-being of the people of Ghana was developed within the Ghana Vision 2020 framework.

From 2003–2005 the Ghana Poverty Reduction Strategy (GPRS I) was launched with a focus on priority areas that are similar to that of MTDP (GPRS, 2003). A second phase of GPRS, the Growth and Poverty Reduction Strategy (II), was initiated from 2006–2009. From 2010–2013, the Ghana Shared Growth and Development Agenda (GSGDA) I was implemented with a focus on development policies and strategies that promote employment creation and income generation to improve welfare (NDPC, 2010). The second phase of the GSGDA II (2014–2017) is currently under way.

Table 2 captures welfare trends in Ghana from 1991/92 to 2012/13 using the Ghana Living Standard Survey (GLSS). From a monetary perspective, using household consumption expenditure as a measure of welfare, the evidence shows that at the national level, the standard of living or welfare of the average person in Ghana has improved. The available statistics show that from 1991/92 to 2012/13, the average

number of persons with poor welfare decreased from 51.7 per cent to 24.2 per cent. As noted, the incidence of welfare among those within the rural localities is poorer than those within the urban localities. However, the welfare of the people in both rural and urban localities has witnessed significant improvement as the number of persons with poor living standard or welfare decreased from 27.7 per cent to 10.6 per cent in the urban localities from 1991/92 to 2012/13. In the same vein, there is evidence that the number of persons living in rural communities with low levels of welfare declined from 63.6 per cent in 1991/92 to 37.9 per cent in 2012/13. However, Northern, Upper East and Upper West regions still record the highest levels of poor welfare ranging from 44.4 per cent in Upper West to 70.7 per cent in Upper East regions in 2012/13.

Table 2: Monetary and Non-Monetary Welfare Trends in Ghana – National, Regional & Ecological

	MONETARY CONSUMPTION				NON-MONETARY POVERTY 2010 (Population Census Data)	
	1991/92	**1998/99**	**2005/06**	**2012/13**	**Percentage of Household**	**Headcount ratio**
NATIONAL	51.7	39.5	28.5	24.2	31.8	42.7
Urban	27.7	19.4	10.7	10.6		27.7
Rural	63.6	49.5	39.3	37.9		72.3
REGIONAL						
Western	59.6	27.3	18.4	20.9	32.2	40.5
Central	44.3	48.4	19.9	18.8	31.0	39.1
Greater Accra	25.8	5.2	11.8	5.6	12.9	18.5
Volta	57	37.7	31.4	21.7	35.9	44.3
Eastern	48	43.7	15.1	33.8	27.7	35.6
Ashanti	41.2	27.7	20.3	14.7	23.1	30.8
Brong Ahafo	65	35.8	29.5	27.9	41.2	51.7
Northern	63.4	69.2	52.3	50.4	74.6	80.9
Upper East	66.9	88.2	70.4	70.7	75.0	80.8
Upper West	88.4	83.9	87.9	44.4	70.2	77.6
ECOLOGICAL ZONES						
Accra (GAMA)	23.1	3.8	10.6	3.5		
Urban Coastal	28.3	24.2	5.5	10.1		
Urban Forest	25.8	18.2	7	9.9		
Urban Savannah	37.8	43	36.9	26.4		
Rural Coastal	52.5	45.2	23.9	30.3		
Rural Forest	61.6	38	27.9	27.9		
Rural Savannah	73	70	60.3	55		

Source: Ghana Statistical Service (GSS), Ghana Living Standard Surveys (GLSS, rounds 3–6) & Population Census (2010).

It is evident that policies to improve agricultural development, productivity and general welfare abound in Ghana. Yet there is clearly a gap in identifying the strategic finance component in agricultural policy, a link which is crucial to welfare. Consequently, although welfare has improved in Ghana, there remains

a lot to worry about. More specifically, there has been no explicit focus on the welfare of smallholder farmers, the majority of whom make up the bulk of economic activity in Ghana.

1.3. RELATED THEORETICAL FRAMEWORK

Theoretically, the welfare implications of finance for smallholder farmers are not explicitly modelled but can be found to be embedded in the conceptual link between finance and household welfare. In that regard, Zeller, Schrieder, Von Braun and Heidhues (1997) and Zeller and Sharma (2002) outline three pathways through which access to finance positively impacts on household welfare. The first channel is through *income generation*. They argue that where finance is accessed to invest in agricultural production or economic activities, it creates the opportunity for income generation with the expected positive effect on household welfare. For instance, with access to finance, the smallholder farmer can procure high-yielding seeds, hire high-skilled labour and adopt fertiliser and mechanised farming methods that increase farm productivity. As a result, this raises agricultural production, increases sales of farm produce and, ultimately, contributes towards income generation. Through income generation, households can meet food and non-food consumption, thereby improving their welfare. As observed by Gonzalez-Vega (1981), access to finance is the root of income generation through engagement in productive opportunities observed.

In support of the above-mentioned channel, Bruhn and Love (2014) theorise that access to finance impacts on household welfare through the labour market channel. They argue that access to finance improves household welfare through self-employment, expansion of informal businesses and smooth operation of informal businesses to help generate income. In recapitulation, access to finance contributes positively towards household welfare through the channels of employment creation and resultant income generation.

The second channel through which finance contributes towards a positive change in the welfare of households is by *decreasing insurance costs through more cost-efficient assets and liabilities* (Zeller et al., 1997; Zeller & Sharma 2002). Access to finance results in a shift away from traditional methods of savings (with low returns) to investment opportunities that have high-risk adjusted return. This, in turn, increases the income flows to buffer their assets and welfare.

The third finance-welfare channel, according to Zeller et al. (1997) and Zeller and Sharma (2002), is *consumption smoothening*. They argue that when households are faced with external economic shocks, finance is required to stabilise and sustain food and non-food consumption during the period of economic

deprivation. This channel had earlier been argued by Deaton (1990), who hypothesised that access to finance fills the household consumption gap by improving their welfare during periods of uncertainties and unpredictable income generation. Kus (2013) further affirms this channel by stating that access to finance is the channel through which households enhance consumption. According to Diagne and Zeller (2001), most financial institutions opt for the *income generation* pathway based on which they extend finance, since that is focused on the development of the economic capabilities of farm households, and more importantly, brings little or no burden during repayment. In sum, the theoretical framework shows that finance creates income, a direct welfare benefit, mitigates risks during periods of shocks by smoothening consumption, and promotes diversification of risks that expose households to hardships.

1.3.1. Related Empirical Review

Like the theoretical gap, most empirical work on the impact of access to finance on welfare is generally on households, with little or no evidence about smallholder farmers. From this empirical evidence, some studies have documented positive impacts, while others do not find any significant impact.

Beginning with studies that have shown positive and statistically significant results, Khandker and Faruqee (2003) provided empirical evidence by estimating the impact of access to finance on welfare in Pakistan. The result of the study revealed that a ten per cent increase in access to finance has a positive and significant effect on welfare by 0.04 per cent. The study deployed a two-stage least squares (2SLS) for estimation using data from 1995/96 agricultural year. Similarly, Ghalib, Malki and Imai (2011) empirically established that access to finance improves household welfare. The findings of the study followed the use of rural household data from Pakistan and was estimated using PSM to control for selection bias.

In Vietnam, Quach et al. (2005) evaluated the impact of access to finance on household welfare and found that access to finance had a positive impact on household welfare by 6.9 per cent and 5.8 per cent respectively, using a cross-sectional data drawn from 1992/93 and 1997/98 Vietnam Living Standards Survey. The estimation was carried out using a 2SLS and the results were found to be statistically significant. In the same vein, a study by Nguyen and Van den Berg (2011) on the impact of access to finance on welfare in Vietnam also indicated that the welfare impact of access to finance improves as the number of poor households decreased by 1.53 per cent in 2004 and 1.38 per cent in 2006. Data for analysis was drawn from the 2004 and 2006 Vietnam Household Living Standard Surveys (VHLSS) and was estimated using the average treatment on the treated (ATET) and instrumental variables with fixed effects to control for endogeneity.

Adams (2006) studied the impact of finance on household welfare in Ghana. The study revealed that access to finance reduces the number of poor households by 34.8 per cent. In other words, access to finance contributes towards improving the welfare or living standards of households in Ghana. Multinomial logit two-stage least squares model was deployed for estimation, while the data for the study was sourced from the 1998/99 Ghana Living Standards Survey (GLSS). Similarly, by estimating the impact of access to finance on welfare, Geda, Shimeles and Zerfu (2006) found that access to finance has a statistically significant effect on welfare. Instrumental variable model was used for estimation to control for endogeneity. The study used household panel data from Ethiopia covering the period from 1994 to 2000.

With regard to studies that found no welfare impact of finance, Diagne (1998) estimated the impact of access to finance on the welfare of 404 households in Malawi. The study showed that the impact of access to finance on welfare was insignificant. A similar study carried out by Amendola, Boccia, Mele, and Sensini (2016) in Mauritania using data from a survey of household living conditions – EPCV 2014 – reached a conclusion of no significant effect of access to finance on welfare.

1.4. DESCRIPTION OF THE PROJECT AND DATA

Data for the study was drawn from the AVCF project. The project was initiated by the DANIDA and was implemented in the Northern Region of Ghana from 2011 to 2015. The objective of the project was to *"*increase income and employment in rural areas, particularly in breadbasket areas of Northern Ghana, through increased agricultural production, productivity and value addition*"* (DANIDA, 2009). The implementation of the "Production component" of AVCF covered all districts in the Northern Region of Ghana with a total number of 27,856 beneficiaries who are smallholder farmers. The beneficiary farmers were involved in the cultivation of either maize or rice or soyabean or groundnut crops only or a combination of some of these crops.

To achieve the objective for the study, vital information was gathered using questionnaires as the survey instrument. The questionnaires were in two parts, one for farmers who directly participated in the "Production component" of the project (project beneficiary group) while the second one was used for farmers who did not participate in the project (project non-beneficiary group). However, the questionnaires were very similar. The questionnaires were used to solicit information on key demographic characteristics and socioeconomic variables, which include household characteristics, farmers' level of education, household assets and access to financial services. The survey also collected

information on household agriculture, which focused on production inputs and outputs, farm size and market access. The data collected was based on the 2014/15 farming season.

To cater for all the districts in the Northern Region, we used a combination of stratified and proportional sampling techniques. We adopted a three-stage random stratified sampling. At the first stage, we selected seven communities from 22 districts each to form 154 communities for sampling. The selection criterion was based on communities with the highest number of beneficiary farmers in a district. At the second stage, we randomly selected a sample size of 1,700 farmers from the 154 communities for data collection. After cleaning and eliminating outliers, we had data comprising 1,564 farmers out of which 176 farmers had access to finance, whereas the remaining 1,388 farmers had no access to finance. At the third stage, we randomly sampled 208 farmers out of the 1,388 farmers who did not have access to finance.

The data for the non-beneficiary control group was also collected on farmers in selected communities within the Northern and Brong Ahafo (BA) regions. The selected areas for this group are within the same agro-ecological zone as the beneficiary group and share similar agricultural practices and socioeconomic characteristics. Data for this group was gathered on 485 farmers who have no access to finance. After eliminating outliers and cleaning data, we had a total number of 466 farmers within the group. Of this number, 233 farmers were sampled for analysis.

1.4.1. Demographic and Socioeconomic Characteristics of Sample Farmers

Table 4.3 presents a brief overview of the socioeconomic characteristics of the farmers and tests for similarities of the two separate groups, that is, the group with access to finance (the treatment group) and farmers without access to finance (control groups). However, as highlighted in the sample design, this study used two control groups:

1. Control group 1 comprised beneficiaries of the AVCF who were excluded from the production credit.
2. Control group 2 comprised farmers from similar ecological zones who were non-beneficiaries of the AVCF project (akin to non-equivalent control).

Table 3 shows that farmers with access to finance are statistically similar to farmers without access to finance, except for slight differences in gender, household size, and years of farming.

Table 3: Demographic and Socioeconomic Characteristics of Sampled Farmers with Access to Finance

		AVCF beneficiary with Access to Finance (Treatment Group)	AVCF beneficiary without Access to Finance (Control Group 1)	AVCF non-beneficiary and without Access to Finance (Control Group 2)
Variable	**Sub-Categories**			
Gender	Male	71.02	60.10**	73.39
Education Grade	No education	76.14	85.10**	79.40
Household Size	Household Size	11.84	12.45	9.17***
Marital Status	Married	91.48	93.75	95.71*
Years of Farming		14.64	15.71	17.12**
Total No. Of Observations		**176**	**208**	**233**

Notes: We used Chi-Square (X^2) for categorical variables and t-test for continuous variables to test for similarities for the beneficiary and non-beneficiary groups. P-values *** p<0.01, ** p<0.05, * p<0.1 indicate the level of significance

1.5. ESTIMATION OF THE AVERAGE TREATMENT EFFECTS

We adopted two estimation techniques, the PSM and the PSW.

1.5.1. Propensity Score Matching (PSM)

PSM is one of the impact evaluation methods that provide effective estimation of a causal effect in the absence of randomisation evaluation (Glennerster & Takavarasha, 2013). Indeed, randomisation, which is cardinal for experimental evaluation of effects that are attributed to treatments, effectively focuses on the design in terms of the random assignment to beneficiary and non-beneficiary groups before the project or program is rolled out (Christie & Alkin, 2013). In this regard, randomisation evaluation exercises much control in the selection of program or project participants prior to implementation. The method and application of randomisation eliminates the problem of selection bias that occurs in observational studies. However, in the absence of randomisation other quasi experimental tools can identify impact. Rosenbaum and Rubin (1983), Jalan and Ravallion (2003) and Glennerster and Takavarasha (2013) indicate that, under such conditions or assumptions, PSM is an effective tool for evaluation. The application of PSM is to mimic randomisation evaluation in order to control for unbiased results. The advantage of this technique is that it allows projects or programs to be evaluated even after its implementation.

PSM was chosen as the most suitable evaluation technique for the estimation of the average treatment effect of access to finance on household welfare of smallholder farmers. The reason is that the provision of finance to smallholder farmers under the AVCF project was neither randomised nor did the project implementing agencies have a practical and a more accurate baseline survey to indicate the effect of access to finance on household welfare that could be used for comparison and estimation of results. According to Gertler, Martinez, Premand, Rawlings and Vermeersch (2011), if a group did not participate in a project, but a counterfactual can be identified for comparison, PSM can be applied.

PSM is "the conditional probability of assignment to a particular treatment given a vector of observed covariates", according to Rosenbaum and Rubin (1983). By this model, both the beneficiaries and non-beneficiaries are given an equal chance of receiving the treatment, which, in this case, is access to finance. This is made possible following the estimation of the probability that a farmer receives finance given the row of characteristics observed within the survey. This is mathematically expressed in equation (1) as follows:

$$e(x) = \Pr(Z = 1 \mid X) \qquad Eq.(1)$$

With reference to Eq. (1), $e(x)$ denotes the propensity score, Z is the treatment (access to finance) and X the observed covariates. The estimation of the probability model in relation to the treatment Z and the covariates X is carried out using either logit or probit regression model (Austin, 2008 and Li, 2012).

Meanwhile, the estimation of PSM requires some assumptions. According to Rosenbaum and Rubin (1983), both the treatment model and the outcome must be conditionally independent, given the set of covariates. This further means that any exogenous variable that affects the treatment cannot impact on the outcome and vice versa. This is shown below as:

$$(Y_1, Y_0) \perp Z \mid X \qquad Eq.(2)$$

The overlap or common support condition is another assumption. This condition limits the units of analysis to a common region based on the propensity score. It offers the opportunity for the beneficiary group to have a comparison observation as per the propensity score. This is also known as statistical matching. A tenet of this assumption is that the conditional probability of each individual (farmer) receiving treatment (access to finance) must be positive and this must be within zero (0) and one (1). This implies that any observation with propensity score outside this region will be dropped to avoid overlapping, which is a violation of the assumption. This assumption is captured as:

$$0 < \Pr(Z_i = 1|X_i) < 1 \qquad Eq.(3)$$

Rosenbaum (2010) referred to both conditional independent and overlap assumptions as assumptions of "strong ignorability". Indeed, satisfying these conditions serves as a pre-condition for balancing covariates. By this, each smallholder farmer within the beneficiary group (access to finance) and non-beneficiary group (without access to finance) must have its covariates balanced based on the propensity scores. In other words, both the beneficiary and non-beneficiary groups must have the same or similar distribution, given the row of covariates. This is shown in equation (3) below:

$$\Pr\{X|Z = 1, e(x)\} = \Pr\{X|Z = 0, e(x)\} \qquad Eq.(4a)$$

In similar vein, the observed covariates X and treatment Z must be conditionally independent given the propensity score (Rosenbaum, 2010). Explained differently, the set of observed covariates X and treatment Z are not expected to be correlated. This is denoted as:

$$X \perp Z \mid e(x) \qquad Eq.(4b)$$

Following the above is the estimation of the average treatment or causal effect, that is, the average treatment effect of access to finance on household welfare of smallholder farmers. This is a calculation of the mean outcome of the beneficiary group (Y_1) and that of the mean outcome of the comparative or control (non-beneficiary) group (Y_0). The mean difference in the outcome of the two independent groups' accounts for the average treatment effect (ATE). The ATET is simply the mean difference of the outcome of beneficiary (treated) and non-beneficiary (untreated) groups among farmers who actually received the treatment (access to finance) (Li, 2012). This is expressed by equation (5) below:

$$ATET_{psm} = E\{Y|Z = 1, e(x)\} - E\{Y|Z = 0, e(x)\} \qquad Eq.(5)$$

1.5.2. Propensity Score Weighting (PSW)

According to Olmos and Govindasamy (2015), PSW is an option to use in any evaluation, given the fact that it addresses the problem of selection bias emerging from a non-randomisation setting. According to Hirano and Imbens (2002) and Cerulli (2015), PSW is drawn from the work of Horvitz and Thompson (1952), who introduced the inverse probability weighting (IPW). The technique was used to estimate the total and mean population following the classification of the population into different strata using a

probability selection model. The estimation method has received a lot of attention and is currently used in the evaluation of the average treatment effect. This technique has been observed to be closely associated with PSM (Cerulli, 2015).

In practice, the application of IPW primarily requires the estimation of the propensity score, given the set of covariates. The estimation of the propensity score is carried out using either the probit or logit regression model as shown in Equation (1). The second requirement is to construct the weights for each observation, that is, both the beneficiary and non-beneficiary groups. The application of this method is aimed at correcting for missing data that emerge as a result of unknown or unobserved variables, and creating a balance of the beneficiary and non-beneficiary groups based on the covariates (StataCorp, 2015; Olmos & Govindasamy, 2015). The weights are shown in equations (6a) and (6b) below. Equation 6a denotes the weight (w_1) for the beneficiary groups while equation 6b also stands for weight (w_0) for the non-beneficiary groups with $\hat{e}(x)$ being the estimated propensity score:

$$w_1 = \frac{1}{\hat{e}(x)} \qquad Eq.(6a)$$

$$w_0 = \frac{1}{1 - \hat{e}(x)} \qquad Eq.(6b)$$

Following these estimations, the weights are used in a weighted least squares (WLS) regression to estimate the ATE, which is the difference in the outcome variable between the treated and untreated groups (Hirano & Imbens, 2002; Cerulli, 2015; Olmos & Govindasamy, 2015). Lunceford and Davidian (2004) and Cerulli (2015) provide an estimation of the ATE using the IPW as follows:

$$ATE = \frac{1}{N}\sum_{i=1}^{N}\frac{Z_i Y_i}{\hat{e}(x_i)} - \frac{1}{N}\sum_{i=1}^{N}\frac{(1 - Z_i)Y_i}{1 - \hat{e}(x_i)} \qquad Eq.(7)$$

From Eq.7, N denotes the number of observations, $Z_i Y_i$ is the outcome of an individual (smallholder farmer) who has access to finance (beneficiary group) and $\hat{e}(x_i)$ is the estimated propensity score used as weight. On the other hand, $(1 - Z_i)Y_i$ denotes the outcome of an individual (smallholder farmer) who did not receive finance (non-beneficiary group) and the propensity of individual farmers within the non-beneficiary group denoted by $1 - \hat{e}(x_i)$.

Cerulli (2015) estimated the ATET as follows:

$$ATET = \frac{1}{N}\sum_{i=1}^{N}\frac{[Z_i - \hat{e}(x_i)]Y_i}{p(Z=1)[1 - \hat{e}(x_i)]} \qquad Eq.(8)$$

In addition to the above, there is the selection of the inverse-propensity weight and regression adjustment (IPWRA), which is another weighting estimator. This estimator is a combination of two methods and is known as a "doubly-robust" estimator (Cerulli, 2015). It follows the steps for the estimation of IPW as enumerated above. However, the ATE of IPWRA is estimated using regression adjustment. The estimations of ATE and the ATET models are shown below following connotations used by Cerulli (2015):

$$ATE = \frac{1}{N}\sum_{i=1}^{N}[(\hat{a}_1 - \hat{b}_1 x_i) - (\hat{a}_0 - \hat{b}_0 x_i)] \qquad Eq.(9)$$

$$ATET = \frac{1}{N_1}\sum_{i=1}^{N} Z_1\,[(\hat{a}_1 - \hat{b}_1 x_i) - (\hat{a}_0 - \hat{b}_0 x_i)] \qquad Eq.(10)$$

From equations (9) and (10), $(\hat{a}_1 - \hat{b}_1 x_i)$ and $(\hat{a}_0 - \hat{b}_0 x_i)$ are the expected or mean outcome for the treated and untreated groups respectively, both of which are estimated by regression adjustment where N_1 and Z_1 in Eq.10 denote the number of farmers and farmers with access to finance respectively.

1.6. CONSTRUCTION OF THE WELFARE (ASSET) COMPOSITE INDEX

Recent debates on welfare policies reveal a growing paradigm shift from income to asset-based welfare measurement. It is argued that assets significantly contribute to household welfare both in the short and long term. In other words, the accumulation of assets is a pathway through which individuals and households improve their welfare (Sherraden, 1990; Paxton, 2003; Sherraden, Zou, Ku, Deng & Wang, 2015). According to Johnson and Sherraden (1992), the unique characteristic of asset ownership is that assets serve multiple development purposes. For example, by creating foundation for household stability, it cushions households against risks, empowers them socially and promotes their participation in decision-making within a community.

However, consistent with the literature, welfare has been measured from either unidimensional or multidimensional perspectives or both, using variables such as household income and consumption expenditure, education, health, and per capita income, among others (Asselin, 2009). This study measured welfare using physical assets as the alternative approach. The significance of adopting assets

as the preferred approach to measuring welfare is that assets reflect financial accumulations by an individual or household over a period and its measurement is also consistent with the use of an income or consumption-based approach (Sherraden, 1990; Sahn & Stifel, 2003).

Studies by Sahn and Stifel (2003), Booysen, Van der Berg, Burger, Maltitz and Rand (2008), Filmer and Scott (2011), Wietzke (2015), and Akotey and Adjasi (2015), among others, have all adopted an asset-based approach to measuring welfare. However, diverse methods were deployed for the construction of the asset index and notable among them are principal component analysis (PCA), factor analysis (FA) and multiple correspondence analysis (MCA) (Booysen et al., 2008). Following the work of Asselin (2002), MCA has recently been used by Booysen et al. (2008); Ayadi, Lahga and Chtioui (2008), and Akotey and Adjasi (2015), among others. The use of MCA is driven by the principle that the data is categorical or nominal. A categorical variable is therefore binary in nature, that is, the individual either owns a particular asset or does not (Asselin, 2002). On the other hand, PCA, which has been widely used, thrives on continuous data.

This study adopted the MCA method for the construction of the welfare index. Our contribution is to extend this method to the agricultural sector where we measure the welfare of smallholder farmers' households. This is, therefore, a paradigm shift from measuring the welfare of smallholder farmers using an income and consumption approach to asset based approach. By adopting the notation used by Ayadi et al. (2008) and Booysen et al. (2008), the method for the construction of the welfare composite index is shown following the equations below:

$$A_i = \frac{\sum_{k=1}^{K} \sum_{j_k=1}^{J_k} W_{j_k}^{k} I_{ij_k}^{k}}{K} \qquad \text{Eq.(11)}$$

where:

A_i is the welfare composite index for each farmer's household i

K is the number of categorical indicators;

J_k is the number of categories for indicator k;

$W_{j_k}^{k}$ is the weight attributed to category j_k; and

$I_{ij_k}^{k}$ is a binary variable equal to 1 when farmers' household i had category j_k, and 0 otherwise.

The welfare composite index (A_i), for each farmer's household i is calculated as the average of the weights of binary variables $I_{ij_k}^k$

The weight to be assigned to each component of welfare index A_i is the normalised score which is obtained from MCA as $\frac{W_{jk}^k}{\lambda_\alpha} = \frac{score}{engen\ value\ for\ axis\ \alpha}$ of the category $I_{ij_k}^k$

where axis alpha (α) = 0 or 1. The full MCA welfare composite index (A_i) for each farmer's household i can also be expressed in the equation below:

$$A_i = I_{i1}W_1 + I_{i2}W_2 + ...I_{ij}W_j \qquad \text{Eq.(12)}$$

A total of twenty-six (26) categorical variables, which are assets accumulated by the households of smallholder farmers over a period, are used for the construction of the asset index. The list of assets and their assigned weights based on the binary variables is shown in Table 4 below. The welfare composite index indicates that owning an asset improves the welfare of a household while not owning an asset reduces the household's welfare. The result of the welfare index shows that the assigned weight of the assets varies from one asset to the other. The first dimension of the MCA explains 75.07 per cent of the inertia.

Table 4: Variables in the Welfare (Asset) Composite Index

Variables (Assets)	Categories	Weights
	Household Ownership of Physical Assets	
Furniture	Owns furniture	1.011
	Does not own furniture	-0.933
Sewing Machine	Owns a sewing machine	2.439
	Does not own a sewing machine	-0.340
Stove (Kerosene)	Owns a stove (kerosene)	4.211
	Does not own a stove (kerosene)	-0.076
Stove (Gas)	Owns a stove (gas)	10.362
	Does not own a stove (gas)	-0.060
Refrigerator	Owns a refrigerator	7.833
	Does not own a refrigerator	-0.223
Freezer	Owns a freezer	8.233
	Does not own a freezer	-0.173
Fan	Owns a fan	3.672
	Does not own a fan	-0.696
Radio	Owns a radio	0.686
	Does not own a radio	-1.770
Radio CD Player	Owns a radio CD player	5.214

Variables (Assets)	Categories	Weights
	Does not own a radio CD player	-0.267
VCD/DVD Player	Owns a vcd/dvd player	4.941
	Does not own a vcd/dvd player	-0.248
Desktop	Owns a desktop	9.569
	Does not own a desktop	-0.064
Laptop	Owns a laptop	10.351
	Does not own a laptop	-0.035
Television	Owns a television set	3.379
	Does not own a television set	-0.792
Rice Cooker	Owns a rice cooker	12.571
	Does not own a rice cooker	-0.042
Iron (Electric)	Owns electric iron	6.499
	Does not own electric iron	-0.272
Iron (Box)	Owns an iron box	1.955
	Does not own iron box	-0.416
Bicycle	Owns a bicycle	0.520
	Does not own a bicycle	-1.703
Motorbike	Owns a motor bike	1.533
	Does not own a motor bike	-0.942
Car	Owns a car	4.876
	Does not own a car	-0.073
Microwave	Owns a microwave	9.261
	Does not own a microwave	-0.009
Mobile Phone	Owns a mobile phone	0.770
	Does not own a mobile phone	-1.495
House	Owns a house	0.370
	Does not own a house	-0.824
Land	Owns a piece of land	0.495
	Does not own a piece of land	-0.890
Jewellery	Owns jewellery	1.404
	Does not own jewellery	-0.358
Mattress	Owns a mattress	1.171
	Does not own a mattress	-1.335
Livestock	Owns livestock	0.465
	Does not own livestock	-0.494

Source: Author's computation based on surveyed data of smallholder farmers in Ghana.

1.7. ESTIMATION PROCEDURES

This section discusses the choice of algorithms and the econometric estimation of the propensity score matching and IPW.

1.7.1. Choice of Algorithms

This study adopted both matching and weighting estimators for the estimation of the treatment or causal effect of access to finance on household welfare of smallholder farmers. The rationale for the choice of these estimators is that they best address the problem of non-randomisation and selection bias. Matching

is done on the propensity score by comparing the outcome of the observed covariate of the treated with the untreated. On the other hand, weighting estimators are based on weighted averages of the observed outcome variables for both the treated and untreated groups.

This study chose two matching estimators, namely nearest-neighbour matching (NNM) and PSM. Both NNM and PSM use specific distance between treated and untreated for matching of observations. In other words, they select the closeness between the treated and untreated observation for matching. In addition, there are two weighting estimators, the IPW and inverse probability weighting regression adjustment (IPWRA). IPWRA is interpreted as a combination of IPW and regression adjustment (RA).

1.7.2. Estimation of Propensity Score

The estimation of the average treatment effect of access to finance on welfare essentially requires the estimation of the probability or propensity score. This could be estimated via the probit or logit regression model. In other words, either of these models is used to predict a farmer's participation in access to finance. We chose the probit regression model for the estimation of the probability of receiving or having access to finance on the assumption that the regression error is standard normally distributed (Cameron and Trivedi, 2010). Access to finance, which is the treatment outcome, is binary, that is, it takes two values. This is shown in the model below, where the treatment variable (access to finance) is denoted as Z. The outcome of the binary variable is:

$$Z = \begin{cases} 1 \text{ if farmer } i \text{ received finance (i.e., beneficiary group)} \\ 0 \text{ if farmer } i \text{ did not receive finance (i.e., non} - \text{beneficiary group)} \end{cases}$$

The data used for this study has adequate information on farmer characteristics as well as community characteristics. Being guided by the information available in our data set, the choice of variables as predictors of access to finance was influenced by economic theory, knowledge about the farmer, farmer's household as well as the design and implementation of the project (Caliendo & Kopeinig, 2008). The results of the estimation of smallholder farmers' participation in access to finance are shown in Table 5 below.

Table 5: Estimation of Propensity Score (Participation in Access to Finance) – Probit Analysis

ISFM	Control Group 1			Control Group 2		
	Coef.	Robust Std. Err	P-Value	Coef.	Robust Std. Err	P-Value
Sex	0.301*	0.154	0.050	-0.178	0.166	0.285
Education Grade completed	0.273	0.181	0.130	0.082	0.174	0.637
Years of farming	-0.012*	0.007	0.098	-0.014**	0.007	0.044
Access to potable water	-0.394***	0.136	0.004	-0.170	0.148	0.250
Access to nearest primary school	-0.194	0.186	0.298	-0.295*	0.165	0.074
Access to nearest secondary school	0.184	0.152	0.227	0.888***	0.155	0.000
Access to health insurance	0.250	0.280	0.371	0.341	0.238	0.153
Access to nearest health centre	-0.770	0.766	0.315	0.974**	0.439	0.026
Access to storage facility	-0.006	0.168	0.970	0.532***	0.191	0.005
Access to telephone service	-0.275	0.258	0.286	-0.065	0.265	0.807
Access to electricity poles	0.068	0.137	0.621			
Constant	0.556	0.811	0.493	-1.226	0.490	0.012
Observations		383			409	
Pseudo R^2		0.047			0.115	

*** p<0.01, ** p<0.05, * p<0.1

Table 5 presents the probit regression based on which the propensity score is estimated and the matching of treated and untreated is carried out. The results show that gender, number of years of farming and access to potable water are more likely to influence access to finance using Control Group 1. The results of the Control group 2 show that number of years of farming, access to nearest primary and secondary school, access to nearest health centre and storage facility are more likely to influence farmers' ability to access finance.

1.7.3. Distribution of Propensity Score Matching

This section highlights the region of common support following the estimation of the propensity score using the probit regression model. Khandker, Koolwal and Samad (2010) referred to the region of common support as those propensity scores ranging between the minimum and maximum values of the observations (smallholder farmers) that are within the treatment group. Using the Control Group 1, the result shows that the region of common support selected ranges from 0.180 to 0.778. Similarly, for the Control group 2, the region of common support selected is from 0.013 to 0.861. The distribution of propensity score across treated and non-treated groups for both Control Group 1 and Control Group 2 are plotted in Figures 1 and 2.

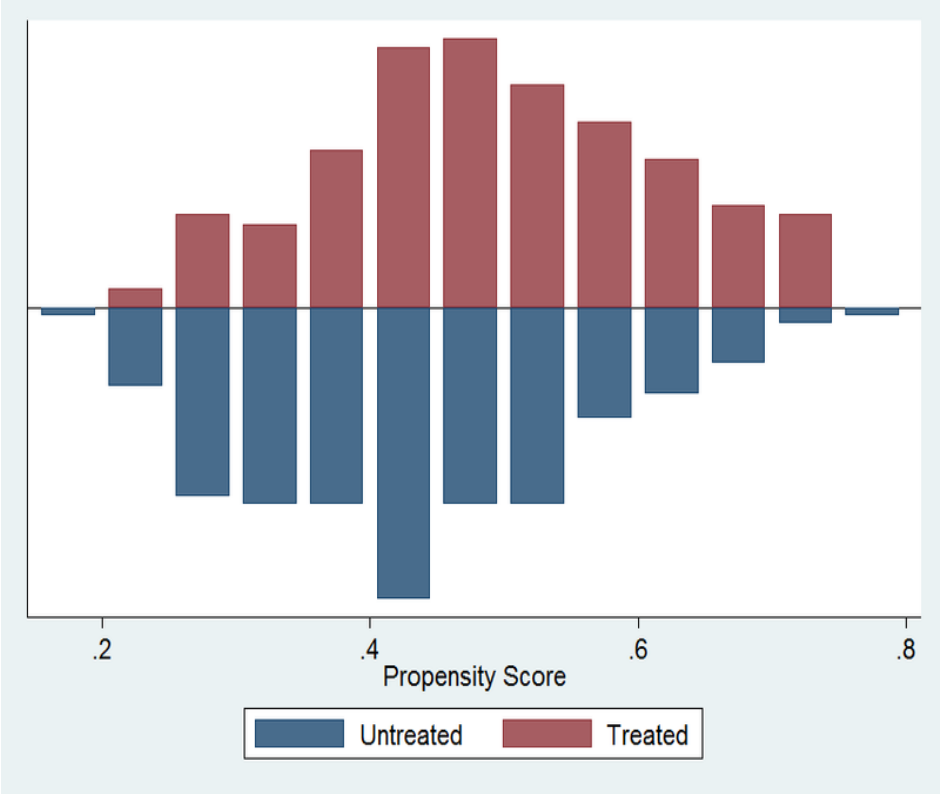

Figure 1: Control Group 1 - Distribution of Propensity Score Among the Treated and Untreated

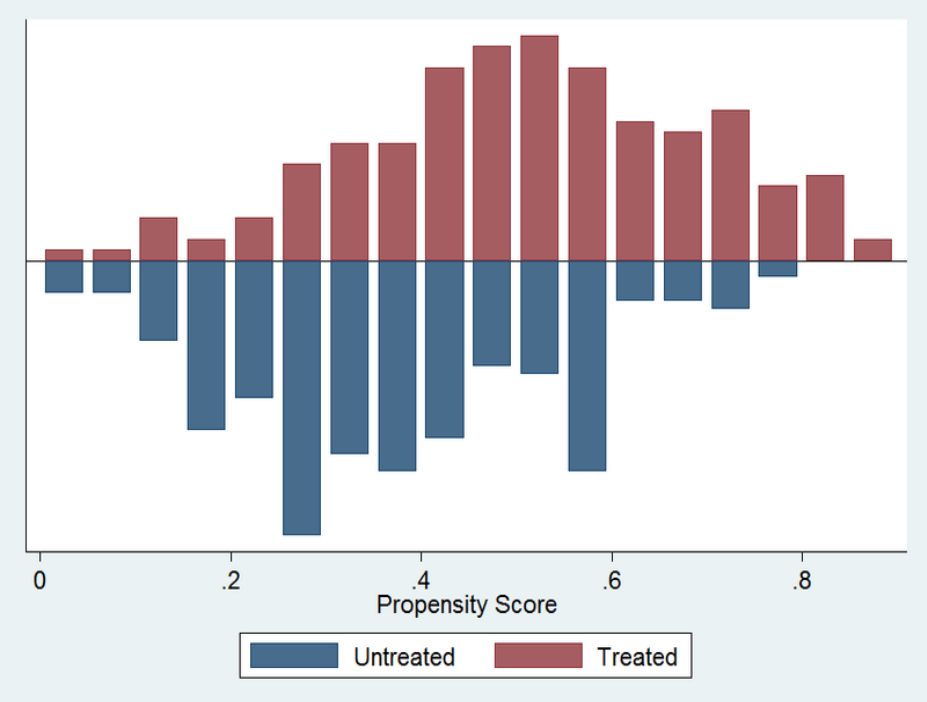

Figure 2: Control Group 2 - Distribution of Propensity Score Among the Treated and Untreated

1.8. RESULTS AND DISCUSSION OF ECONOMETRIC ANALYSIS

In this section, we present the results of the estimation of the effect of access to finance on the welfare of smallholder farmers using both PSM and PSW applications to ensure robustness of results. Under the PSM estimators we used one to five (1 to 5) matching for estimating the ATET. We also employ an additional PSW reweighting estimator by Cerulli (2015), which is applied via bootstrapping with 50 replications.

Table 6 presents the estimation of the ATET using Control Group 1 and Control Group 2. The evidence as established by this study is that access to finance improves the welfare of smallholder farmers. Using all five estimators, the results were found to be statistically significant except for the result of the reweighting estimator under Control Group 1. A comparison of the two estimation results has clearly shown that the gains or impact of finance on welfare of the household of smallholder farmers in Control Group 2 is higher than Control Group 1. For instance, regarding the Control Group 1, the results of the PSM and IPW show that the welfare of a smallholder farmer within the beneficiary group is 3.5 per cent and 2.6 per cent respectively higher than a farmer in the non-beneficiary group. However, evidence from Control Group 2 using same estimators reveals that the welfare of a smallholder farmer within the beneficiary group is 7.7 per cent and 7.9 per cent respectively higher than a farmer in the non-beneficiary group. The rest of the estimators have shown similar trends.

Table 6: Estimation of ATET Using Five Algorithms

Algorithms	Control Group 1			Control Group 2		
	ATET			ATET		
	Coefficient	Standard Errors	P-value	Coefficient	Standard Errors	P-value
Nearest-neighbour Matching (nnmatch) – (1 to 5 matching)	0.026**	0.013	0.048	0.078***	0.012	0.000
Propensity-score Matching (psmatch) – (1 to 5 matching)	0.035***	0.012	0.003	0.077***	0.015	0.000
Inverse-Probability Weights (IPW)	0.026*	0.014	0.059	0.079***	0.013	0.000
IPW Regression Adjustment (IPWRA)	0.025*	0.013	0.053	0.078***	0.013	0.000
Reweighting (treatrew)	0.024	0.016	0.138	0.084***	0.015	0.000

Significance levels are based on AI Robust standard (errors in parentheses)
*** p<0.01, ** p<0.05, * p<0.1

1.9. POSTESTIMATION RESULTS

This section provides a test of the reliability of the results. It establishes a proof of balance of the covariate and a test of a hidden bias.

1.9.1. Covariates Balance

According to Austin (2011), "propensity score is a balance score". In this light, the baseline covariates or characteristics are expected to be similar when comparing the treated and the untreated groups using the propensity score or weight. The objective is to ensure that the model for the propensity score is accurate. This implies that where the covariates are not balanced, the propensity score is either over or under estimated (Ibid). To establish the accuracy of the propensity model on account of a balanced covariate, the application of the standardised difference is therefore required. Flury and Riedwyl (1986) and Tritchler (1995) define standardised difference as "mean difference in units of standard deviation". This is interpreted as the difference between the mean outcome of the treated and the untreated groups over the units of pooled standard deviation or the standard deviation among the total number of observations.

The vector of variables selected from the dataset used for the estimation of the propensity score are binary variables. Following the work of Austin (2011), we used the mathematical formula that considers binary variables to calculate the standardised difference (SD) as shown in Eq. 8 below. With reference to equation (8), $\hat{X}_{treated}$ and $\hat{X}_{untreated}$ represent the population means of the treated and the untreated groups respectively.

$$SD = \frac{(\hat{X}_{treated} - \hat{X}_{untreated})}{\sqrt{\frac{\hat{X}_{treated}(1 - \hat{X}_{treated}) + \hat{X}_{untreated}(1 - \hat{X}_{untreated})}{2}}} \qquad Eq.8$$

The results of the estimation of the weighted standardised difference of the various estimators are presented in Table 7. According to Austin and Stuart (2015), there is no universal agreement on the benchmark or limit to the score or value of the standardised difference at which one can reach a conclusion on the covariates being balanced or otherwise. Cohen (1992) provided population effect size index for various tests and described a standardised difference (effect size) with a value of 20 per cent (0.2) as small, 50 per cent (0.5) as medium and 80 per cent (0.8) as large. Accepting the value of 0.2 implies that the standardised difference that exists between the two groups on the account of the baseline

covariate is small. On the other hand, Austin (2009) argues that a standardised difference of not greater than ten per cent (0.1) can be accepted as "negligible imbalance". However, Stuart, Lee and Leacy (2013) have clearly indicated that a standardised difference of value ranging from 0.1 to 0.25 is an acceptable imbalance. The evidence as shown in Table 7 indicates that all covariates are within the acceptable imbalance score of 0.1 to 0.25.

Table 7: Covariate Balance Summary

STANDARDIZED DIFFERENCE								
VARIABLES	Control Group 1				Control Group 2			
	Raw	NNM	PSM Weighted	IPW / IPWRA	Raw	NNM	PSM Weighted	IPW / IPWRA
Sex	0.235	0.109	0.010	-0.022	-0.053	-0.070	0.104	0.044
Education Grade	0.239	0.130	0.139	-0.018	0.078	0.048	-0.047	0.010
Number of Years of Farming	-0.110	-0.048	-0.045	0.016	-0.226	-0.038	0.001	-0.103
Access to Potable Water	-0.304	-0.163	0.089	0.023	0.008	-0.005	-0.055	-0.021
Access to Primary School	-0.098	-0.003	0.032	0.024	0.120	-0.010	0.060	-0.011
Access to Secondary School	0.100	0.032	0.029	-0.003	0.597	0.151	0.021	0.033
Access to Health Insurance	0.082	-0.010	-0.082	0.035	0.355	-0.020	0.060	0.072
Access to Health Centre	-0.073	-0.110	-0.046	0.015	0.309	0.000	0.078	0.009
Access to Storage Facility	0.016	0.067	0.000	0.000	0.270	0.211	0.043	0.065
Access to Telephone Service	-0.082	0.000	0.031	0.030	0.004	0.005	0.095	0.055
Access to Electricity Poles	0.041	0.033	0.094	0.019				
Total Number of Observations	383	352	352	383.0	409	352	352	409.0
Treated Observations	176	176	176	190.8	176	176	176	207.7
Control Observations	207	176	176	192.2	233	176	176	201.3

1.9.2. Sensitivity Analysis

This section focuses on testing for the existence of a hidden bias or otherwise. Rosenbaum (2002) referred to hidden bias as any variable that is not observed and, for that matter, not controlled or not included as part of the covariates in the estimation model. In this study, a sensitivity analysis was conducted to test whether the effect of access to finance on the welfare of smallholder farmers is caused by the fact that the smallholder farmer received access to finance or whether it can be attributed to an unknown variable. This study applied the Rosenbaum bounds (rbounds) technique for the test of hidden bias which is carried out following psmatch2 command.

Table 8 shows that the result is free from a hidden bias. For Control Group 1, for instance, the critical level – gamma (Γ) at which a decision is made indicates that from 1.0 to 1.5, there is no effect of unknown variable. Similarly, Control Group 2 also showed no effect of unknown variable and, for that matter, the result is insensitive to biases using the critical level of Γ 1.0 to 1.8. The decision is made based on five per cent significant level using the upper bound. On that note, to show a hidden bias in Control Group 1 and Control Group 2 implies that there must be an upward movement or a change in magnitude of gamma (Γ) by more than a factor of Γ=1.5 and Γ=1.8 respectively.

Table 8: Rosenbaum Sensitivity Analysis for Hidden Bias

Gamma (Γ)	Control Group 1 sig+	Control Group 2 sig+
1	0.000	0.000
1.1	0.000	0.000
1.2	0.001	0.000
1.3	0.004	0.000
1.4	0.013	0.001
1.5	0.033	0.003
1.6	**0.069**	0.008
1.7	0.123	0.018
1.8	0.198	0.035
1.9	0.288	**0.062**
2	0.389	0.101

1.10. CONCLUSION

This essay evaluated the impact of access to finance on the welfare of smallholder farm households using data from a field survey carried out in the Northern Region of Ghana. To control for selection bias as a result of the observational study, we adopted the PSM and the PSW for estimation. By using these

techniques for intensive evaluation, we compared the mean outcome of the beneficiary (treated) group, that is smallholder farmers with access to finance, with the mean outcome of non-beneficiary (untreated) group, also smallholder farmers who are financially constrained, to assess the impact of access to finance on the household of smallholder farmers.

Using two non-beneficiary (untreated) groups for robustness checks, the study has shown a positive and statistically significant effect of access to finance on the welfare of smallholder households. We can conclude that access to finance stimulates improvements in welfare of smallholder farm households. The result is therefore consistent with theory on the link between finance and welfare. In Africa, smallholder farming is a fundamental production activity through which households can use finance to increase their welfare. Most household economic activity in Africa is structured around agriculture and smallholder farming. However, very little is known about the impact of finance on smallholder farmers. This essay therefore provides relatively new evidence on the effect of finance on the welfare of smallholder farmer households using the case of Ghana.

This means that financial sector policies must be focused not only on rural finance in general but instead must be geared towards unlocking the challenges of agricultural financing at all levels. To this end, developing a comprehensive agricultural value-chain finance policy will play a cardinal role towards improving access to finance and improving the welfare of smallholder farmers. Agricultural policies must also have significant financing subcomponents aimed at finacing the agricultural value chain.

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APPENDIX 'A'

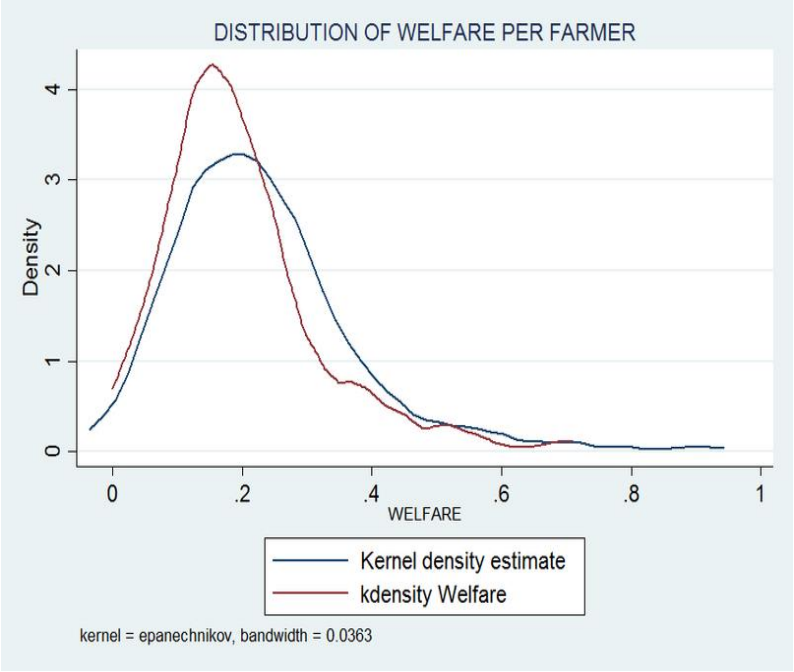

Figure 4.3: Control Group 1 – Distribution of welfare per a beneficiary farmer (treated) compared to non-beneficiary farmer (non-treated). Samples matched by 1-to-5 nearest neighbour matching

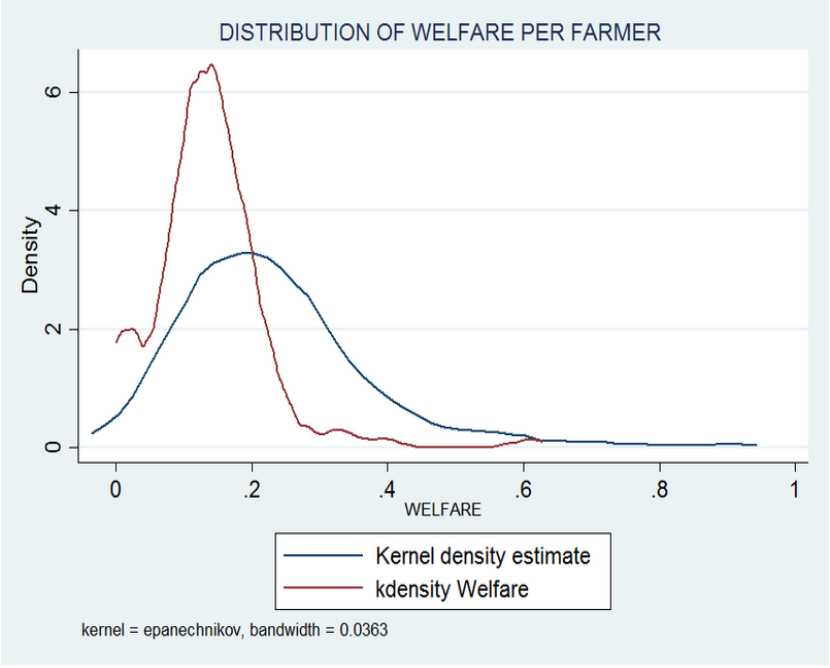

Figure 4.4: Control Group 2 – Distribution of welfare per a beneficiary farmer (treated) compared to non-beneficiary farmer (non-treated). Samples matched by 1-to-5 nearest neighbour matching

APPENDIX 'B'

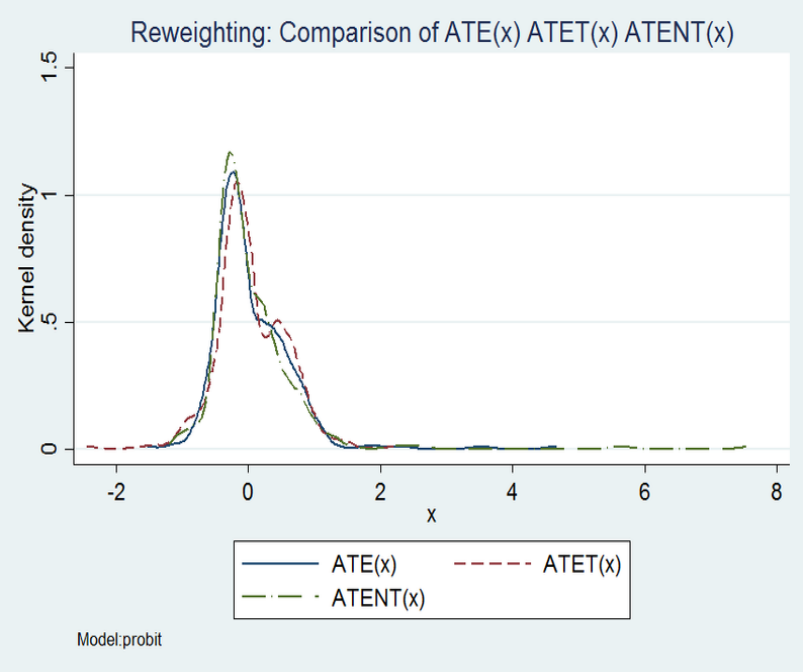

Figure 4.5: Control Group 1 – Estimated Kernel Density for the Distribution of ATE(x), ATET(x) and ATENT(x) by Weighting or Reweighting on the Propensity Score

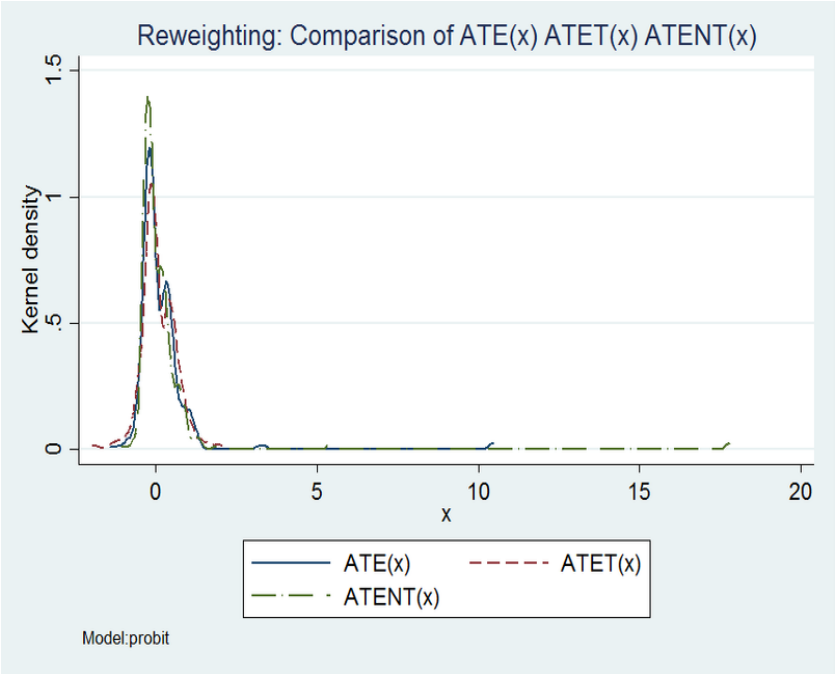

Figure 4.6: Control Group 2 - Estimated Kernel Density for the Distribution of ATE(x), ATET(x) and ATENT(x) by Weighting or Reweighting on the Propensity Score

APPENDIX 'C'

Table 4.9: Definition and Summary Statistics of Variables Used for Probit Estimation and Econometric Estimation of the Impact of Finance on Welfare of Smallholder Farm Household in Ghana

Variable	Obs	Mean	Std. Dev.	Min	Max	Label
Welfare	383	0.214	0.133	0.001	0.906	Farmer's household welfare status
Gender	384	0.651	0.477	0	1	1 if Farmer is male or otherwise zero (0)
Education Grade	384	0.190	0.393	0	1	1 if Farmer is educated (received a minimum of basic education) or otherwise zero (0)
Number of Years of Farming	384	15.219	9.945	1	50	Number of Years of Farming by a Farmer
Access to Potable Water	383	0.392	0.489	0	1	1 if Farmer's household has access to potable water or otherwise zero (0)
Access to Primary School	383	0.783	0.413	0	1	1 if Farmer's household has access to primary school education or otherwise zero (0)
Access to Secondary School	383	0.501	0.501	0	1	1 if Farmer's household has access to secondary school education or otherwise zero (0)
Access to Health Insurance	383	0.932	0.252	0	1	1 if Farmer has access to health insurance or otherwise zero (0)
Access to Health Centre	383	0.992	0.088	0	1	1 if Farmer's household has access to health centre or otherwise zero (0)
Access to Storage Facility	383	0.201	0.401	0	1	1 if Farmer's household has access to storage facility or otherwise zero (0)
Access to Telephone Service	383	0.068	0.252	0	1	1 if Farmer's household has access to telephone services or otherwise zero (0)
Access to Electricity Poles	383	0.546	0.499	0	1	1 if Farmer's household has access to electricity pole or otherwise zero (0)

APPENDIX 'D'

Table 4.10: Definition and Summary Statistics of Variables Used for Probit Estimation and Econometric Estimation of the Impact of Finance on Welfare of Smallholder Farm Household in Ghana

Variable	Obs	Mean	Std. Dev.	Min	Max	Label
Welfare	409	0.178	0.122	0.001	0.906	Farmer's household welfare status
Gender	409	0.724	0.448	0	1	1 if Farmer is male or otherwise zero (0)
Education Grade	409	0.220	0.415	0	1	1 if Farmer is educated (received a minimum of basic education) or otherwise zero (0)
Number of Years of Farming	409	16.051	11.134	1	50	Number of Years of Farming by a Farmer
Access to Potable Water	409	0.311	0.463	0	1	1 if Farmer's household has access to potable water or otherwise zero (0)
Access to Primary School	409	0.731	0.444	0	1	1 if Farmer's household has access to primary school education or otherwise zero (0)
Access to Secondary School	409	0.369	0.483	0	1	1 if Farmer's household has access to secondary school education or otherwise zero (0)
Access to Health Insurance	409	0.880	0.325	0	1	1 if Farmer has access to health insurance or otherwise zero (0)
Access to Health Centre	409	0.954	0.211	0	1	1 if Farmer's household has access to health centre or otherwise zero (0)
Access to Storage Facility	409	0.149	0.357	0	1	1 if Farmer's household has access to storage facility or otherwise zero (0)
Access to Telephone Service	409	0.056	0.231	0	1	1 if Farmer's household has access to telephone services or otherwise zero (0)