Impact of Agricultural Cooperatives on Farmer's Technical Efficiency: Evidence from Haricot Bean Producers, Southern Ethiopia

Sileshi Abebe[1], Teklebirhan Alemnew[2]

[1, 2]Lecturers, Department of Economics, Arba Minch University, Ethiopia

Abstract: ***The government of Ethiopia had considered cooperatives as important instruments to economically empower smallholder farmers through improving farmer's productive efficiency. However, there is lack of empirical evidence that tackles the impact of cooperatives on farmer's technical efficiency. Therefore, this paper investigates the impact of cooperatives on smallholders' technical efficiency. To address the research objective, a cross-sectional data was obtained from 400 randomly selected Haricot Bean producing farm households in Burji special district, Southern Ethiopia. Stochastic Production Frontier and Propensity Score Matching (PSM) models were used to analyze the data. Our result indicates that cooperative members are more likely to be households that are literate, ownland certificate, larger family size, own cell phone, and leadership experience. We also found that age of household head is positively and significantly associated with cooperative membership while distance from the town of the district reduces farmer's cooperative membership. Our study revealed thatthe mean technical efficiency score of the Haricot Bean producing farm households is found to be 71.8% with a mean technical efficiency score of 74.4% and 70% for cooperative member and non-member households, respectively. Our estimation result shows that cooperative membership has a strong positive impact on smallholder's technical efficiency. The results suggest that cooperatives can play an instrumental role in improving the technical efficiency of smallholder farmers in the study area.***

Keywords: Cooperatives, Impact Evaluation, Stochastic Frontier, Technical Efficiency, Ethiopia

1. Introduction

Agriculture continues to be the dominant sector in Ethiopia. It accounts for 35% of the country's GDP;over 65% of employment, and over 70% of the country's exports (NBE, 2018, WB, 2018).Currently, Ethiopia's real gross domestic product (GDP) growth decelerated to 7.7% in 2018 partly due to the weaker performanceof the agriculture sector (WB, 2018). The smallholder agriculture low productive efficiency is reflected in terms of greater incidence of poverty and food insecurity of the rural population almost all of which are smallholder farmers compared to urban counterparts (NPC, 2017, WB, 2018).

Evidences (Afework H., Endrias G., 2016,IFAD, 2013, MoARD, 2010, Salami A., et al., 2010) indicated that smallholder farmers low productivity stems from their inherent constraints including poor access to modern inputs, inadequate credit, poor infrastructure, inadequate access to markets, high transaction costs and post-harvest losses, high dependence on rainfall, limited bargaining power, poor land management practices and environmental degradation, and inadequate agricultural extension services and farm technology.

Acknowledging the role of agriculture development for the country's economy, Ethiopia has envisioned achieving accelerated and sustained growth of agriculture with a significant shift in agricultural productivity in the second Growth and Transformation Plan period (NPC, 2016). In an effort to overcome the constraints facing smallholder farmers' agriculture and transform the sector, the Ethiopian government has placed large emphasis on promoting agricultural cooperatives as the main organizational vehicles to economically empower the rural poor people (Tefera D., *et al*, 2016).According to the Ethiopian Agricultural Cooperatives Sector Development Strategy (2012-2016), agricultural cooperativesare agricultural-producer-owned organizations whose primary purpose is to increase member producers' production and incomes by helping better link with finance, agricultural inputs, information, and output markets. Moreover, Adurayemi C., (2014) asserted that agricultural cooperatives are formed to meet farmers' mutual needs and goals that none of them could achieve alone. For over a century, agricultural cooperatives have been recommended as an important instrument to transform smallholder farmers' agriculture all over the world. That was mainly because cooperative organizations were believed to increase smallholder farmers' access to farm technology, and extension services to optimize on-farm technical efficiency, given the limited resources available (D. Abebaw and M.G. Haile, 2013, Abate G. T., et al., 2013). It is arguedthat agricultural cooperatives are the best institutional intervention for rural development and attaining food security in any country. The developed nations like the United States of America, Canada, Australia, almost all European countries and China have attained food self-sufficiency mainly through Cooperatives (Veerkumaran G.,2007).

Agricultural cooperatives can increase farmers' productivity and incomes by pooling their assets and competencies together to overcome market barriers and other constraints via supporting collective service provisions and economic empowerment (FAO, IFAD, WFP, 2012, ATA, 2012). This idea was supported by ICA (2013) report indicating that cooperatives have played a major role in the agricultural industries of all developed and many developing countries for well over a century: playing significant role in farm supply; providing fertilizer and other inputs, and product marketing including transport, storage and processing.

Moreover, (Tefera D., et al., 2016, D. Abebaw and M.G. Haile, 2013, Sifa C., 2013, Kindie G., Tsegaye A., 2012, Minot N., Daniel A., 2012) pointed out that cooperatives offer small agricultural producers opportunities and a wide range of services, including improved access to markets, natural resources, information, agricultural technologies, credit, training and warehouses, and hence reduces transaction costs, pre-harvest and post-harvest losses. They also facilitate smallholder producers' participation in decision-making at all levels, support them in securing land-use rights, and lower prices for agricultural inputs (Sifa C., 2013, FAO, IFAD, WFP, 2012).

On the assumption that rural based cooperatives are appropriate organizational instruments to empower the rural poor, the current government of Ethiopia has created more conducive environment to encourage the establishment and operation of cooperatives all over the country. For instance, unlike proclamations in the socialist regime, the current proclamations (Proclamation no 147/1998 and 985/2016) ensured that the principle of cooperatives are voluntary and open membership, democratic member control, member economic participation, autonomy and independence (FDRE, 1998, 2016). Obviously, the principles are so defined in order to enhance development and sustainability of cooperatives which are thought to empower members and hence push the entire economy forward. Moreover, the government of Ethiopia had tried to put in place an enabling legal framework, and established federal, regional, Zonal and district level support institutions that provide financial, material and technical support for cooperative establishment and operation throughout the country (FDRE, 2002, ATA, 2012, Bezabih E., 2009).Despite government's effort towards the establishment and operation of agricultural cooperatives, membership participation in cooperative in rural Ethiopia is still low (Bernard T. and Spielman D., 2009, FCA, 2016).

Apart from the above promising evidences on the role of cooperatives, the experience of agricultural cooperatives as a vehicle for development in Ethiopia, and to a great extent in Africa as a whole, has been mixed. According to Bezabeh (2011) as cited in Sifa C., (2013) the large-scale introduction of agricultural cooperatives in the 1970s and 1980s with compulsory membership was associated with declining agricultural output per capita and productivity. On the other hand, there have been cooperative success stories in Africa; for instance the dairy sector in Kenya,Catfish and vegetables in Nigeria and Niger, coffee in Ethiopia, and cotton in Mali, had shown that cooperatives can be instrumental to empower members (ATA, 2012). However, Sifa C., (2013) indicated that no African country has achieved a sustained and large scale increase in staple crop yields as a result of cooperative action and many cooperative development programs have failed to achieve their objectives.

To the knowledge of the researchers, there are limited studies on the determinants of participation in cooperatives and its impact on smallholders' technical efficiency. Besides, the findings are inconclusive. For instance, studies by Addai N. K., *et al*, (2014) from Ghana, and Fischer E., and Qaim M., (2012) from Kenya found that cooperative membership has no effect on farmers' technical efficiency. On the other hand, studies by Abate G. T., et al., (2013) from Ethiopia, and Wanglin M., et al, (2018) from Apple farmers in China found that membership in agricultural cooperative has positive effect on technical efficiency of smallholder farmers.

Regarding cooperative membership, studies by Thomas W., *et al.,* 2015, D. Abebaw, M.G. Haile, 2013, Minot N., Daniel A., 2012, Nugussie Z., 2010, Bernard T., and Spielman D. J., 2009) are conducted at country level in Ethiopia while no study has been carried out in Burji Special district. Besides, almost all the studies have considered the whole array of cooperative societies at aggregated level. Fischer and Qaim, (2012) asserted that the potential benefits of cooperative societies are highly sector and product specific. Hence, aggregate analysis could miss the very nature of agricultural cooperatives owing to aggregation bias and hence might lead to misleading results.

Consequently, the concerns above gives rise to fundamental questions: What are the real factors that influence farmers whether to participate in agricultural cooperatives? Do agricultural cooperatives really contribute to smallholder farmers' efficiency? In this study, therefore, to address the existing research gaps, we have tried to empirically identify the factors that influence smallholder farmers' decision oncooperative membership participation and measure and analyze producers' technical efficiency, and examine whether cooperative membership affects farmers' technical efficiency in the study area.

The rest of this paper is organized as follows. The next section is a brief survey of the literature emphasizing on cooperative movement in Ethiopia and empirical evidences on the impact of cooperatives on farmer's technical efficiency. The methodology section outlines the sampling procedure and type of data used for the study. Besides, it outlines the method of data analysis and thereby describes the econometric procedures employed to estimate technical efficiency and the impact of cooperative membership on farmers' technical efficiency. The results and discussion section presents and discusses the estimated results on factors affecting farmers' cooperative membership, technical efficiency and impact of cooperative membership on farmers' technical efficiency. The last section summarizes the main findings, and draws some policy implications.

2. Literature Review

2.1 An Overview of Cooperative Movement in Ethiopia

The practice of cooperation to solve mutual problems through organized and coordinated efforts has a long history in Ethiopia. Traditional forms of cooperation involved community members voluntarily pooling financial resources through "iqub", which is an association of people having the common objectives of mobilizing resources, especially finance, and distributing it to members on rotating basis. There were also initiatives for labour resource mobilization intended to overcome seasonal labour shortages, known as "Jigge", "Wonfel", "Debo", among others. There also was the "idir", which was an association for provision of social and economic insurance for the members in the events of death, accident, damages to property, among others (Bezabih E, 2009). These informal institutions which are called cultural cooperatives continue to operate in Ethiopia.

The establishment of modern cooperatives in Ethiopia dates back to the reign of Haile Selassie (the Imperial period) when the first Farm Workers' Cooperatives Decree (Cooperatives Decree No. 44/1960) was enacted. Since then, three distinct periods of cooperative movement were observed in the country: cooperative movement during the Imperialperiod (1960 to 1974), the Socialist period (1974 to 1990), and the EPRDF (1990 to the present) (EIAR, 2011). Cooperatives established between 1960 and 1974 were based on the Cooperatives Decree No. 44/1960 meant for the establishment of agricultural cooperatives with the objective of assisting the development of the sector. More specifically, the establishment of cooperatives in this period was necessitated mainly due toincreased unemployment rate, rapid ruralto urban migration and land use policy challenges and shortage of foreign exchange.However, cooperative membership was limited to (and predominantly were) large landholders, and hence it excludes smallholders(Dagne M., et al, 2017).However, cooperatives established in this period were weak and failed to empower farmers due to problems such as land tenure system of the regime, lack of credit and skilled man power for cooperative establishment and movement, and poor agricultural markets (EIAR, 2011, Kindie G., Tsegaye A., 2012).

Following the regime change in 1974 to a Socialist government, a new cooperative proclamation (Proclamation No. 71/1975)was issued in 1975meant for the establishment of Producers' cooperatives and service cooperatives. However, it was amended in 1978 by cooperative society's proclamation No. 138/1978, which included the establishment of other cooperatives. In the first quarter of 1990, there were about 3,316 producers' cooperatives and 525 service cooperatives.However, cooperative establishment and their operation during the Socialist regime was state driven, and they were not sustainable. That is, membership was not based on interest and willingness and cooperative leaders were not elected by members rather they were government appointees(EIAR, 2011). Following the downfall of the Derge regime in May 1991, almost all producers' cooperatives were dissolved themselves (EIAR, 2011), and the local people vandalized most of the service cooperatives for their assets (Dagne M., et al, 2017).

Between 1991 and 1994cooperatives did not get any policy attention by the current GoE for the reason that the government's attention was mainly drawn towards stabilizing, bringing peace and creating administration organs (Veerkumaran G., 2007). Later on partly due to cooperative experts' dedication and partly due to the government's commitment towards cooperative development, the current government of Ethiopiaenacted new Agricultural Cooperative Societies Proclamation (Proclamation No. 85/1994) as a new cooperative proclamationto provide an enabling environment for agricultural cooperatives to flourish (EIAR, 2011, Tefera, *et al.*, 2016). This proclamation states that "the government sets convenient conditions for the peasants living in rural areas to be organized freely and willingly to jointly solve their economic and social problems through pulling their resources. Unlike the past two regimes, the current government opened a legal space to organize cooperatives voluntarily, democratically and within a market setting.

Moreover, the current GoE recognizing the potential role of agricultural cooperatives as a major contributor for rural development hadtried to put in place an enabling legal framework for cooperative development in the country. To this end, the government enacted the second proclamation (No. 147/1998) in 1998. This proclamation outlined the layers of organizational structure of the cooperatives into primary cooperatives, unions, federations, and cooperative leagues that can foster broader growth of the movement.The proclamation also outlined related organs of primary cooperatives that include members, a general assembly, a special resolution, and a management committee with clear roles and responsibilities. Besides, it indicated the possible formation of an appropriate authority, such as a government organ established at federal, regional, or local bureaus level (FDRE, 1998).In effect, the first government organ called Federal Cooperative Commission (FCC) was established in 2002 by Proclamation No. 274/2002 (FDRE, 2002), and later named the Federal Cooperative Agency (FCA) which is currently in charge of promoting cooperatives in Ethiopia. This agency is responsible to organize, register, provide training, finance and other technical and material support, ensure the legality and security of cooperatives and improve the market share of cooperatives and conduct research on cooperatives and thereby promote establishment, growth and strengthening cooperatives all over the country (FCA, 2016). The central objective behind the efforts in expanding and strengthening cooperatives was (and is) to enhance smallholder farmers' capacity to access improved inputs, increase their productions, and commercialize their produce, further leading to increased agricultural productivity and rural income as part of an effort to eradicate poverty and rural food insecurity (Bernard T. and Alemayehu S., 2013).

Mainly due to the considerable efforts put in place for the establishment and operation of cooperatives in the country for over two and half decade, currently primary agricultural cooperatives reached to 22,379 with a total membership of about 8.2 million farmers in Ethiopia. In other words, agricultural cooperatives account for 30%of primary cooperatives with 58% membership in the country (FCA, 2016).

2.2 Empirical Evidence

The impact of cooperatives on technical efficiency is one of the least researched areas. Few studies were conducted with regard to the impact of cooperatives on smallholders' technical efficiency in developing countries though the results remain inconclusive. Some studies (Abate G. T., et al., 2013, Wanglin M., et al, 2018) are in support of the principle that cooperative membership improves member's technical efficiency through facilitating access to production inputs as well as credit and extension linkages. Others (Addai N.K., et al, 2014, Mwaura F., 2014) found that membership in farmer based cooperatives does not affect farmer's productivity and/or technical efficiency.

The study by Wanglin M. et al, (2018) on agricultural cooperative membership and technical efficiency of Apple farmers in China using Propensity Score Matching (PSM) method found that the average technical efficiency score is higher for cooperative members relative to their counterparts, highlighting the positive role of agricultural cooperatives in promoting efficient usage of production inputs. Similarly, a study by Abate G. T., et al. (2013) on the impact of agricultural cooperatives on farmers' technical efficiency in Ethiopia found that membership in cooperatives improves members' technical efficiency where cooperative members are found to be more efficient by 5 percentage points compared to non-members.

On the other hand, Addai N.K., et al, (2014) investigated the effect of membership in farmer-based-organizations on Maize farmers' technical efficiency and yield in Ghana using Propensity Score Matching (PSM) estimator. The study shows that there is no significant impact of farmer based organization on technical efficiency and yield of maize farmers. Similarly, a study by Mwaura F. (2014) on the effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda found that group membership reduces the productivity of sweet potatoes, beans and maize producers while it increases the productivity of Banana and Cassava producers. These results contradict with the idea that farmer based organizations enhance members efficiency and productivity by easing access to productive inputs and facilitating extension linkages.

Generally, based on the existing empirical findings, one may conclude that the effectiveness of agricultural cooperatives in improving members' technical efficiency is country and location specific. It is also argued that efficiency impact of cooperatives depends on whether membership improves farm technology adoption in the specific location (Abebaw D. and M.G. Haile, 2013).

3. Methodology

3.1 Data Source and Sampling Procedure

This study was conducted in Burji Special District of Southern Ethiopia the population of which is highly dependent on Haricot Bean production for home consumption and as a source of cash. To address the objectives of the research, this study depends mainly on primary data sources obtained from sample Haricot Bean producing farm households. Through survey questionnaire, data on household demographic, socioeconomic and farm related characteristicswas obtained.

Sample households were selected by using both probability and nonprobability sampling procedure. According to the District administration office, there are about 13,101 rural households in Burji Special District in 2017. First, six Kebeles[1] were purposively selected from(a total of 23 rural Kebele's of) the District based on theirpotential of Haricot Bean production.And then, sample households were selected proportionately from each of the sixKebeles using systematic random sampling procedure. The sample size was determined usingYamane Taro's (1967:886) sample determination formula as follows:

$$n = \frac{N}{1 + N\,(e^2)} = n = \frac{13{,}101}{1 + 13{,}101\,(0.05^2)} = 388$$

Where, $n = 388$isthe sample size, $N = 13{,}101$is total population (rural households) of the District and $e = 5\%$is level of precision

That is, for the study, the minimum sample size is 388 households. However, to compensate for potential nonresponses and errors, questionnaire was administered to 450 farm households selected from the six Kebeles of the District. After data encoding,400 questionnaires were qualified to be included for the analysis.

3.2 Method of Data Analysis

The data obtained from the study area through questionnaire was analyzed using both descriptive and econometrics methods of analysis.Descriptive tools were used to distinguish between the characteristics of cooperative member and non-member farm households while the empirical estimations were used to ascertain causality among variables of interest, and evaluate the impact of cooperative membership on farmers' technical efficiency. Therefore, the section that follows outlines the empirical models used to address the objectives of the study.

3.3 Empirical Model Specification

3.3.1 Model for Determinants of Farmers' Cooperative Membership

As cooperative membership is a dichotomous variable where a farm household can either be a cooperative member or non-member, a binary choice model is appropriate; the general form of which is stated by Gujarati (2008) as:

$$Pr\{T_i = 1/X\} = Pr\{T_i^* > 0\} = Pr\{X_i'\beta + \varepsilon_i > 0\} = Pr\{\varepsilon_i > -X_i'\beta\} = G\{X_i'\beta\} \quad (1)$$

Where, *G(.)* denotes the assumed distribution function of ε_i. $T_i$is treatment status/members = 1

In this study, we choose the binary logistic regression model where G(.) is assumed to have a (cumulative) logistic distribution and is given as:

$$G(Z_i) = P_i = \frac{exp(Z_i)}{1 + exp(Z_i)} = \frac{e^{\beta_0 + X\beta}}{1 + e^{\beta_0 + X\beta}} \quad (2)$$

In the logistic regression function given in equation (2), $P_i = \frac{e^{Z_i}}{1+e^{Z_i}}$is the probability of being cooperativemember. Then, $1 - P_i$, the probability of being non-member is given as:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \quad (3)$$

Taking the ratio of the probability of an event occurring (P_i) to the probability of an event not happening ($1 - P_i$) and the resulting ratio is called ***odds ratio***:

$$\frac{P_i}{1 - P_i} = \frac{\frac{e^{Z_i}}{1+e^{Z_i}}}{\frac{1}{1+e^{Z_i}}} = e^{Z_i} \quad (4)$$

[1]Kebele is the smallest administrative unit in Ethiopia

Take the natural log of the above odds ratio and the resulting equation is called logit.

$$L_i = ln\left(\frac{P_i}{1-P_i}\right) = \ln(e^{Z_i}) = Z_i \qquad (5)$$

Where, L_i is the log of the odds ratio and called Logit which is linear in regressors (X_i) and in parameters.
Therefore, the empirical model for the determinants of smallholder farmers' cooperative membership status based on Logit model is specified as:

$$L_i = \beta_0 + \beta_1 Age + \beta_2 Sex + \beta_3 Deduc + \beta_4 Fam\_Size + \beta_5 Farm + \beta_6 Land\_Cert + \beta_7 Ext + \beta_8 Off\_farm + \beta_9 Ox + \beta_{10} Leadership + \beta_{11} TLU + \beta_{12} Phone + \beta_{13} Radio + \beta_{14} Distance + \varepsilon_i (6)$$

Where, L_i, Age, Sex, Deduc, Fam_Size, Farm, Land_Cert, Ext, Off-farm, Ox, Leadership, TLU, Phone, Radio and Distance stands for Logit, age of household head, Male dummy for sex of household head, dummy for education of household head, Family size in adult equivalent, farm size in hectare, dummy for land ownership certificate, annual frequency ofextension visit, dummy for off-farm participation,number of Ox owned by the household, dummy for leadership experience of household head, livestock ownership other than Ox measured in tropical life unit, dummy for mobile phone ownership and dummy for radio ownership, distance to the center of the district, respectively.

3.3.2 Model for Efficiency Analysis

Stochastic frontier approach was applied to estimate the level of technical efficiency of farmers because of its ability to distinguish inefficiency from deviations that are caused from factors beyond the control of farmers. Crop production is likely to be affected by random shocks such as weather and drought. In addition, measurement errors are likely to be high. Therefore, in situations where random shocks and measurement errors are high, a model that accounts for the effect of noise is more appropriate. Thus, the stochastic frontier production function is more appropriate for this study. Following the work of Aigner, Lovell & Schmidt (1977) and latter extended by Battese & Coelli, (1995), the stochastic frontier production model can be specified as;

$$Y_i = f(x_i, \beta)\exp(V_i - U_i), \qquad i = 1, 2, \ldots, 400$$

Where, Y_i is the output of the i[th] producer, x_i −vector of N inputs used by the producer, β is a vector of unknown parameters, V_i is the zero-mean random error associated with random factors not under the control of the producer and U_i is the farmers' production inefficiency component.
Given the above frontier specification, the extended stochastic frontier empirical model of this study is given as:

$$ln(output_i) = \beta_0 + \beta_1 ln(Farm) + \beta_2 ln(Seed) + \beta_3 ln(Labor) + \beta_4 ln(Oxen) + \beta_5 ln(Fertilizer) + \varepsilon_i(V_i - U_i) \ldots\ldots (7)$$

Where, **output** is the Haricot Bean output (kg) of the i[th] farmer; **Farm** is the area put under Haricot Bean production in the 2018 production season (ha); **Seed** is the amount of Haricot Bean seed applied (kg); **Labor** constitutes both family and hired labour (in man-days) used for production; **Fertilizer** is the amount of chemical fertilizer applied in the Haricot Bean plot (kg); $\boldsymbol{\beta_0 - \beta_5}$ are the parameters to be estimated; $\boldsymbol{\varepsilon_i}$is the error term, equal to $(\boldsymbol{V_i - U_i})$; $\boldsymbol{V_i}$is a two-sided random error component beyond the control of the farmer; $\boldsymbol{U_i}$is a one-sided inefficiency component.

On the other hand, the level of technical (in) efficiency is associated with farmers' socioeconomic characteristics (Battese and Coelli1995).Empirical evidence shows that technical inefficiency, $U_i$is influenced by a combined effect of various farmer, institutional and location specific factors. Thus, the empirical model for the determinants of technical (in)efficiency is specified as:

$$U_i = \delta_0 + \delta_1 HAge + \delta_2 Sex + \delta_3 DEduc + \delta_4 Coopmm + \delta_5 DMKT + \delta_6 Farm + \delta_7 Dinsect + \delta_8 Land_{cert} + \delta_9 Ext_{Cont} + \delta_{10} Ox + \delta_{11} Off_{farm} + \delta_{12} Gochie + \delta_{13} Otomalo + \delta_{14} Klicho + \delta_{15} Gera + \delta_{16} Gemyo + W_i \qquad (8)$$

Where, $HAge$ is age of household head; Sex is a male dummy for sex of household head; DEduc is literate dummy for education status of head; Coopmm is a dummy variable for farmers membership in cooperatives where 1 is assigned for members; DMKT is distance from home to market of farmers (minute); Farm is the landholding put under Haricot Bean production (ha); $Dinsect$ is a dummy variable for application of insecticide; Land_Cert is dummy variable for those who own/take land ownership certificate; Ext_Cont is frequency of extension contact per annum; Ox is the number of Ox owned by the household; Off_Farm is dummy for participation in off-farm income generating activities;Gochie, Otomalo, Klicho, Gera and Gemyo are dummy for kebeles, and δ is a vector of unknown parameters and W_i are unobserved random terms in the inefficiency model.

Following Battese & Coelli (1995), the single-stage, maximum likelihood estimation (MLE) approach which allows for a simultaneous estimation of the parameters of the stochastic frontier (equation-7) and the inefficiency model (equation-8) was employed in this study.

After prediction of sample producers' technical efficiency score, the impact of agricultural cooperative membership on smallholders' technical efficiency was examined by using Propensity Score Matching (PSM) method. Thus, PSM procedure is outlined in the following section.

3.3.3 Model for Impact of Cooperatives

The very objective of this paper was to answer the question: *"Does cooperative membership affect the technical efficiency score of smallholders in the study area?"*To answer this question we follow the counter- factual approach of causality (Austin P., 2011). In a randomized experiment, the mean impact of a treatment on the treated can be measured by computing the difference between mean values of the outcome variable of interest for the treatment and control groups. However, this approach cannot be applied for the present case since cooperative membership is likely to be non-random. That is, cooperative members and non-members may not be directly comparable as members may self-select (or be selected) into the program based on initial differences; the mean outcome of the two groups differs even in the absence of the treatment.

In such a setting, an impact evaluation is carried out using a suitable non-experimental method (Khandker R. ,et al., 2010, Caliendo & Kopeinig, 2008). One of such methods is the Propensity Score Matching (PSM) technique (Rosenbaum and Rubin, 1983) which is employed in this study. The main idea of this method is to construct a suitable comparison group with non-member farmers that are similar to cooperative members in all relevant observed characteristics (Caliendo & Kopeinig, 2008 and Khandker R.,et al., 2010). The first step in the application of PSM is to estimate the predicted probability that a household is a member of a cooperative(also known as the propensity score)given a set X_i of observed characteristics. The propensity score can be estimated as follows:

$$p(X_i) = Pr(T = 1/X_i) \quad (9)$$

where,$p(X_i)$denotes the propensity scores obtainable from either a binary logit or probit model and $Pr(T = 1/X_i)$ is probability of treatment/cooperative membership given observed covariates.

In this study, the propensity score is estimated by a logit model which regresses cooperative membership (1= members and 0 = non-members) on observed personal, household, farm and location characteristics.Therefore, propensity scores were derived from the logit model specified in equation [6] above which is the extended form of equation [9]. The next step in the implementation of the PSM method is to compute the PSM estimator of the average effect of treatment on the treated (ATT) by taking the average difference in outcomes between treatment and control group appropriately matched by the propensity score using one or more matching algorithm(s).Several matching algorithms are identified in the literature such as the nearest-neighbor (NN) matching, caliper/ radius matching, stratification/interval matching, and kernel matching, among others (Khandker R., et al., 2010, Becker and Ichino, 2002).

Becker and Ichino (2002)revealed that the robustness of the PSM estimator (i.e., ATT)can be checked by applying alternative matching algorithms.Therefore, in this paper, all the four matching algorithms were employed to pair cooperative members to similar non-members using the estimated propensity score.

Following Becker and Ichino (2002), the average treatment effect on the treated (ATT), which in our case is the average impact of cooperative membership on members' technical efficiency, can be estimated as follows:

$$ATT = E\{Y_{1i} - Y_{0i}/T_i = 1\} = E\{E\{Y_{1i} - Y_{0i}/T_i = 11, p(X_i)\}\}$$
$$ATT = E_{p(X_i)/T_i=1}\{E[Y_{1i}/T_i = 1, p(X_i)] - E[Y_{0i}/T_i = 0, p(X_i)]\} \quad (10)$$

Where,Y_1 and Y_0 are, respectively, values of the outcome variables ofinterest for cooperative members/treated, $T_i = 1$ and non-members/untreated, $T_i = 0$ (i.e., in our case efficiency scores); i refers to households. The statistical significance of ATT is tested using bootstrapped standard errors which take into account the variation caused as a result of the matching process.

The main assumption behind matching is selection on observables, also known as conditional independence assumption (CIA) (Rosenbaum and Rubin, 1983). However, if there are unobserved variables that affect both cooperative membership and the outcome variableof interest, a hidden bias might arise to which matching estimators are not robust (Caliendo & Kopeinig, 2008). In particular, hidden bias leads to both positive and negative unobserved selection. Positive unobserved selection occurs if households who become members of a cooperative are also more likely to have improved technical efficiency. In this respect, the treatment effect would be overestimated. In contrast, the treatment effect would be underestimated when negative unobserved selection exists. Unfortunately, CIA cannot be tested directly with non-experimental data. To address this concern, we took several measures. First, following the suggestion in the recent literature (Caliendo M. & Kopeinig S., 2005 and Khandker R., et al., 2010), we included several covariates in ourpropensity score specification to minimize omitted variables bias. Second, matching is implemented on the region of common support,$0 < p(X_i) < 1$ (Caliendo M. & Kopeinig S., 2005). Third, we use the Rosenbaum bounds approach (Rosenbaum, 2002) to test the sensitivity of the estimated results to hidden bias.

4. Results and Discussion

4.1. Descriptive Analysis

Table 1 below presents the summary statistics of sample households by cooperative membership status. As evidenced in the table, 164 (41%) of the total sample farm households are cooperative members while the remaining 236 (59%) are non-members. Among the cooperative members, the majority of them, 71 (43.29%) belongs to saving and credit cooperatives while the remaining 67 (40.85%) and 26 (15.85%) belongs to multi-purpose agricultural cooperatives and marketing cooperatives, respectively. The mean age (a proxy for farm experience), family size in terms of adult equivalent, inorganic fertilizer and distance to district town are statistically different between cooperative members and non-members. Cooperative members are more likely to be found in areas closer to district town.

Table1: Characteristics of Sample Farm Households by Cooperative Membership Status

Variables	Mean		Mean Diff. test
	Members (N=162)	Non_Members (N=236)	(P-Value)
Head_Age	46.21	42.42	0.003
Family Size (Adult)	4.62	4.24	0.002
Output (Kg)	1172.07	1052.84	0.207
Farm Size (ha)	0.921	0.941	0.712
Seed (Kg)	76.22	76.42	0.975
Fertilizer (Kg)	100.99	89.12	0.085
Labor used/Man-days	61.23	62.11	0.827
Oxen used/Oxen-days	19.88	19.44	0.678
Oxen Owned	3.122	2.81	0.108
Tropical Life Unit	2.60	2.26	0.132
Extension visit	2.42	2.39	0.874
Distance to market	92.50	92.74	0.971
Distance to District town (Minute)	133.08	147.90	0.023
Technical Efficiency	0.744	0.700	0.006

Source: survey data, 2018

On the other hand, Table 1 reveals the impact indicator variable, i.e., technical efficiency score, of members and non-members. The average technical efficiency of members and non-members stood at 0.744 and 0.70, respectively. That is, farm households that belong to agricultural cooperatives were found to be more efficient by 4.4 percentage points as compared to non-members and the mean difference is statistically significant at 1 percent level of significance. However, as stated earlier this result cannot be used to make inferences regarding the impact of cooperatives on technical efficiency of farm households since confounding factors should be controlled for.

Table 2: Summary of dummy Variables used in the econometric model

Dummy Variables	Category	Members (N=162)	Non-Members (N=236)	Pearson chi2(1)
Sex	Male	140	198	0.1591
	Female	24	38	
Literacy	Literate	118	132	10.594***
	Illiterate	46	104	
Own land certificate	Yes	167	148	21.944***
	No	69	16	
Off-farm Participation	Yes	44	32	11.07***
	No	120	204	
Insecticide applied	Yes	113	83	0.720
	No	51	153	
Leadership experience	Yes	72	73	7.04***
	No	92	163	
Own Radio	Yes	114	145	2.76*
	No	50	91	
Own Mobile	Yes	144	138	40.02***
	No	20	98	

Table 2 shows that cooperative members are also more likely to be literate, those participating in off-farm income generating activities, possess land ownership certificate. It also appears that cooperative member households are more likely to have radio and mobile phone than non-member households. Interestingly, household heads of cooperative members are more likely to have leadership experience than non-members household heads.

4.2. Determinants of Cooperatives Membership

To explore the factors affecting Haricot Bean producing farm households' cooperative membership status, a binary logistic regression model was estimated. Table 3 presents the odds ratio and marginal effect results of the logit model.

Table 3: Logistic Regression of the Determinants of Farmers' Cooperative Membership

Variables	Odds Ratio Coefficient (Std.Err)	Marginal Effect Coefficient (Std.Err)
Number of Obs = 400; LR $\text{Chi}^2(15)$ = 115.05; *Log Likelihood* = −213.22; Prob > Chi^2 = 0.0000; PseudoR^2 = 0.23		
Head_Sex	1.049 (0.349)	0.011 (0.077)
Head_Age	1.039*** (0.011)	0.009*** (0.03)
Family Size (Adult)	1.350***(0.136)	0.070*** (0.023)
Head_Literate	2.591***(0.753)	0.211*** (0.060)
Landholding (ha)	0.456**(0.142)	−0.183** (0.072)
Land_Certificate	3.098***(1.074)	0.233*** (0.060)
Extension Visit	0.968 (0.073)	−0.008 (0.018)
Tropical Life Unit	0.968 (0.060)	−0.008 (0.014)
No of Oxen Owned	1.038 (0.094)	0.009 (0.021)
Distance from Town	0.992** (0.003)	−0.0018** (0.0006)
Off_farm participation	1.568 (0.526)	0.118 (0.078)
Leadership Experience	1.658* (0.446)	0.119* (0.064)
OwnMobile Phone	5.219*** (1.619)	0.335*** (0.050)
Radio Ownership	1.341 (0.355)	0.067 (0.060)
Constant	0.008*** (0.006)	
Mean Variance Inflating Factor (VIF): 1.31; *Link Test*: $Coop\_MM = -0.101 + 1.11\hat{y} + 0.109\hat{y}^2$; Z_Value: (−0.73)(7.88) (1.52)		

*** Significant at 1%.
** Significant at 5%.
* Significant at 10%.

The estimated logit model is statistically significant at the 1% significance level. Most of the covariates in the logit model have the expected sign and comply with previous studies. The results indicate that membership in cooperatives is strongly associated with the household's demographic and socioeconomic characteristics as well as institutional factors. In particular, age of household head (a proxy for farm experience) is found to increase the likelihood of cooperative membership. This result is in line with the finding of a study from Ethiopia by D. Abebaw and M. Haile, (2013). Similarly, consistent with the findings of Bernard T., & Spielman D. J. (2009) and Odegbile, O.S., et al, (2015), the result revealed that households with larger family size in terms of adult equivalent are more likely to be cooperative members. This is mainly because cooperative participation requires additional labor supply to take part in the activities of cooperative organizations. Similarly, households with literate head are more likely to be cooperative members suggesting the importance of knowledge in enhancing cooperative membership. This is consistent with a study by Minot N. & Daniel A. (2012) which pointed out that more educated farmers are more likely to be members of agricultural cooperatives in Ethiopia.

As far as land certification is concerned, the Ethiopian government has been implementing land registration and certification program since 2002 yet some farmers still haven't get one. The certification is believed to increase land security rights; reduce land related disputes and enhance the motivation of farm households to invest on their holdings which in turn improves their farm output and productivity. Interestingly, our result revealed that households that possess land ownership certificate are more likely to be cooperative members. This might be because that cooperative membership is one of the ways to invest on landholdings to improve production and farm productivity.

As expected (D. Abebaw, M.G. Haile, 2013), leadership experience by the head and owning mobile phone increases the likelihood of cooperative membership. Consistent with Fischer E., and Qaim M., (2012), access to credit has statistically significant and positive effect on cooperative membership. On the contrary, distance to the district town has a significant negative effect on cooperative membership.

On the other hand, despite we expect a positive relationship between off-farm employment participation, frequency of agricultural extension services as well as radio ownership, and cooperative membership, the relationship is found to have statistically insignificant effect on cooperative membership.

The coefficient of landholding is negative and statistically significant at 5%. This reveals that farmers with relatively larger farm size are less likely to be members of cooperatives (7.5% lower) than their counterparts. This finding is consistent with a study from Nigeria by Fashogbon A., et al., (2015) which has discovered that an additional increase in farm size will significantly reduce the probability of cooperative membership by 4.6%. However, this result is contrary to the findings of Fischer and Qaim (2012) from Kenya Banana producers, Issa N., & Chrysostome N. J., (2015) from Rwanda Coffee sector, Abate G. T., et al (2013) from Ethiopia. These studies discovered that the size of the land holding has a positive and significant effect on the probability of cooperative membership. This contradiction in finding is perhaps due to the fact that the importance of cooperative membership depends partly on the nature of cooperative (marketing or others) and the purpose of production (mainly for commercial or mainly for home consumption) being considered.

4.3. Estimation of Production Function and Technical Efficiency Analysis

The stochastic frontier production model is used to estimate the technical efficiency of sample households. Before proceeding to model estimation, tests were conducted for the assumption of stochastic frontier model.

First, we detected the presence of inefficiency in the production function using alternative tests. This is made in order to decide whether the traditional average production function (OLS) best fits the data set as compared to the stochastic frontier model (SFM). As illustrated in at the bottom section of table-3, both $\boldsymbol{\lambda}$and $\boldsymbol{\sigma}$have positive coefficients, and is statistically significant at 1 per cent significance level. The estimated value of $\boldsymbol{\delta_u^2}$and$\boldsymbol{\delta_v^2}$ is 0.078 and 0.020, respectively. These values indicate that the difference between the observed (actual) and frontier (potential) output are due to inefficiency and not chance alone.

Moreover, likelihood-ratio test wasconducted by estimating the stochastic production frontier assuming the null hypothesis of no technical inefficiency in the input output data. The likelihood-ratio test statistics is calculated to be LR= $-2(LH_0 - LH_1) = -2\big(-54.48 - (-4.27)\big)$ =100.42.

The test result indicates an outright rejection of the null hypothesis of no technical inefficiency since the test statistic ($LR = 100.42$) is way above the 1% level of significance (5.412) provided by Kode and Palm (1986).

All the test results show that the inefficiency component of the error term is significantly different from zero, which indicates the presence of a statistically significant inefficiency component. This implies that a part of the Haricot Bean farmers' inefficiency in Burji district is due to technical errors. The value of gamma ($\boldsymbol{\gamma}$)which makes it possible to measure the contribution of the error due to technical inefficiency (U) in the total variability of the output from the potential level is estimated to be 0.799 indicating that 79.9% per cent of the difference between the observed and frontier output is primarily due to factors which are under the control of farmers. Therefore, the stochastic frontier approach is an adequate representation of the production system in the study area.

Second, we evaluated the hypothesis that farm-level technical inefficiency is not affected by the socioeconomic variables included in the inefficiency model, equation-8 (H_0: $\delta_1 = \delta_2 = \cdots = \delta_{16} = 0$) using the likelihood-ratio test. The calculated LR value of 100.42is greater than the critical value of 33.92at 16 degrees of freedom. This shows that the null hypothesis (H_0) that all explanatory variables are simultaneously equal to zero is rejected at 5% level of significance. Therefore, the variables included in the model were simultaneously explaining the variation in technical efficiency among the sample households.

In general, the test results reveal that the stochastic frontier model along with the inefficiency representation given in equation-8 is adequate representations of the production system in the study area. Following Battese and Coelli (1995) approach, we estimate a one-stage simultaneous maximum likelihood estimate for the parameters of the Cobb-Douglas stochastic frontier model to predict households' technical efficiency scores and examine the factors affecting technical inefficiency in the study area.The table below presents the Maximum Likelihood estimates of a Cobb-Douglas type stochastic frontier model.

Table 4: Maximum Likelihood (ML) Estimates of Stochastic FrontierModel

Dependent Variable: Haricot Bean Production in Kg (Logged)			
Inputs (in natural log)	**Coefficient**	**Std. Err.**	**Z-value**
Farm size/ha	0.023	0.074	0.32
Seed/Kg	0.693	0.054	12.82***
Labor/man-days	0.221	0.036	6.06***
Oxen/Oxen-days	0.0002	0.049	0.00
Fertilizer/Kg	0.027	0.011	2.41**
Constant	3.276	0.279	11.75***
$Sigma\_u$ (δ_u)	0.279	0.027	10.31***
$Sigma\_v$ (δ_v)	0.140	0.022	6.41***
Lambda ($\lambda = \delta_u/\delta_v$)	1.992	0.036	55.02***
Gamma [$\gamma = \delta_u^2/(\delta_u^2 + \delta_v^2)$]	0.799		
Log likelihood function	-4.52		
Wald chi2 (5)	1049.78		
Prob>chi2	0.000		

*** Significant at 1%
** Significant at 5%
Source: Survey data, 2018

As can be seen above, the coefficients of Farm size, Seed, Labor, Oxen and Fertilizer represent the output elasticities in the production function. All these elasticities are positive implying that the postulate of the theory of production which states that output is a positive function of input levels is satisfied. The elasticities of Seed, Labor, and Fertilizer are statistically significant while that of Farm size and Oxen is statistically insignificant. In terms of magnitude of elasticities, seed is the most important determinant of output in the study area, followed by labor and fertilizer. Generally, the result shows that Haricot Bean output responds positively and significantly to increases in seed quantity, the quantity of labour used throughout the production season, and the quantity of inorganic fertilizer. This result is in line with the findings of Abate G.T., et al (2013), Mango N., et al, (2015), Zannou A. et al, (2018). Hence, an increase in these inputs would increase Haricot Bean production in the study area.

Technical Efficiency and Output Gap

One of the main interests of this study is to measure Haricot Bean producing farm households' technical efficiency score and the factors determining variation in technical (in) efficiency among producers in the study area. Besides, Knowledge of the individual farmer's technical efficiency and actual output in Haricot Bean production enables to determine the potential level of Haricot bean output farmers could have produced through efficient use of existing inputs and technology.

Given the functional form used, estimation procedure implemented, distributional assumption ofthe inefficiency component(U_i), individual efficiency scores were estimated. The mean technical efficiency score of Haricot Bean producing farmers in the study area is 71.8% with a minimum of 23.8% and a maximum of 95.90%. This implies that on average, Haricot bean farmers were able to obtain 71.8% of the potential output from the given combination of production inputs. The implication of the result is that an average Haricot bean producer can expand production by about 28.2% using the existing resources and level of technology. In other words, on average the sample households can reduce their inputs by 21.2% to get the output they are currently getting. More specifically, the frequency distributions of efficiency estimates obtained from the stochastic frontier model (Figure 1) shows that 9% of sample farmers operated below efficiency level of 50% while only 12.25% of them operated between 90% and 95.90% efficiency level. Besides, 38.5%, 16.75%, and 23.5% of the Haricot Bean Producers were able to obtain within 50 to 72%, 72 to 80% and 80 to 90% of their potential production level, respectively.

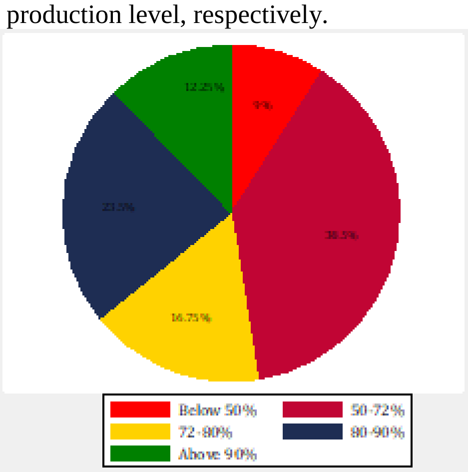

Figure 1: Distribution of Technical Efficiency Scores (TE) among sample households
Source: Survey data, 2018

Given the actual Haricot Bean output and the estimated technical efficiency score of each individual farmer, the potential Haricot Bean output was estimated for the sample Haricot Bean producers by dividing the actual individual level of Haricot Bean output by the predicted technical efficiency scores. After calculating potential Haricot Bean output, the output gap of Haricot Bean production was estimated. Output gap was estimated by taking the difference between technically full efficient level of output (i.e., potential output) and actual output.

The mean technical inefficiency was 28.2% which caused 358.207 kg output gap in Haricot Bean production on average with mean actual output and potential output amounts to 1101.723 kg and 1459.93 kg, respectively. This shows that sample households in the study area were producing on average 358.207 kg lower Haricot Bean output relative to the potential output they could have produced had they efficiently utilized the existing input combination. In other words, the result indicated that there is a potential to increase Haricot Bean output on average by 358.207 kg with the existing input and technology through improving technical efficiency of farmers alone. Figure 3 illustrates that under the existing input resources and technology, there is a room to increase Haricot Bean production through improving efficiency in the study area.

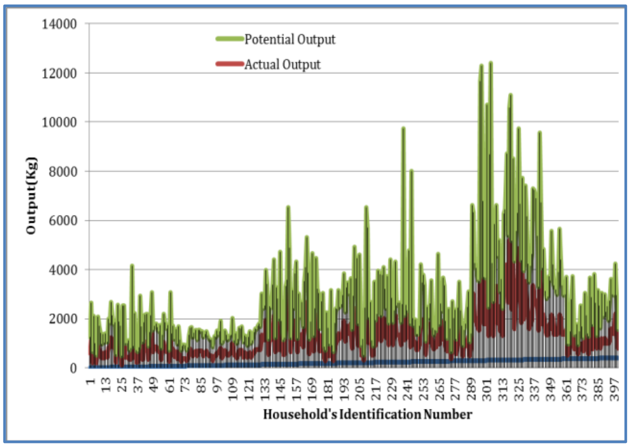

Figure 3: Comparison of the actual and potential level of output

4.4. Determinants of Technical Inefficiency of Haricot Bean producers

After measuring the level of technical efficiency and having information about the existence of technical inefficiency, it is essential to identify causes of technical inefficiency.**Table 5** presents the Maximum Likelihood estimates of the technical inefficiency model.

Given the estimated technical inefficiency model (Table 5), the coefficients of head_literate, cooperative member, land certificate, insecticide application, and number of Oxen owned are negative and statistically significant implying that technical efficiency is higher if the farmer is literate, a member of cooperative, own land certificate, applied insecticide, and has more oxen. Education status of household head (which is a proxy variable for managerial ability of farmers) had statistically significant and positive relationship with technical efficiency in Haricot Bean production at 10% level of significance. The result indicated that literate farmers had higher technical efficiency in Haricot Bean production than their illiterate counterparts. This is due to the fact that education increases the farmers' ability to utilize existing technologies and attain higher efficiency level.

As noted earlier, land certification is believed to increase land security rights and thereby enhance the motivation of farms to invest and work harder on their holdings which in turn improves their farm output and productivity. Interestingly, our result revealed that households that possess land ownership certificate are more efficient compared to households that are not yet certified. Similarly, the study revealed that as the number of Oxen owned by a farmer increases, farmer's technical efficiency rises. This is undoubtedly true that oxen is the major input used for production in the study area, and the more oxen a farmer has the more timely tilling of the farm he/she would have especially during peak production season.As expected the coefficients ofextension contact and participation in off-farm income generating activities are negative but they are statistically insignificant.

On the other hand, the coefficient of age of household head is positive implying that farms managed by younger household heads are more efficient than those managed by older household heads and this finding is supported by a recent study on Philippines Rice sector by Paul S. and Shankar S., (2018). Also the coefficient of farm sizeis positive implying that higher farm size contributes to farmers' inefficiency but it is insignificant. In the inefficiency model, Kebele dummies were included as explanatory variables to capture location specific farm related correlates of inefficiency. The coefficients of the Kebele dummies are positive and significant indicating that technical efficiency in Walya Kebele is higher than the level in any other Kebele.

Table 5: Maximum Likelihood estimates of factors affecting technical inefficiency

Variables	**Coefficient**	**Std.Err**
_Constant	0.149	0.257
Head_Age	0.007***	0.002
Head_Male	0.053	0.063
Head_Literate	−0.088*	0.052
Farm size (ha)	0.0028	0.094
Cooperative Membership	**−0.092***	**0.052**
Distance to the nearest market (Minute)	−0.015	0.034
Land certificate	−0.117*	0.071
Extension contact	−0.011	0.016
Applied insecticide	−0.087*	0.052
Number of Oxen owned	−0.104***	0.025
Off_farm Participation	−0.099	0.065
Location(Kebele) Dummy+ Gochie	0.252*	0.137
Otomalo	0.514***	0.146
Klicho	0.447***	0.153
Gemyo	0.556***	0.163
Gera	0.426**	0.185

+ WalyaKebele is the reference category
**** Significant at 1%*
*** Significant at 5%*
** Significant at 10%*
Source: Survey data, 2018

With regard to membership in agricultural cooperatives, the result indicates that membership reduces technical inefficiency by about 0.092 units, and it's statistically significant at 10% level. Concurrently, from the descriptive statistics (see **Table 1**) we understood that the mean technical efficiency of cooperative members is significantly higher than that of non-members. The result is in line with the finding by Abate G. et al (2013). However, we cannot draw any conclusion at this stage as this difference can be partially or totally due to original differences among households. Therefore, to assess the impact of being a member of agricultural cooperative, we use Propensity Score Matching (PSM) method that computes the average difference in technical efficiency scores between cooperative members and non-members in the common support region. The result is presented and interpreted in what follows.

4.5. Impact of Agriculture-BasedCooperatives on Smallholders' Technical Efficiency

This study is intended mainly to measure the average impact of cooperative membership on farm households' technical efficiency. In other words, we estimate the Average Treatment Effect on the Treated (ATT), where the treatment is cooperative membershipand the treated are member farmers. The GoE recent effort towards strengthening the establishment and operation of rural based cooperatives is on the assumption that cooperatives could improve their member's production and productivity through enablingthem in getting better access to productive inputs and services including training on better farming practices that enhance their productive efficiency (FDRE, 1998). To find out whether farmer-based cooperatives are actually improving farmer's productive efficiency in the study area, we estimate technical efficiency impact of cooperatives (ATT) using the Propensity Score Matching (PSM)procedure. But before estimation using matching, we check whether there is sufficient overlap in the distribution of the propensity scores of cooperative members and non-members (see **Figure 4** for visual inspection).

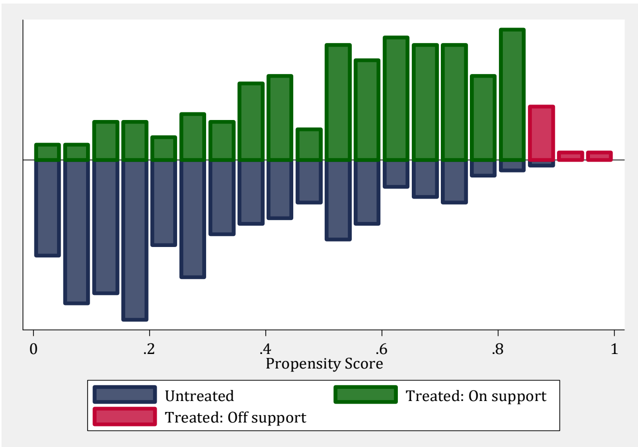

Figure 4: Distribution of Propensity Scores for the cooperative members and non-members

Interestingly, the two groups have substantial overlap in their propensity score distributions, and this allows estimation of treatment effects (ATT) using matching. The impact of cooperative membership is estimated using alternative estimators to ensure robustness **(Table 6)**. As can be seen from the table, all the matching estimators yield similar results and show that cooperative membership has a positive and statistically significant effect on smallholder's technical efficiency. More specifically, the technical efficiency score would be 5.6-7.3 percentage points higher for cooperative memberfarmers compared to non-members.

Table 6: Effect of cooperative membership on technical efficiency of smallholders (ATT)

Matching Estimator+	ATT
Kernel Matching (bandwidth = 0.06)	0.073(0.019)***
Nearest 1 Neighbor	0.056 (0.019)***
Radius (Caliper = 0.05)	0.058(0.016)***
Stratification	0.066(0.018)***

*** Significant at 1%.

+ATT estimates of nearest neighbor matching were obtained by applying 'nnmatch' command using the bias adjustment option in Stata. Figures in the parentheses are bias-adjusted standard errors (nearest neighbor matching) and bootstrapped standard errors (number of replications = 100) for kernel, radius and stratification matching estimators. With the kernel, radius and stratification matching estimators common support condition is imposed and the matched sample includes 164 cooperative members and 230 non-members.

Diagnostic Tests

In evaluating the reliability of estimates reported above, we carried out two tests: the covariate balance test, and sensitivity test to hidden bias. To check whether the balancing requirements of PSM are satisfied in our data, the pstest command is used in Stata. As shown in the appendix (see Table A1), members and non-members have statistically similar characteristics after matching compared to the unmatched sample characteristics (see Table 1 and Table 2). In particular, the test for equality of the two group means shows that there is no statistically significant difference between members and non-members after matching. Moreover, the standardized differences (% bias) for the mean values of all covariates between members and non-members are below 20% which implies that our matching is successful (Rosenbaum and Rubin, 1985). This reassures that the balancing requirement is adequately satisfied.

Robustness of ATT Estimates to hidden bias

One of the assumptions of the PSM method is the conditional independence or unconfoundedness (Rosenbaum P.R.,& Rubin, 1983) which implies that treatment assignment is entirely based on observed characteristics.The assumption is violated if unobserved characteristics determine treatment assignment. Hence, the basic concern is whether unobserved factors can alter inference about treatment effects. Therefore, we check for sensitivity of the ATT results to hidden bias using the Rosenbaum bounds procedure (Rosenbaum P.R., 2002). The upper bounds significance levels for $\Gamma = 1, 2, \text{and } 3$ are 0.0001, 0.0001, and 0.0001, respectively. The implication is that the ATT estimates are insensitive to a bias that would double as well as triple the log odds of differential assignment due to unobserved factors**.** Therefore, the result reveals that the ATT estimates are insensitive tohidden bias.

Table 6: Rosenbaum Bounds Sensitivity Test

Gamma (Γ)	Sig+	Sig-	t-hat+	t-hat-
1	0	0	0.69	0.69
2	1.1e-14	0	0.64	0.74
3	2.2e-10	0	0.61	0.77

Besides, we also carried out robustness test using alternative matching algorithms. According to Becker and Ichino, (2002), if ATT estimates of different matching algorithms are similar the estimates are not sensitive to hidden bias. As can be seen from **table 6**, the ATT estimates of the four matching algorithms are similar implying that the estimates are insensitive to hidden bias.

5. Conclusions

Improving agricultural production and productivity is one of the policy priorities of Ethiopia. In this respect, farmers' cooperatives are expected to play an instrumental role in achieving better growth in the sector. Over the last two and half decades, the current government of Ethiopia has enacted a series of cooperative proclamations to lay down the foundation for the establishment and operation of cooperatives in the country. Cooperatives are involved in the delivery of different services to their members including, among others, dissemination of improved farm inputs (e.g., fertilizers, improved seeds, pesticides, and insecticide), provision of saving, creditservices and marketing of members' farm outputs, and provision of training for members. Through improving access to input and output markets as well as facilitating extension and credit access, cooperatives are believed to enhance technical efficiency of smallholder farmers. However, on the one hand, despite the government's long years effort in promoting the establishment and operation of cooperatives, rural based cooperative membership has remained low, on the other hand, empirical studies that tackles the impact of cooperatives on smallholder cooperative member farmer's technical efficiency are very limited in Ethiopia.

Therefore, this research was an attempt to (1) identify the factors affecting cooperative membership, (2) measure and analyze the technical (in)efficiency of Haricot Bean producers and (3) examine the technical efficiency impact of cooperatives on smallholder farmers' in the study area. To address these objectives, a cross-sectional data was obtained from 400 randomly selected Haricot Bean producing farm households in Burji special district, Southern Ethiopia. Logistic regression, Stochastic Production Frontier and Propensity Score Matching (PSM) models were used to analyze the data. 164 (41%) of the total sample households were cooperative members while the remaining 238 (59%) were non-members. Among the cooperative members, 71 (43.29%), 67 (40.85%) and 26 (15.85%) belongs to saving and credit, multi-purpose cooperatives and marketing cooperatives, respectively.

Our result indicates that cooperative members are more likely to be households that are literate, own land certificate, with larger family size, own cell phone, and leadership experience. We also found that age of household head is positively and significantly associated with cooperative membership while distance from the town of the district reduces farmer's cooperative membership. In an effort to get insight about the reasons and/or problems militating against their cooperative membership, non-member farmers were asked about their reasons of being non-member.Accordingly, ignorance, lack of knowledge about the benefit of cooperative membership, and problem with elected cooperative leaders are identified as the major reasons of smallholder farmers for being non-member of cooperatives. This finding is in line with the finding of studies from Ethiopia by Meniga M., (2015), and Dejen D. and Matthews H., (2016). The studies indicated that low awareness creation practices and misuse of cooperative society's capital by cooperative management bodies' results in frustration by non-members to join the existing cooperatives.Therefore, it can be concluded that lack of awareness about the need for and potential benefits of agricultural cooperatives is partly responsible for the low level of cooperative membership in the study area. This implies that access to information as in the form of education; cell phone and leadership position are vital instruments to enhance cooperative membership and growth in the study area.

Our study revealed that the mean technical efficiency score of the Haricot Bean producing farm households is found to be 71.8% with a mean technical efficiency score of 74.3% and 70% for cooperative member and non-member households, respectively. In other words, the mean technical inefficiency is 28.2% which caused 358.207 kg output gap in Haricot Bean production on average with mean actual output and potential output amounts to 1101.723 kg and 1459.93 kg, respectively. This implies that sample households in the study area are producing on average 358.207 kg lower Haricot Bean output relative to the potential output they could have produced had they efficiently utilized the existing input and technology. Therefore,improving the technical efficiency of farmers' will increase Haricot Bean output on average by about 358.207 kg with the existing input and technology. On the other hand, households with literate head, own land certificate,applied insecticide, households with larger number of Oxen, and farms managed by younger household heads are more efficientrelative to their counterparts. Education status of household head (which is a proxy variable for managerial ability of farmers) had statistically significant and positive relationship with technical efficiency in Haricot Bean production at 10% level of significance.

As far as the efficiency impact of cooperatives is concerned, the result shows that cooperative membership has a strong positive impact on smallholder's technical efficiency. The results suggest that farmer cooperatives have improved the technical efficiency of smallholder farmers in the study area. In summary, if cooperatives are equipped with the required institutional and managerial capacity, they can play an instrumental role in improving the technical efficiency of smallholder farmers.

6. Recommendations

Rapid population growth coupled with productive land fragmentation inflicts a threatening challenge in terms of food insecurity in agrarian economies like Ethiopia. To ensure food security and get rid of poverty, improving smallholders' technical efficiency through improving access to improved farm technologies, input and output markets and rural organizations remains to be a viable option in this 21st century. Based on the study, it is clear that improving smallholders access to information infrastructure and land certification, education, and other related interventions designed to improve literacy as well as improving the managerial efficiency and operation of cooperatives will enhance cooperative membership and hence growth of cooperatives in the study area. Thus, further promoting, deepening and supporting cooperatives as appropriate rural organizations is instrumental to improve farmers membership and reap the potential gains obtainable in terms of enhanced crop production and rural development.

7. Acknowledgment

This study would never be completed without the contribution of many people to whom we would like to express our gratitude. For most, we would like to express our deepest gratitude for Arba Minch University for covering all the necessary costs of this study.

References

[1] Abate, G. T.; Francesconi, G. N., and Kindie G., (2013): Impact of agricultural cooperatives on smallholders' technical efficiency: evidence from Ethiopia. Trento, Italy: European Research Institute on Cooperatives and Social Enterprises (EURICSE). 32p. (EURICSE Working Paper 50/13)

[2] Abebaw, D. and M.G. Haile (2013): The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia; *Food Policy*, 38:

[3] Addai K. N., Owusu V., and Abbeam G. D., (2014): Effects of Farmer – Based- Organization on the Technical efficiency of MaizeFarmers across Various Agro-Ecological Zones of Ghana: *Journal of Economics and Development Studies*, Vol. 2, No. 1, pp. 141–161

[4] Adurayemi c., (2014): Cooperative societies in Nigeria: Prospects and Problems; *International Journal of Behavioral Social and Movement Sciences:* Ogun State, Nigeria

[5] Afework H., Endrias G. (2016). Review on smallholders' agriculture commercialization in Ethiopia: What are the driving factors to focus on? *Journal of Development and Agricultural Economics*, Ethiopia.

[6] Aigner, D. J., Lovell, C. A. & Schmidt, P. (1977): Formulation and Estimation of Stochastic Frontier Function Models. *JournalofEconometrics*6 (July 1977): 21-37

[7] Austin P., (2011): An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies, Multivariate Behavioral Research, 46:3, 399-424

[8] Battese,G.E.&Coelli,T.J. (1995). A Model for Technical Efficiency Effects in a Stochastic Frontier Production for Panel Data. *Empirical Economics* 20: pp. 325-332
[9] Becker, S.O. and Ichino, A. (2002). "Estimation of average treatment effects based on propensity scores", Stata Journal 2(4), pp. 358-377.
[10] Bernard T. and Alemayehu S., (2013). Returns to Scope? Smallholders' commercialization through multipurpose cooperatives in Ethiopia: International Food Policy Research Institute, Ethiopia.
[11] Bernard T., Gashaw T. A. and Solomon L., (2013), Agricultural cooperatives in Ethiopia: Results of the 2012 ATA Baseline Survey. International Food Policy Research Institute: Washington, DC.
[12] Bernard, T., &Spielman, D. (2009): Reaching the rural poor through rural producer organizations: A study of agricultural marketing cooperatives in Ethiopia. *Food Policy, 34*.
[13] Bernard, T., A.S. Taffesse and E. Gabre-Madhin (2008): Impact of cooperatives on smallholders' commercialization behavior: evidence from Ethiopia, *Journal of Agricultural Economics*, 39.
[14] Bezabih E., (2009): Cooperatives: A Path to Economic and Social Empowerment in Ethiopia. International Labour Office. Coop[AFRICA] working paper, n. 9. Dar es Salaam.
[15] Caliendo, M., Kopeinig, S., (2005): Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys 22*, pp. 31–72.
[16] Dagne M., Terefe D., and Christian F., (2017). The Development of Agricultural Cooperatives in Ethiopia: History and a Framework for Future Trajectory:DOI: 10.4314/ejossah.v13i1.3
[17] Tefera D. A., BijmanJ., and Slingerland M., (2016). Agricultural cooperatives in Ethiopia: Evolution, functions and impact: *Journal of International Development.*
[18] EIAR (Ethiopian Institute of Agricultural Research), (2011). Cooperative Movement in Ethiopia: Cooperatives and Supporting Organizations Performance, Constraints, and Intervention Options, Addis Ababa, Ethiopia
[19] ATA (Ethiopian Agriculture Transformation Agency) (2012).Agricultural Cooperatives Sector Development Strategy (2012-2016), Addis Ababa, Ethiopia.
[20] FAO, IFAD and WFO, (2012):*Agricultural cooperatives: paving the way for food security and rural development*, Rome, Italy.
[21] Fashogbon A., Awoyemi T.T, Awotide A. B., (2015). Factors Influencing Smallholder Farmers' Participation in Cooperative Organization in Rural Nigeria, *Journal of Economics and Sustainable Development:Vol.6, No.17*, University Of Ibadan, Nigeria.
[22] FCA (Federal Cooperative Agency), (2016). Cooperatives Statistical Data http://www.fca.gov.et/#
[23] FDRE (Federal Democratic Republic of Ethiopia), (1998).*Establishment of Cooperative Societies* Proclamation No. 147/1998, Federal NegaritGazeta. Addis Ababa, Ethiopia.
[24] FDRE (Federal Democratic Republic of Ethiopia), (2016): *Agricultural Cooperative Societies* Proclamation No. 985/2016. Federal NegaretGazeta. Addis Ababa, Ethiopia.
[25] FDRE (Federal Democratic Republic of Ethiopia), (2002). Cooperatives' Commission Establishment Proclamation No. 274/2002.
[26] Fischer, E., Qaim, M., (2012). *Linking smallholders to markets: determinants and impacts of farmer collective action in Kenya*. World Development 40, 1255–1268.
[27] IFAD (2013):*Smallholders, food security, and the environment*: United Nations Environment Programme.
[28] ICA (International Cooperative Alliance Africa Region) (2013). *Africa Cooperative Development Strategy* (2013-2016), Nairobi, Kenya.
[29] Issa N., &Chrysostome N. J., (2015). Determinants of Farmer Participation in the Vertical Integration of the Rwandan Coffee Value Chain: Results from Huye District. *Journal of Agricultural Science; Vol. 7, No. 9*, Rwanda.
[30] Khandker R., Koolwal B., and Samad A., (2010): "Handbook on Impact Evaluation, Quantitative Methods and Practices", the World Bank, Washington DC.
[31] Kindie, G. and Tsegaye, A. (2012). Agricultural cooperatives and rural livelihoods: Evidence from Ethiopia. *Annals of Public and Cooperative Economics*, 83(2), pp. 181–198. https://doi.org/10.1111/j.1467-8292.2012.00460.x
[32] Mango N.,Makate C.,Hanyani B., Siziba S., and Lundy M. (2015): A stochastic frontier analysis of technical efficiency in smallholder maize production in Zimbabwe: The post-fast-track land reform outlook, *Cogent Economics & Finance* 3.
[33] Meniga M., (2015), and Dejen D. and Matthews H., (2016): Agricultural Cooperatives, Opportunities and Challenges, the Case of Bench Maji Zone, Ethiopia:*Journal of Poverty, Investment and Development*, 22, pp. 57-70
[34] Meniga M., (2015): Growth and Challenges of Cooperative Sector in Ethiopia; *International Journal of Scientific Research, 4:351-356.*
[35] Minot N., Daniel A., (2012).Role of agricultural cooperatives and storage in rural Ethiopia: Results of two surveys; International Food Policy Research Institute, Washington, DC.
[36] NBE (National Bank of Ethiopia) (2018). Annual Report on the Ethiopian Economy
[37] MoARD (Ministry of Agriculture and Rural development) (2010): Ethiopia's Agriculture Sector Policy and Investment Framework: Addis Ababa, Ethiopia.
[38] Mwaura F. (2014): Effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda: *African Crop Science Journal*, Vol. 22, pp. 917 – 927
[39] NPC (National Planning Commission of Ethiopia), (2016). Growth and Transformation Plan II, Federal Democratic Republic of Ethiopia: Addis Ababa, Ethiopia.
[40] NPC (National Planning Commission of Ethiopia), (2017). Ethiopia's Progress towards Eradicating Poverty: An Interim Report on 2015/16 Poverty Analysis Study: Addis Ababa, Ethiopia.
[41] Nugussie, Z. (2009). *Why Some Rural People Become Members of Agricultural Cooperatives while Others do not*. Mekelle University, Ethiopia.

[42] Odegbile K., Ogunleye, A., and Zacchaeus O., (2015): Analysis of Socio Economic Factors Affecting Farmers Participation in Cooperative Societies in Surulere Local Government Area of Oyo State: *Journal of Agriculture and Veterinary Science. Vol. 8, PP 40-44*
[43] Paul S. and Shankar S., (2018): On estimating efficiency effects in a stochastic frontier model, *European Journal of Operational Research;* vol-271, pp-769-774
[44] Rosenbaum, P.R. (2002).Observational Studies (2nd ed.), New York, NY: Springer.
[45] Rosenbaum, P.R. and D.B. Rubin (1983) 'The central role of the propensity score inobservational studies for casual effects', Biometrika, 70 (1): 41–55.
[46] Salami A., Kamara A. and Z. Brixiova (2010).Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities: Working Paper, Africa development bank, Tunisia.
[47] Samuel A. M. (2006). Reducing Poverty in Developing Countries: Some Lessons *from Latin America*; International Food Policy Research Institute.
[48] Veerkumaran, G.,(2007). Ethiopian Cooperative Movement: an Explorative Study.Mekele: Mekelle University, Department of Cooperatives.
[49] Wanglin M., Alan R., Peng Y., and Nazmun R. (2018). Agricultural cooperative membership and technical efficiency of apple farmers in China: An analysis accounting for selectivity bias: *Journal of Food Policy*
[50] WB (World Bank) (2018).Ethiopia Economic Update 7: SPECIAL TOPIC:Poverty & HouseholdWelfare in Ethiopia,2011-16

Author Profile

Mr. Sileshi Abebe Jemaneh received his B.A. degree in Economics from Wollo University, Ethiopia, in 2012, and his Msc degree in Economic Policy Analysis from Addis Ababa University, Ethiopia, in 2015. He is currently a lecturer in Department of Economics, Arba Minch University, Ethiopia.

Mr. Teklebirhan Alemnew Gebeyehu received his B.A. degree in Economics from Wollo University, Ethiopia, in 2012, and his Msc degree in Economic Policy Analysis from Addis Ababa University, Ethiopia, in 2015.He is currently a lecturer in Department of Economics, Arba Minch University, Ethiopia.

Appendix

Table A1: Test of Matching Quality

Variables	Mean		%Bias	*p-Value for equality of means*
	Members	Non-members		
Head_Sex	0.845	0.845	0.0	1.000
Head_Age	45.329	46.323	-7.8	0.522
Family Size (Adult)	4.561	4.503	4.8	0.678
Head_Literate	0.703	0.697	1.4	0.902
Landholding (ha)	0.916	0.923	-1.2	0.906
Land_Certificate	0.897	0.897	0.0	1.000
Extension Visit	2.367	2.303	3.9	0.726
Tropical Life Unit	2.618	2.376	10.8	0.338
No of Oxen Owned	3.055	3.213	-8.7	0.453
Distance from Town	134.26	127.74	11.6	0.302
Off_farm participation	0.223	0.297	-17.9	0.156
Leadership Experience	0.439	0.387	10.7	0.358
Owned Mobile Phone	0.871	0.826	10.8	0.269
Radio Ownership	0.684	0.652	6.8	0.548