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Effect of Off-farm Income on Smallholder Commercialization: Panel Evidence from Rural Households in Ethiopia

Tesfaye Berhanu Woldeyohanes[1], *Thomas Heckelei*[1] *and Yves Surry*[2]

[1] *Institute for Food and Resource Economics, University of Bonn, Germany*

[2] *Swedish University of Agricultural Science, Department of Economics*

Abstract.

This paper investigates how off-farm income affects crop output market participation decision and marketed surplus of smallholder farmers in Ethiopia. A double-hurdle model is estimated using three waves of panel data from Ethiopian Rural Household Survey (ERHS). The article controls for unobserved heterogeneity using correlated random effect procedure and potential endogeneity of off-farm income using a control function approach. Results show that off-farm income has no significant influence on household output market participation. But conditional on positive market participation, each additional earning from off-farm work has negative and statistically significant effect on marketed surplus. This indicates farmers use earnings from off-farm source rather for consumption purpose than as a source of liquidity to invest in agricultural production and increase marketable surplus. Our result has policy implications that expanding higher earning rural enterprises through capacity building and human capital investment is vital. This could improve the returns to labor for off-farm work participating land-poor households in the process of smallholder agricultural commercialization.

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1. Introduction

Commercialization of smallholder agriculture is part of agricultural transformation in which a given farm household shifts its production from a highly subsistence-oriented production towards more commercialized production targeting market for its input demand and output supply (Jaleta et al., 2009; Pingali and Rosegrant, 1995). It is considered as an indispensable pathway towards economic growth and development for most low income countries relying on the agricultural sector (von Braun, 1995; Pingali and Rosegrant, 1995; Timmer, 1997). According to Pingali (1997), subsistence production may not be viable to achieve sustainable household food security and welfare in the long run.

The Ethiopian agricultural sector is still dominated by subsistence-oriented smallholders characterized by low levels of productivity. In the last two decades, the government has adopted an agricultural-based development strategy for national economic transformation in which commercializing smallholder agriculture was the focal point (MoFED, 2003; MOFED, 2010). More emphasis was given to intensification of smallholder agriculture through the use of new technologies, infrastructure development and better access to service institutions (Gebremedhin et al., 2006; MoFED, 2003; MOFED, 2010). This is because increasing productivity and production of marketable surplus of staple food crops to link farmers up with output market is the most common form of agricultural commercialization at the early stage of commercial transformation (Gebre-ab, 2006; Pingali and Rosegrant, 1995). However, smallholder farmers are often constrained by lack of liquidity to finance the inputs typically needed to increase productivity, particularly when agricultural credit is lacking or not easily accessible to poor (Carter et al., 2004). Ethiopia is not an exception: although the government provides some credit services through different microfinance institutions, it is not easily accessible to all farmers.

There were strands of literature that shows off-farm income can be a crucial means to overcome working capital constraints to invest in agriculture particularly if credit markets are thin or missing whereas off-farm options can be accessed easily (Barrett et al., 2001; Hernandez et al., 2010; Oseni and Winters, 2009; Reardon et al., 1994; Woldehanna, 2000). Oseni and Winters (2009) found a positive effect of off-farm income on farm investment by compensating missing or imperfect credit markets (Oseni and Winters, 2009). Even though agriculture is the main source

of livelihoods in rural Ethiopia, households also engage in various forms of off-farm employment driven by different push and pull factors (van den Berg and Kumbi G.E., 2006; Rijkers et al., 2008; Woldehanna and Oskam, 2001). There is, however, far less literature on how off-farm work participation and income from this source interacts with smallholder commercialization at household level.

Some theoretical reasoning suggests that off-farm income could have both positive and negative effects on smallholder commercialization. For instance, according to Woldehanna (2000) off-farm income can enhance smallholder commercialization if used as a liquidity source for farm investment that will increase productivity and production of marketable surplus. This in turn may increase the proportion of crops sold by smallholder farmers. This is more likely if household engages in higher earning wage or self-employment activities and saving rate is higher (Woldehanna, 2000; Woldehanna and Oskam, 2001). Off-farm income may also assist farmers in consumption smoothing when there is production and market related risks following agricultural commercialization (Evans and Ngau, 1991; Holden et al., 2004; Reardon et al., 1994). This may help them to develop a willingness to move from "safety first" food cropping to risky but high value cropping with a buffer of cash from nonfarm activities (Reardon et al., 1994).

In contrast to this, off-farm income can have a negative effect on smallholder commercialization if it leads to an increase household's demand for both agricultural and non-agricultural consumption goods (Kan et al., 2006; Woldehanna, 2000). In this case, farmers that have previously used income from product sales to purchase non-agricultural consumption goods may replace this with cash income from off-farm employment and now consume what they produce and become self-sufficient. Hence, the marketed surplus might be lower than what it would be otherwise.

At the macro level, the linkage between agricultural commercialization and off-farm employment can be explained through growth linkages. That means advancement in agricultural commercialization creates rural off-farm employment opportunity for the poor (Binswanger and von Braun, 1991; von Braun, 1995). Although this is very crucial for rural development, information on the nature of interaction that could exist at the household level is more beneficial for the design of pro-poor public policies. Thus, this study looks at factors affecting smallholder

farmers' decision to participate in crop output market and how much they sell focusing on role of off-farm income.

This paper makes two contributions to the existing literature on smallholder commercialization. We test empirically the direction of relationship between off-farm income and smallholder commercialization to provide information that is relevant to current agricultural policy in Ethiopia. Previous studies on the determinants of smallholder commercialization considered level of commercialization in its static form – measuring level of output and input market participation at a given point in time and relied on cross-sectional data. However, smallholder commercialization could be seen as a dynamic process, as the decision to participate in the crop market and amount to sell could change due to changing circumstances. In this study we use three waves of household panel data from Ethiopian Rural Household Survey (ERHS) to analyze determinants of smallholder commercialization controlling for unobservable individual heterogeneity. The other contribution of this paper is application of control function approach to deal with suspected endogeneity in nonlinear panel models. In this study, we think off-farm income could be correlated with time-varying unobservables due to simultaneity. We use the control function approach to test and control for endogeneity following the procedure by Papke & Wooldridge (2008) in fractional response model and extend it to double-hurdle model.

The rest of the paper structured as follows. The conceptual framework is presented in section 2. Section 3 presents the empirical strategy followed by data presentation in section 4. Results and discussions are presented in section 5, while section 6 presents conclusions and policy implications.

2. Conceptual Framework

We use the basic non-separable farm household model (Singh et al., 1986) to drive household market supply. The basic assumption of non-separable farm household model is that imperfect market conditions for product and factor markets make the production and consumption decisions of farm household non-separable (Sadoulet and de Janvry, 1995; Singh et al., 1986). In this case, not only the production decision affects the consumption decisions but also the consumption decision affects the household production and ultimately output market supply decisions. This study recognizes in the Ethiopian context the assumption of non-separability is likely to hold so

that households' socio-demographic characteristics will affect its desired level of output supply (de Janvry and Sadoulet, 2006). In addition to household demographic characteristics, in this setting household output supply decision is also affected by off-farm income.

Given these assumptions, households are assumed to maximize utility with respect to consumption (c_i), production (q_i), input use (k_i), sales (s_i) and purchase (b_i) of each good $i = 1, 2, ...N$. The goods include all self-produced agricultural commodities, other market commodities and leisure. Household produces agricultural goods (q_i) using land, labor and other variable inputs (k_i). The optimization problem is to maximize utility function (1) subject to the liquidity (2), commodity balance (3), productiontechnology (4) and non-negativity (5) constraints.

$$(1) \qquad \max_{q_i, s_i, b_i, c_i, k} U(c, \mathbf{z_u})$$

Subject to

$$(2) \qquad \sum_i p_i^m (s_i - b_i) - p_i k_i + W \geq 0$$

$$(3) \qquad q_i - k_i + E_i - c_i + b_i - s_i \geq 0$$

$$(4) \qquad G(q_1 ... q_n, k_1 ... q_n; \mathbf{z_q}) \equiv 0$$

$$(5) \qquad q_i, s_i, b_i, c_i, k_i \geq 0 \text{ ; for } i = 1, \ldots, N$$

Where p_i^m denotes the market price for commodity *i*, E_i is endowment of commodity *i*, *W* is exogenous off-farm income which could be earned or unearned and z_u and z_q represents household demographic and production characteristics, respectively. The cash budget constraint (2) states that households' purchase has to be less than or equal to sales of any or all i^{th} crops plus liquidity form off-farm income. The commodity balance in the constraint equation (3) states that total quantities consumed, used for input and supplied to market equals or less than total quantity produced, endowed and purchased from market of each commodity *i*. The production technology

constraint (4) corresponds to a well-behaved production function that relates all the inputs to outputs. Equation (5) is the non-negativity constraint.

The above conceptual framework holds under the absence of transaction costs. However, recent empirical work on smallholder market participation and agricultural supply response considered transaction costs as one possible factor underlying heterogeneous market access by smallholders (Alene et al., 2008; Barrett, 2008; Bellemare and Barrett, 2005; Holloway et al., 2001; de Janvry et al., 1991; Key et al., 2000). High transaction costs may widen the price margin between the effective price paid by buyers and effective price received by sellers and ultimately determine households market positions (Barrett, 2008; de Janvry et al., 1991; Key et al., 2000; Sadoulet and de Janvry, 1995). Differences in transaction costs and access to assets and services to mitigate this transaction costs can explain why some farmers participate in market while others become simply self-sufficient.

Let us consider a given household faces crop and household specific transactions costs per unit of quantity sold and bought, which are equal to $\tau^c(\boldsymbol{Z,A,G,W})$. This involves both the proportional and fixed transactions costs that may depend on vector household demographic characteristics, ***Z***, access to public goods and services, ***G***, asset holding, ***A***, and liquidity from off-farm income, *W*. Then, the cash budget constraint accommodating variable (τ^v)[1] and fixed (τ^f) transactions costs can be rewritten as:

$$(6) \qquad \sum_i [(s_i(\boldsymbol{p_i^m} - \delta_i\tau^v) + \delta_i\tau^f - b_i(\boldsymbol{p_i^m} + \gamma_i\tau^v) - \gamma_i\tau^f)] - p_i k_i + W \geq 0$$

δ_i takes value 1 for the seller households and 0 for autarkic households for each good *i*, while γ_i takes value 1 for buyer households and 0 for autarkic. This constraint equation suggests that when transactions costs are involved, the price received by the seller household is lower than the market price $\boldsymbol{p_i^m}$ by the amount of transaction costs. Whereas, for buying households the market price for each unit bought increases by the amount of transaction cost incurred. Buying and

[1]Both variable (τ^v) and fixed (τ^f) transaction costs are a function of household demographic characteristics, ***Z***, access to public goods and services, ***G***, asset holding, ***A***, and liquidity from off-farm income, *W*.

selling transaction costs are assumed to be different for the same household and the same commodity.

The first order conditions of the maximization problem of utility function will yield the reduced-form output market supply (8), conditional on the market participation (7) (Goetz, 1992; Key et al., 2000)[2].

Output market participation decision:

$$(7) \qquad q_{si}^{mp} = (\boldsymbol{p_i^m}, \tau^f, \tau^v, \boldsymbol{z_u}, \boldsymbol{z_q}, W)$$

Output market supply decision:

$$(8) \qquad q_{si} = (\boldsymbol{p_i^m} - \tau^v, \boldsymbol{z_q}, W)$$

In equation (7) q_{si}^{mp} is households' discrete market participation decision which is determined by comparison of the expected utility form alternative marketing regime (i.e., participation vs autarky). This will be affected both by fixed and proportional transactions costs; market prices; household demographic and production characteristics; commodity endowment and off-farm income. For those who participate in market, the volume traded (q_{si}) in equation (8) is unaffected by the fixed transaction cost. Once the fixed cost of participation in the market is paid, farmers can sell any volume of output without additional cost except variable transaction cost, τ^v, that varies proportionally with traded volume .

3. Empirical Model

Previous studies have modeled farmers' market participation as a two stage decision process. This is because farmers' market participation is assumed to involve two separate decisions: the decision to participate in market or not and the level of participation. The two stage decision process in our conceptual model (7) and (8) is specified along with the error terms as given in equations (9) and (10). The dependent variable in (10) is the aggregate quantity of food crops

[2] Optimal quantity consumed and input demand equations are also part of the first order equations, but here we include only the optimal quantity supplied that we are interested in.

sold by household *i* at time *t*. The main reason to use aggregate quantity is to make the most out of data, i.e. to use all the available information in the data by including the aggregate of all food crops produced and sold by households in that particular period. Aggregating over multiple crops makes it impractical to work with physical quantities since different crops produced and sold cannot be aggregated directly. Hence, we aggregate the weighted physical quantities of each crop sold using village level price as a weight.

$$(9) \qquad M_{it}^{*} = \alpha w_{it} + X'_{it}\beta + c_{1i} + u_{it} \quad \text{and} \quad M_{it} = \begin{cases} 1 \, if \; M_{it}^{*} > 0 \\ 0 \, otherwise \end{cases}$$

$$(10) \qquad S_{it}^{*} = \gamma w_{it} + Z'_{it}\theta + c_{2i} + v_{it} \quad \text{and}$$

$$S_{it} = \begin{cases} S_{it}^{*} \, if \; S_{it}^{*} > 0 \, and \, M_{it} = 1 \\ 0 \; otherwise \end{cases} \; ; \quad i = 1, 2, ..., N \qquad t = 1, 2, ..., T$$

Equation (9) is a binary choice whether to participate in market as seller, whereas equation (10) represents the decision on the amount to sell conditional on first decision. M_{it}^{*} is a latent variable. The corresponding observed variable M_{it} takes value 1 if household *i* participate in crop output market as seller at time *t* and 0 otherwise. The actual quantity of crop sold by household *i* at time *t*, is given by S_{it}. S_{it}^{*} is the latent variable indicating potential quantity supply to market. The key variable of interest, off-farm income earned, is represented by w_{it}. The coefficient estimates of α and γ and their corresponding standard errors provide the estimate of the effect of off-farm income on smallholders crop output market participation decision and value of crop sold, respectively. The vector of other explanatory variables that affect smallholders' crop market participation decision and value of crop sold are represented by X_{it} and Z_{it}, respectively; β and θ represents the vector of corresponding parameters.

We have two kinds of error terms. The first kind is time invariant unobserved heterogeneity, represented by c_{1i} and c_{2i} in (9) and (10), respectively. These are time invariant individual characteristics which affect households' crop output market participation decision and volume traded. These factors might include preferences, soil quality, the farmer's management ability and degree of risk aversion which are commonly unobservable or difficult to measure due to its qualitative nature. The second component of the error term is time varying unobserved shocks

affecting households' market participation decision and marketed supply represented by u_{it} and v_{it}, respectively.

The selection of vector of explanatory variables X_{it} and Z_{it} is based on related previous works (Alene et al., 2008; Gebremedhin et al., 2009) and literatures on the determinants of smallholder commercialization (Von Braun, 1994; Jaleta et al., 2009; Sadoulet and de Janvry, 1995). Accordingly, value of crop production; vector of households' resource endowments; household and household head related demographic characteristics; vector of variables related to proportional and fixed transaction costs and regional dummies for agro-ecological difference between regions are included (see table 1 below for full lists of explanatory variables).

3.1. Specification Issues and Estimation

Previous studies used either Heckman's (1979) sample selection (Alene et al., 2008; Bellemare and Barrett, 2006; Boughton et al., 2007; Ehui et al., 2003; Gebremedhin et al., 2009) or double hurdle and switching regression models (Goetz, 1992; Omiti, 2009) to estimate smallholder market participation in (8) and (9). Some other considered it as a single decision process and used a more restrictive Tobit model (Holloway et al., 2000). Selection of an appropriate econometric model partly depends on how we treat zero observations in quantity of crop supplied to market. Zero observations may occur due to different reasons. Even though households may be potential sellers they may not be able to supply to market constrained by different factors such as fixed transaction costs. Households may prefer to be autarkic if shadow price lies between the mark-up selling and buying price due to high transaction costs (Key et al., 2000). In such a case zero observation is a corner solution which is an optimal choice by the farmers not to participate in the crop output market. Therefore, the corner solution model is more appropriate than a selection model.

Tobit estimator proposed by Tobin (1958) is a corner solution model that could be used to model the household's market supply decision. However, in the Tobit model it assumes that the partial effect of particular covariate on the probability of participation and the expected value of quantity supplied must have the same signs (Wooldridge, 2010). Moreover, it assumes that the relative effects of two continuous covariates on the probability of participation and the expected value of

quantity supplied are identical. These assumptions are considered as fairly restrictive (Wooldridge, 2010), especially when the factors that affect household market participation decision are different from factors that affect the intensity of participation.

Two part model relaxes these restrictive assumptions of the Tobit model by allowing different mechanisms to determine the participation and amount decisions. It may seem justifiable that Heckman selection model would be used in this study. However, Heckman selection model is designed for incidental truncation, where zeros are unobserved values which is not the case in this study. In our case, a corner solution model is more appropriate than a selection model because, due to fixed transaction costs and other constraint factors, we assume that many of the farmers choose not to participate in output markets as sellers. That means the zeros in the data reflect rather farmers' optimal choice not to participate in markets as crop sellers than representing missing values. Therefore, in our case, a corner solution model is more appropriate than a selection model.

Double Hurdle model (DH) relaxes the restriction imposed by Tobit model by allowing different mechanisms to determine the discrete probability of participation and volume of transaction conditional on participation. The DH model is more flexible and fits our problem better than the Tobit model because it allows for the fact that fixed transaction costs may affect a farmer's decision to participate in the crop market, but once the decision to participate has been made, fixed costs may not affect the quantity sold. Therefore, the DH model proposed by Cragg (1971) is used in this study to estimate the effect of off-farm income on smallholder crop market participation and intensity of sale. In hurdle 1 a household's head decides whether or not participate in the crop output markets, and if she choose market participation, hurdle 2 considers the quantity of crop sold. The maximum likelihood estimator (MLE) in the hurdle 1 can be obtained using a probit estimator. Then, the MLE for hurdle 2 can be estimated from truncated normal regression model. The original assumptions by Cragg (1971) on errors from hurdle 1 and hurdle 2 that assume independence, normal distribution and zero covariance between the two errors conditional on the explanatory variables is maintained in this study. The appropriateness of the DH against the Tobit estimator can be evaluated using a likelihood ratio test.

3.2. Controlling for Endogeneity

There could be potential simultaneity of off-farm work with crop output market participation decision and amount of sale. While smallholder commercialization could be affected by off-farm earnings, increased income as a result of higher commercialization could also help farmers to overcome capital constraint and engage in own off-farm business that would increase off-farm income. In that case, off-farm income is likely to be endogenous and correlated with unobserved time varying shocks.

The use of conventional methods like Fixed Effect Two Stage Least Square (FE2SLS) to control potential endogeneity is not appropriate when both the dependent variable in the structural model and potentially endogenous covariates are non-linear (Wooldridge, 2010). In this study, we apply control function approach (CFA) to test and control for potential endogeneity of off-farm income. The CFA requires some strictly exogenous covariates excluded from the structural model to be used as instrumental variable with other covariates in the reduced form of potentially endogenous covariates same as for fixed effect two stage least square in linear model (Papke and Wooldridge, 2008). The estimation procedure involves regressing off-farm income on instruments and all other covariates in the structural model of smallholder commercialization. Then, we take residuals from reduced form model and include them as additional covariate in the structural model. In the CFA, the significance of the coefficient of the residual in the structural model both tests and controls for indigeneity of off-farm income (for more details on CF approach see Papke and Wooldridge, 2008; Rivers and Vuong, 1988; Smith and Blundell, 1986; Vella, 1993).

The reduced-form model for off-farm income is estimated using one step tobit model. The CFA requires an instrumental variable (IV) to be used in a reduced-form model but excluded from the structural model of crop output market participation and volume sold. The requirement is that, the (IV) should be correlated with the potentially endogenous off-farm income but should not be correlated with unobserved time varying shocks, u_{it} and v_{it} in the structural model. We use household labor supply measured as the total number of adult equivalents per household as an IV in the reduced form model. It measures the amount of labor available to participate in off-farm work and determines earnings from off-farm source. After conditioning on other covariates, we believe household labor supply would not be correlated with other time varying unobserved

shocks in the structural models. Hence, it is reasonable to believe the instrument itself is exogenous.

3.3. Controlling for Unobserved Heterogeneity c_i

In a nonlinear panel data model, the covariates must be independent of unobserved heterogeneity c_i [3] to obtain unbiased and consistent estimates for parameters. This is often a strong assumption, leading to biased coefficient estimates if not controlled. We use of correlated random effects (CRE) following Mundlak (1978) and Chamberlain (1984) approach to relax the assumption of independence between covariates and unobserved heterogeneity, c_i. The CRE estimator, unlike the standard random effects, allows for the correlation between unobserved heterogeneity (c_i) and vector covariates across all time periods by assuming the correlation takes the form of $c_i = \tau + \overline{X}_i \xi + a_i$, where $\overline{X}_i$ is time average for all time varying covariates in equation (9) and (10) above. These variables have the same value for each household in every year but vary across households. τ and ξ are constants and a_i is an error term for constant with normal distribution, $a_i \mid X_i \sim Normal\left(0, \sigma_a^2\right)$. In practice to implement CRE, we specify a model for the distribution of unobserved heterogeneity in equations (9) and (10) as a linear function of time average of time varying explanatory variables, $\overline{w}_{it}$, $\bar{x}_{it}$ and $\bar{z}_{it}$ whereas τ is absorbed in to the intercept term.

The CRE approach has more benefits than the traditional random effect estimator in panel data analysis. First, by including the vector of time-averaged explanatory variables we can control for time invariant unobserved heterogeneity as with fixed effects without encountering the incidental parameters problem in nonlinear models. Second, it allows measuring the effect of time invariant explanatory variables just as in traditional random effect estimator (Ricker-Gilbert et al., 2011; Wooldridge, 2002).

3.4. Obtaining Conditional and Unconditional Average Partial Effects (APEs)

After estimating the CRE double hurdle model, we have estimated the average partial effect (APE) of changes in the explanatory variables on the probability of being market participant and

[3] c_i represents the unobserved heterogeneity c_{1i} and c_{2i} in participation decision, equation (9) and volume decision, equation (10), respectively .

on conditional as well as unconditional expected value of quantity of crop sold. To obtain APE first we have to derive average partial effect of every explanatory variable of interest for every observation *i* at particular time *t* in the dataset. Then, the APE is just an average of all partial effects for every observation in the dataset. For nonlinear models and if discrete variables exist in the model, the APEs are considered of greater interest and more representative than the partial effects at the average (Papke and Wooldridge, 2008; Ricker-Gilbert et al., 2011; Wooldridge, 2010). The standard errors for APEs are obtained using delta method and bootstrapping following the procedure proposed by Burke (2009)[4].

4. The Data

This study is based on Ethiopian Rural Household Survey (ERHS) panel data collected by Addis Ababa University in collaboration with Oxford University, UK and the International Food Policy Research Institute (IFPRI), USA. The survey was started in 1989, visiting 450 households in seven farming villages in Central and Southern Ethiopia (Dercon and Hoddinot, 2004). In 1994, the survey was expanded to 15 villages so as to cover the main agro-climatic zones and main farming systems in the country. Farming systems were considered as an important stratification basis in selecting villages. A household was then proportionately and randomly selected after stratifying, based on gender of household heads (Dercon and Hoddinot, 2004). In total, about 1477 households are covered in the 1994 survey. These households have been re-interviewed in the late 1994 as well as in 1995, 1997, 1999, 2004 and 2009. The households are from 15 peasant associations of four major regions of Ethiopia, i.e. Oromia, SNNP[5], Amhara, and Tigray. The data covered villages in most rural parts of Ethiopia.

For this study, the data is compiled from 1997, 1999 and 2004 survey rounds. The three survey rounds were selected because they contain sufficient observations on variables of interest for our study. The sample attrition is low, with only 12.4 percent between 1994 and 2004 (or 1.3 per cent per year) (Dercon and Hoddinot, 2004). Limited access to land for cultivation in other areas could be one of the plausible reasons for low attrition rate. Finally we have managed to have a balanced panel data for 1,184 households.

[4] To obtain the unconditional APE in hurdle 2 we have estimated the DH model using *craggit* command is Stata following procedure described in (Burke, 2009). The standard error for unconditional APE effect is obtained via bootstrapping 100 times.

[5] SNNP refers to the Southern Nation Nationalities and Peoples region of Ethiopia

4.1. Variable Description

Summary statistics of variables used in this study for pooled data are shown in **Table 1** in the Appendix. The dependent variable in hurdle 1- the discrete crop output market participation decision is a dummy variable which takes value of 1 if household *i* sold any food crop at period *t*. The pooled data contains 3552 farm households of which 67.8% participated in crop market as sellers. Total value of crops sold, the dependent variable in hurdle 2, is the aggregate value of all crops sold by household *i* at period *t*. We construct this variable by aggregating quantity of each crop sold using village level price[6] as a weight. In the dataset, the quantity for each crop sold was reported in a local unit which is converted in to kilogram using a conversion factor provided in the data. On average, household sells about Birr 926.78 worth crop produce. Because of food market imperfections in developing countries, production and consumption decisions are usually non-separable (Sadoulet and de Janvry, 1995). Particularly at the early stage of commercialization, surplus production of staple food crops is more common than production of cash crops exclusively for market. As a result most of the crops supplied to market are surplus products after satisfying household subsistence requirements. In such circumstances, increasing production level is expected to have positive impact on market participation and volume sold. Thus, we include total quantity of crop produced as additional explanatory variable in the econometric model.

The pooled data shows slightly above 42% of households participated in off-farm employment either as self-employed or wage worker. Off-farm income is the amount of total earnings in ETB from wage work either skilled or unskilled and/or self-employment in own business activities. Payments are made either in cash or in kind and we have converted it to cash using conversion factor provided in the data. Average off-farm income for the whole sample household is ETB 202.33 per household.

Head of household's average age, measured in years, for the total sample household is 48.6. About 74% of households in the sample are male headed household. The average family size is 5.7 with household labor supply of 2.93 persons which also implies dependency ratio of 1.94.

[6] All monetary values are in 2004 constant price Ethiopian Birr (ETB) simply called Birr; 1USD = 19.95 Ethiopian Birr in Oct. 2014 http://www.nbe.gov.et/market/birrcurrencies.html

Education of household head is a dummy variable that takes value of 1 if a household head participated at least in any level of primary education. This is because majority of households were not attending any schooling and the number of household heads attending schooling above primary education is almost nil. Hence, in this study, head of household is considered as literate if he/she has enrolled in any level of primary education and able to read and write. Average land holding per household for the panel sample household is 1.47 hectare which is larger than the current national average land holding of 1 hectare per household. The amount of livestock owned by household during the survey period is measured by tropical livestock unit (TLU). The average livestock owned per household is 3.05 TLU, while 40.7 % of the sample household owned at least one transportation animals.

The average distance from village to the nearest market in kilometers is 10.66, ranging from a minimum of 1 km to 25 km. This indicates there are wide variations in terms of access to close agricultural markets. Agricultural extension programs are expected to improve access to information by facilitating smallholder linkages with input and output markets. The dummy variable for participation in extension program that take value 1 if household participated either in government or Sasakawa Global 2000 extension program is included in the model. The pooled data indicates only slightly above 10% of the sample households participated in extension program during the three survey rounds. This might be due to the low level of public extension coverage until the late 1990s. For instance, when the government launched the extension program called Participatory Demonstration and Training Extension System (PADETS) in 1995, the number of participants in extension program where only 3200. The coverage was increased to 4.2 million in 2002 (Gebremedhin et al., 2006). It is expected that surplus production and the level of commercialization to be affected by agro-climatic and other geographical differences. Hence regional dummies for Oromia, Amhara and SNNP regional states is created and added to the explanatory variables. Tigray region is left out to be used as a reference in the analysis.

5. Results and Discussions

5.1. Specification tests

As previously mentioned, the double hurdle model is an alternative to the tobit specification, thus tobit model is nested in double hurdle model. We check appropriateness of double hurdle model

against Tobit model using a likelihood ratio (LR) test. The LR statistic comparing the two model is 1603.66 with a *p-value* equal to 0.000. The result reveals the null hypothesis that the farmer's market participation consists of just one decision process can easily be rejected in favor of the double hurdle model.

To test for endogeneity of off-farm income, we have estimated the reduced-form model from which the residuals are derived. Tobit estimator results from the reduced-from model of factors affecting amount of off-farm income is given in Table 2 in the Appendix. In linear models, there are a number of tests for weak instrumentality (Staiger and Stock, 1997; Stock et al., 2002). These tests uses partial correlation between the IV and potentially endogenous variable derived from the linear reduced-form model. In our case, however, the reduced-form model is a nonlinear corner solution model. We are unaware of tests for weak instrumentality in case of nonlinear model. Therefore, the only option to check for strength of our instrument is to look at the partial correlation of our IV, labor supply per household, in the reduced form model. The result shows there is strong partial correlation between labor supply and potentially endogenous off-farm income which is statistically significant at 1% level. There is also little to believe that our IV will be correlated with the error term in the structural model after conditioning on other covariates. Thus, we feel confident that labor supply is a strong and valid instrument for potentially endogenous variable, off-farm income.

The next step is to test for endogeneity of our key variable, off-farm income, using the control function approach. The residual from the reduced form model is included as additional covariate in both hurdle 1 and hurdle 2. In the CFA, the test of endogeneity is the statistical significance of the coefficient of the residual in both decision models.

Failure to reject the null hypothesis of exogeneity based on the *t statistic* implies that off-farm income can be treated as if it were exogenous to output market participation and quantity sold. The test results from *p-value* for both hurdles indicate that the residual term is not significant as shown in the Table 3. Hence, there is no evidence in the data to reject the null hypothesis of no correlation between off-farm income and the error terms in the structural models. We therefore estimated the CRE double hurdle model without including the residual term as additional covariate.

5.2. CRE Double Hurdle Model Estimation Results

Table 4 in the Appendix presents the results from CRE double hurdle model of factors influencing households' decision of output market participation and amount of crop sold. The coefficients of hurdle 1 are the average partial effects (APEs) of each explanatory variable on the probability of market participation. Whereas the conditional average partial effect (CAPEs) in hurdle 2 is the marginal effect of each explanatory variable on the quantity of crop sold conditional on first stage participation decision has been made. The unconditional marginal effect (UAPE) captures the joint impact of a variable on the changes in the probability of market participation and in the level of marketed supply. It is more interesting and of practical importance as it combines both effects unconditionally.

As shown in the Table 4, the coefficient on off-farm income in hurdle 1 is positive but not statistically significant. This implies, holding other factors constant, an increase in off-farm earning has no influence on the probability of farmer's output market participation. However, conditional on positive participation in the first stage, off-farm income has negative effect on household marketed supply and statistically significant at 10% level. The economic effect indicates that on average each additional ETB 100 off-farm income earnings decreases the value of crop sold by ETB 11.9, all other factors being constant. The UAPE indicates the overall influence of off-farm income on household market supply is not significant at any conventional significance level.

The negative influence of off-farm income on household market supply conditional on positive participation decision is consistent with the notion that off-farm income slows down smallholder commercialization due to its income effect. Meaning, an increase in off-farm income may negatively influence market supply by increasing household's consumption demand for own production (Woldehanna, 2000). Moreover, if off-farm income is geared toward consumption instead of investing in farm capital, then off-farm work ends up competing with agriculture for labor and other resources than being a complement. This in turn lowers production and marketable surplus. Research findings by Alene et al. (2008) and Omiti et al (2009) for Kenyan smallholder farmers also support this results. This is more evident particularly if the poor is pushed in to off-farm activities due to small land holding and drought incidence, for instance.

Our empirical finding doesn't support the hypothesis that off-farm income promotes smallholder commercialization through capital investment in agriculture and risk diversification. Perhaps participation in off-farm activities does help smallholder farmers to overcome liquidity constraints. Particularly when agricultural growth is hampered by credit constraints, the additional resources can be used by farmers for the adoption of innovations and the purchase of input. Such positive effect of off-farm income in providing liquidity to agriculture was recently shown by Oseni and Winters (2009). But, it depends on types of activity, amount of income earned and the way that liquidity is used.

Regarding other determinants of smallholder commercialization, our results show that degree of participation in crop market is influenced by the value of crop produced, gender, family size, the size of livestock owned and land holding size, all with expected signs. Similarly, the degree of market participation and the volume of crop sold are significantly influenced by regional dummies and dummies for survey rounds. On average each additional ETB 1000 value of crop production makes a household about 10 percentage points more likely to participate in the output market, other factors held constant. Conditional on positive participation decision in hurdle 1, on average an increase in value of crop produced by ETB 100 increases quantity of crop sold by 23.5 ETB, other factors being constant. The result is statistically significant at 1% level. This finding confirms that most of the time crops marketed by smallholders are surplus product after satisfying household subsistence requirement and increased production means more surpluses to sell.

Land size, which can be considered as household's wealth, has positive and statistically significant (10% significance level) influence on the probability of market participation. On average, each additional hectare of land increases the quantity of crop sold by ETB 306.7 conditional on the fact that participation decision has been made, which is also statistically significant at 1% level. The UAPE coefficient also indicates influence land holding size on the quantity of crop sold is estimated to be ETB 79 which is statistically significant at 1% level. This result confirms that land is a key constraint input for rural household and land holding per capita is declining mainly because of rapidly growing population. Moreover, land market for smallholder farmers is nonexistent in Ethiopia as land is state property and farmers have only usufruct right. Our result is also consistent with what others found elsewhere in developing countries (e.g. Alene et al., 2008). Size of livestock owned is related with higher probability of market participation which is significant at 5% level. Whereas the CAPE coefficient shows one

TLU more livestock on average reduces the value of crop sold by ETB 58, given the household is participating in crop market. It is statistically significant at 5% level. This is what would be expected *a priori*. This result also supports the idea that more livestock offers alternative financial income for household so that marketed surplus would be lower. A similar effect of livestock ownership on quantity of crop sold was found in Ethiopia by Gebremedhin et al. (2009). Gender of household head indicates probability of output market participation is higher by 4 percentage points if the household is male-headed. The UAPE also indicates that being a male-headed household on average increases the quantity of crop sold by ETB 70, other factors being constant. This might be due to the cultural influence that male farmers have better access to information and well networked within the community that helps them to trade at lower cost and participate more in output market than their female counterpart. This finding may suggest that any policy actions designed to strengthen smallholder market integration has to bring the gender aspect into the center of discussion so that equal participation of female farmers would be ensured. Contrary to what we expected, conditional and unconditional influences of family size on the quantity of crop sold are not statistically significant, although it has a negative effect on the probability of market participation. Similarly, our empirical finding does not show any significant influence of education of household head both on household market entry and marketed surplus. This might occur because the majority of household heads was not attending any schooling and the proportion of household heads attending schooling above primary education was quite small.

The coefficients of transport animals and distance to nearby markets, which are included to control for the effect of variable transactions costs, is not significant in the hurdle 1. But both of them have the prior expected sign. Conditional on the participation decision that has been made, one km distance from nearest market on average decreases the quantity crop sold by 39.55 ETB which is statistically significant at 10% level. The negative influence of distance from market also makes sense and supports the idea that infrastructure development strength smallholder's market integration by reducing marketing cost. Perhaps because 41 % of households in the panel data own transport animals, owning more of transport animals does not have a separate influence on market participation and quantity of crop sold. Participation in extension program has no significant influence on the probability of market participation. But it has a positive effect on marketed surplus conditional on participation decision has been made in first stage and statistically significant at 10 % level. This result contradicts our prior expectation of extension

program's role in improving access for marketing information through smallholder linkages with input and output markets. The result may suggest the need for extension services to strength the marketing extension in addition to input and credit service supply.

Both probability of market participation in hurdle 1 and CAPE in hurdle 2 is higher for households in Oromia, Amhara and SNNP regions compared to those in Tigray region. The result also shows that the magnitude of influence on the value of crop sold is also quite stronger and the difference is statistically significant at 1% level. This could be due to the fact that Oromia, Amhara and SNNP are located in ago-ecological zones more favorable for agricultural production. The probability of household market participation is lower by 5 percentage points in the survey round 1997 and 1999 compared to 2004. Conditional on positive participation decision in the first stage and compared to the 2004 round, the quantity of crop sold declines on average by 359 and 271.5 ETB for the 1997 and 1999, respectively. These effects are statistically significant at 5% level. This finding may suggest that there has been an improvement in terms of smallholder market integration over the course of period.

6. Conclusions and Policy Implications

Several studies have been conducted on the linkage of farm and off-farm employment and their contribution in poverty reduction. However, the nature of interaction between income from off-farm employment and smallholder commercialization has received little attention in the empirical work. More specifically, there exists minimal empirical literature on possible direction of relationship between off-farm income and smallholder commercialization at household level. Regarding the linkage between agricultural commercialization and off-farm employment at the macro level, advancement in agricultural commercialization can create rural off-farm employment opportunity for the poor. Although this is very crucial for rural development, information on the nature of the interaction that could exist at the household level is more beneficial for the design of pro-poor public policies. Different studies also indicate there is a growing importance of rural off-farm employment in rural Ethiopia following rapid population growth and declining land per capita. Thus, understanding the direction of relationship between off-farm income and smallholder commercialization has important implications for public policy to support rural communities during the process of economic transformation.

In this study, we use three waves of panel data from Ethiopian Rural Household Survey (ERHS) to test empirically the effect of off-farm income on household's output market participation as seller and volume of crop sold. We find off-farm income has no discernible influence on household output market participation decision. Nevertheless, conditional on positive market participation, each additional earnings from off-farm work has negative and significant effect on household market supply. Although the magnitude of economic effect on marketed surplus is small, it seems consistent with the notion that off-farm income slows down smallholder commercialization due to its income effect. Indeed, our empirical finding indicates there is no evidence to support the hypothesis that off-farm income promotes smallholder commercialization by relaxing liquidity constraint to invest and raise productivity and marketable surplus. This might be due to the fact participation in off-farm activities by land poor households is due to lack of options not as a choice. They may participate in lower earning activities such as wage work and their saving rate would be small. The policy implication of our finding is that expanding higher earning rural enterprises through capacity building and human capital investment is vital. This may help to improve the returns to labor for off-farm work participating land-poor households as Ethiopian smallholder commercialize.

Our results also show that increased crop production per household is a major determinant of both probability of participation in crop market as a seller and the extent of market participation. This finding supports the idea that most of the crops marketed by smallholders are surplus product after satisfying household subsistence requirement and increased production means more surpluses to sell. Gebremedhin et al. (2009) also found the same effect of increased crop production on smallholder market integration. We found that extension program participation is insignificant in determining the probability of market entry. Nevertheless, it has a positive influence on the quantity of crop sold conditional on the participation decision has been made. Similarly, our result indicates land holding has significant and positive influence on household market participation and quantity of crop sold. These effects altogether have wider policy implications to strengthen the linkage between smallholder household and output market. First, given the current small land holding system in Ethiopia, the possible option is intensification of agriculture by expanding and strengthening the institutional support services via extension program. Second, strength the marketing extension service and make them more easily and widely accessible.

We find distance to the nearest market negatively and significantly affect how much values of crop a household sells once the participation decision has been made. This indicates household's access to rural infrastructure is quite critical to link them up with crop output markets by reducing marketing cost and need public policy attention. Our finding also indicates male headed household more participate in output market and the overall influence on value of crop sold is also positive. The implication is that any policy action designed to strength smallholder linkage to output market has to consider the gender aspect and empower female farmers.

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Appendix

Table 1. Definitions and summary statistics of variables used in the econometric analysis (N=3552)

Variable description	Mean	Min.	Max.	SD
Dependent variables				
Hurdle 1: Market participation (=1 if sold any crop at time t)	0.679	0	1	0.467
Hurdle 2: Total quantity of crop sold (ETB)	926.78	0	56824.5	2432.98
Explanatory variables				
Key Explanatory Var.: Off-farm income (ETB)	202.33	0	47027.78	1022.95
Participation in off-farm employment (=1 if participated)	0.42	0	1	0.49
Age of household head (year)	48.62	15	105	15.20
Gender (=1 if head of household is male)	0.74	0	1	0.44
Education (= 1 if attend any level of primary school)	0.27	0	1	0.44
Family size (number of household member)	5.71	1	26	2.63
Farm land size owned (ha)	1.47	0.05	9.88	1.26
Livestock owned (TLU)	3.05	0	58.3	3.24
Aggregate quantity of crop produced (ETB)	2023.78	0	63752.11	3106.30
Transport animals (=1 if household owned at least one)	0.407	0	1	0.49
Distance to the nearest market (km)	10.66	1	25	5.81
Involvement in extension program (=1 if participant)	0.11	0	1	0.310
Oromia (Dummy if household lives in Oromia region)	0.275	0	1	0.447
Amhara (Dummy if household lives in Amhara region)	0.323	0	1	0.468
SNNP (Dummy if household lives in SNNP region)	0.296	0	1	0.457

Source: own calculation based on 1997, 1999 and 2004 ERHS data

Note: TLU=Tropical Livestock Unit

Table 2. Factors affecting off-farm income earned by households using pooled Tobit estimator-reduced form model

Independent Variables	N = 3,552 Pseudo R^2 = 0.062		
	Coefficients [a]	Delta-Method Std.Err.	P-value
Labor Supply (number of adult equivalent)	101.526*	34.306	0.003
Total quantity of crop produced (ETB)	-0.020	0.012	0.118
Age of household head (year)	-6.519*	2.541	0.010
Gender (=1 if head of household is male)	40.580	85.960	0.633
Education (=1 if head of household enrolled at least in any primary level)	134.674	86.007	0.116
Family size (number of HH members)	2.669	20.017	0.894
Farm land size owned (ha)	-50.634	35.799	0.157
Livestock owned (TLU)	-38.711**	17.993	0.031
Transport animals (number of pack animals owned)	-30.172	36.829	0.413
Distance to the nearest market (km)	-18.044*	6.666	0.007
Involvement in extension program (=1 if participated)	148.492	112.114	0.185
Oromia	252.002***	140.283	0.072
Amhara	394.928*	140.451	0.005
SNNP	384.978*	134.126	0.004
Round 1 (1997) dummy (=1)	-515.313*	93.908	0.000

Round 2 (1999) dummy (=1)	368.349*	83.397	0.000

Note: *, **, *** indicates that the corresponding coefficients are significant at the 1%, 5%, and 10% levels, respectively; coefficients and *p*-values obtained by *margins* command in Stata.

[a] The coefficients displayed are the average partial effects (APEs)

Table 3. Test for endogeneity of off-farm income

Models	*Z-statistic*	*P-value*	Conclusion
Market participation decision –hurdle 1	0.59	0.554	Exogenous
Sales value –Hurdle 2	0.87	0.383	Exogenous

Table 4. CRE double-hurdle model – Marginal effects of variables influencing probability of market participation and marketed surplus

Independent Variables	**Hurdle 1-Market participation decision Probit Estimator**	**Hurdle 2 Quantity of crop sold Truncated normal Estimator**	
	APE (SE)	CAPE (SE)	UAPE (SE)
Off-farm Income (ETB)	4.67e-06 (8.34e-06)	-0.119*** (0.070)	-0.0255 (0.0207)
Total quantity of crop produced (ETB)	0.00012* (7.09e-06)	0.2348* (0.0111)	0.2471* (0.0290)
Age of household head (year)	-0.0019 (0.0015)	14.32 (14.018)	2.2321 (3.1210)
Gender (=1 if head of household is male)	0.0422 * (0.0123)	175.052 (130.838)	70.0253*** (36.2554)
Education (=1 if head of household enrolled at least in any primary level)	0.0005 (0.0163)	100.102 (105.192)	33.6382 (34.6967)
Family size (number of members)	-0.0104** (0.0058)	- 3.376 (34.598)	-12.3376 (10.8384)
Farm land size owned (ha)	0.0125*** (0.0081)	306.738* (58.808)	79.1468* (21.4856)

Livestock owned (TLU)	0.0110**	-58.007**	-6.1337
	(0.0047)	(29.812)	(8.8345)
Transport animals (number)	0.0069	107.386	24.1689
	(0.009)	(70.316)	(27.4904)
Distance to the nearest market (km)	-0.0028	- 39.553***	- 9.0363
	(0.0026)	(23.050)	(5.5655)
Involvement in extension program (=1 if participated)	-0.0226	332.501***	57.69556
	(0.0222)	(125.991)	(46.3875)
Oromia[a]	0.1648*	4737.187 *	2481.571
	(0.0219)	(792.295)	(1845.241)
Amhara[a]	0.0398***	4397.642 *	2007.022
	(0.0221)	(787.215)	(1432.685)
SNNP[a]	0.3636*	4514.196 *	2613.22***
	(0.0193)	(779.678)	(1443.474)
Round 1 (1997)[b]	-0.0510**	-358.982**	-106.6166*
	(0.0211)	(175.092)	(42.2494)
Round 2 (1999)[b]	-0.0565*	-271.5884**	26.1543
	(0.0186)	(137.838)	(40.0161)
Sample Size (N)	3552	2410	
Pseudo- R^2	0.39		

Note: ***,** and * indicates significance at 10%, 5% and 1% level; The APE and CAPE are obtained by *margins* command in Stata and values in parenthesis are standard errors obtained by delta method. The standard errors and p-values for UAPE are obtained by bootstrapping at 100 replications after simultaneously estimating hurdle 1 and hurdle 2 by *craggit* command in Stata.

[a] Tigray region is excluded from the regional dummy to use as a control; [b] Year 2004 is excluded to use as a control dummy for comparison.

Source: own calculation based on 1997, 1999 and 2004 ERHS data