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Full Length Research Paper

A study of off-farm labor supply decision of adults in rural Ethiopia

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This article examined the determinants of off-farm labor supply decision of adult members of households in rural western Ethiopia using cross-section data collected from 324 sample households. The double hurdle model was employed and the off-farm work participation and hours of work decision of male and female adults were jointly estimated. The result indicated that individual characteristics, household composition, availability of credit, value of off-farm equipment and location factors significantly influenced participation decision; yet, individual attributes, economic incentives and location were the major determinants of hours of work decisions. The findings imply that given the importance of off-farm activity in alleviating the problems of low agricultural productivity and the resulting low income, policy measures which can promote rural investment and create employment opportunities in off-farm activities may help minimize the effects of low farm income.

Key words: Double hurdle, Ethiopia, household, off-farm, labour supply.

INTRODUCTION

The rural poverty and living conditions of the rural people are highly heterogeneous problems in developing countries. Particularly, the problems are very much severe and diverse in sub-Sahara Africa (World Bank, 2008). Therefore, households in such countries adopt different livelihood strategies in order to cope up with such diversified living condition and poverty situation. The rural farm households prefer to diversify their economic activities and income sources because returns to their asset endowments in the main sector (agricultural) decreases in relation to the returns from using them in activities outside agriculture (Stefan and Manfre, 2005). This implies that an access to assets is one of the main factors that influence the ability of farmers to diversify into non-farm activities.

In fact, poverty reduction requires individuals to be engaged in productive employments and economic activities that could help them generate adequate income to secure the standard of living (Ellis, 2001; Haggblade et al., 2010; Bernardin, 2012). In the context of developing countries, the appropriate area to be targeted in this regard is the rural and agricultural sector. Because three out of every four poor people in developing countries live in rural areas, most of them depend on agriculture for their livelihoods; and also eighty-five percent of poor people in sub-Saharan Africa live in rural areas (World Bank, 2008). All these indicate that agriculture is still the main source of living for the majority of rural households in most developing countries and is expected to be targeted in an effort to reduce poverty.

The potential of the agricultural sector to contribute to poverty reduction effort requires increasing its productivity, which is found to be very difficult in most developing countries (David, 2010). Indeed, the importance of agricultural growth to poverty reduction efforts is clearly demonstrated during the economic transformation of Asian countries where rapid growth of productivity in the farm sector helped drove this process (Awuor, 2007). However, this is not the case in most parts of rural Africa including Ethiopia. Evidently, rural farm households in sub-Saharan Africa failed to achieve

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rapid agricultural productivity growth (Jayne et al., 2010; Kwadwo and Samson, 2012). Therefore, the expectation that agriculture on its own could achieve the goal of reducing poverty through increasing productivity and redressing issues of access to key agricultural resources did not work in sub-Sahara Africa. Thus, agriculture on its own is unable to provide sufficient means of survival and means to escape out of poverty for the majority of poor rural households (Awuor, 2007; World Bank, 2008; Emmanuel, 2011). As a result, farm households in rural areas participate in multiple economic activities and thus diversify income sources to minimize agriculture related problems.

In view of this, off-farm activity has recently become one of the main income diversification strategies widely practiced by most farmers in developing countries. It offers employment opportunities for the growing rural population both in the form of wage employment and self-employment. The importance of off-farm activities as source of income, employment, expansion of farm activities and way out of poverty among rural farm households in most developing countries is well recognized (Tassew, 2000; Cornilius, 2010; David, 2010; Haggblade et al., 2010; Adewunmi et al., 2011; Benedito et al., 2011; Aziz and den Berg, 2012; Bernardin, 2012). Although agriculture is the dominant sector where almost all rural households make a living in most developing countries, the rural economy in such countries, in general, is composed of both farm and off-farm activities.

This study examines the determinants of off-farm labor market participation and hours of work decisions of male and female adults. The term 'off-farm activity' in this context refers to all activities away from one's own property, regardless of sectoral or functional classification, which can be either wage employment or self-employment activity (Barrett et al., 2001). Thus, the off-farm labor supply is defined to include the time devoted to off one's own farm work which consists of time allocated to wage employment activities (both in farm and non-farm sectors) as well as non-farm self-employment activities.

In general, off-farm activities are considered to be important components of the rural economy of developing countries. In Ethiopia too, even if agriculture is the dominant sector where many farm households make a living, rural off-farm activities also play significant role in employment creation, income generation and enhancing farm production activities (Tassew, 2000; Mulat et al., 2006; Beyene, 2008). However, emprical studies regarding off-farm labor supply of households in rural Ethiopia are not only limited but also the few available studies considered participation and hours of work decisions as if they are determined by the same set of factors. As a result, they estimated single equation models (Tassew, 2000; Abebe, 2002; Beyene, 2008).

This study used the double hurdle approach to examine the off-farm labor supply decision of adults in the study area. The approach is more realistic because it distinguishes participation decision from hours of work decision and also relaxes the restrictive assumptions implied by the Tobit model. The use of this model in the study area was justified using the data and econometric methods. Moreover, the existing literature in rural Ethiopia could not adequately differentiate the responses by adult male and female members of households using this approach. Therefore, the objective of this study is to examine the determinants of off-farm labor supply decision of adult male and female members of households using the double hurdle model.

The rest of this paper is organized as follows. Subsequently, the theoretical literature on the basic agricultural household model commonly used to analyze labor supply decision of households is given, after which the econometiric model used to analyze the data is specified. This is followed by an introduction of the data set and the condition of off-farm activities in the study area. The empirical results of this study are discussed and finally, the conclusion and policy implications are provided.

THE THEORETICAL FRAMEWORK

The theoretical framework used in this study is the well known agricultural household model. The model incorporates production and consumption decisions of households into a single unit (Singh et al., 1986; Benjamin, 1992; Taylor and Adelman, 2003). There are two broad classes of this model used in most empirical studies - separable and non-separable. Separability is grounded on restrictive assumptions such as existence of perfectly competitive labor markets, perfect substitution of family and hired labor, perfect substitution of farm and off-farm labour and absence of specific disutility associated with working off the farm and so on (Singh et al., 1986; Taylor and Adelman, 2003). Under such assumptions, individuals are willing to participate in off-farm activity as long as the off-farm wage rate is greater than the marginal value of farm labor. Under the separability assumption, the decision can be made in two stages (de Janvry et al., 1991). First, the household decides how much total labor to use on own farm in order to maximize profits from farm production without any consideration of its consumption decision. Secondly, based on its farm profits, the market prices of crops produced and wage rates, the household decides how much to consume, how much labor to supply, and how much labor to hire.

In reality, labor markets in developing countries are imperfect (de Janvry et al., 1991) as a result of which household decisions can not be separable. The household model is non-separable when the production decision is affected by consumption preferences (Taylor and Adelman, 2003). Under this case, production and consumption decisions are linked because the decision maker is both a producer who is choosing the allocation of labor and other inputs to farm production and at the

same time is a consumer choosing the allocation of income from farm profits and labor sales to the consumption of commodities and services.

The non-separable agricultural model provides the theoretical basis for the analysis of off-farm labor supply decision of households. This study adopted the model developed by Skoufias (1994) and also applied by Abebe (2002), which assumes non-separability due to imperfect substitution of the various labor inputs in the production process, absence of disutility associated with working off-farm and existence of binding liquidity constraints in off-farm employment. Individuals/households maximize utility given as a function of leisure time for both sex groups, household income and a vector of household and individual characteristics given by the form:

$$Max\ U\ (L_m, L_F, Y; Z_m, Z_f, H) \quad (1)$$

where:

Y is the household income;

L_m and L_F are leisure time of adult males and females respectively;

Z_m and Z_f are individual characteristics of males and females respectively;

H is a vector of household and farm characteristics.

The utility function is maximized subject to a number of constraints such as time constraint which states that farm households allocate their members' total time endowment (T_i) among farm work (F_i), market work (M_i) and leisure time (L_i) where subscript i represents an index for male and female members, that is:

$$T_i = F_i + M_i + L_i \quad (2)$$

where i is an index representing male and female (i = m, f).

The production constraint is incorporated into household's full income expression given as the sum of restricted conditional farm profit, off-farm income and non-labour income given as:

$$Y = \pi(p, v, F_m, F_f, Z_m, Z_f, A, H) + W_m M_m + W_f M_f + R, \quad (3)$$

The non-negativity constraint indicates that the time allocated to each activity should be positive or zero. That is:

$$F_i \geq 0, M_i \geq 0, L_i \geq 0 \quad (4)$$

As shown in equation (3), household income (Y) is the sum of the restricted conditional farm profit (π), income from market work (off-farm income) and non-labour income expressed as remittances (R). The restricted farm profit depends on factors that affect farm production decision such as farm output prices (*p*), variable farm inputs (*v*) including hired farm labor, on-farm family labor (F_m and F_f), individual characteristics of male and female family members (Z_m and Z_f), fixed farm inputs such as land (A) and household, location and farm characteristics (H). Assuming that profit and utility functions maintain the regularity property, the optimum household time allocation can be obtained after substituting the constraints into the utility function and taking the derivatives. Assuming interior solution, the necessary conditions for off-farm time allocation are summarized as follows:

$$\frac{\partial \pi}{\partial F_i} = -\frac{\partial U / \partial F_i}{\partial U / \partial Y} = W_i^s = X_r^l \beta_{ir} + \varepsilon_{ir} \quad (5)$$

where (i = m, f) and W_i^s is the shadow price of labor working on the farm and:

$$-\frac{\partial U / \partial M}{\partial U / \partial Y} - \frac{\lambda_i}{\partial U / \partial Y} = W_i^m = X_i^l \beta_{il} + \varepsilon \quad (6)$$

where W_i^m is the market wage rate of laborer working off the farm and λ_i represents the Lagrange multipliers associated with non-negativity constraints of working off-farm, X_r^l and X_i^l are a vector of explanatory variables, β_{ir} and β_i are parameters to be estimated and ε_{ir} and ε_i are error terms.

The equilibrium condition of equation (5) states that the household equates the marginal rate of substitution of on-farm family labor of type i for money income with the shadow wage of the corresponding labor. For household members working off-farm, equation (6) states that the marginal rate of substitution of off-farm work for income by labor type *i* should be equal to the market wage rate of the corresponding labor type. The decision of an individual household member whether or not to participate in off-farm work depends on the comparison of the market wage rate (W_i^m) and the individual's reservation wage (W_i^R). According to agricultural household model, an individual household member participates in off-farm work if his reservation wage is less than the off-farm wage or if the marginal rate of substitution of off-farm work for income does not exceed the off-farm wage. For off-farm work, the reservation wage is the marginal value of an individual's labor time when all of it is allocated to farm labor. The reservation wage is an endogenous variable influenced by a number of exogenous variables that affect household farm production decision such as farm prices (both input and

output price), fixed farm inputs, individual and location attributes and household characteristics (reference). Generally, those variables that increase the reservation wage are likely to reduce the probability of participation, whereas variables that raise the market wage rate, tend to increase the probability that an individual seeks off-farm employment. For variables that raise both the reservation wage and off-farm wage, the net effect on the probability of off-farm work is *a priori* uncertain.

SPECIFICATION OF THE ECONOMETRIC MODEL

The study specifies the econometric model used to examine the determinants of off-farm labour supply decision of adult male and female members of households. Since wage rates are important variables (economic incentives) in labor supply decisions, the market wage rate is included in the analysis. Due to data limitations, the shadow wage rates of working on the farm for adult males and females are not considered separately, but the household level shadow wage and important variables that may affect the shadow wage of individuals are considered in the analysis. The shadow wage rate was predicted from marginal product of family labor obtained from household level farm production function specified in Cob-Douglas functional form. The market wage rate is obtained by dividing the total off-farm income by the total off-farm hours worked and is predicted using wage offer equation. Since all adults do not participate in the off-farm labor market, a sample selection bias may occur, as a result of which Heckman's two-stage estimation (Wooldridge, 2002) is used to solve this problem. In the estimation of wage offer equation using Heckman's two-stage method, the inverse mills ratios are derived from the probit regression which is then used in the second stage of estimation. The off-farm wage function is predicted using the following specification:

$$\ln W_i = \sum \ln \beta Z_i + \varepsilon_i \qquad (7)$$

where W_i is the market wage rate, β is vector of estimated parameters, Z_i is a vector of explanatory variables and ε is error term disturbance with (i= f, m) representing index for male and female.

Specification of off-farm labor supply function

Many empirical studies analyzed off-farm labor supply of farm households by considering a binary choice dependent variable (participation versus non-participation), and thus estimated a Probit model (Beyene, 2008; McCarthy and Sun, 2009) or a Logit model (Norsida and Ismaila, 2009; Roslan and Siti, 2011). But both logit and probit models ignore an important aspect of labor supply decision, that is, the hours of work decision. As a solution to this problem, some other studies examined the off-farm labor supply decision of households using single equation Tobit model (Tassew, 2000; Abebe, 2002).

However, again the Tobit model by itself has many drawbacks. In the Tobit specification, first, all zero observed hours of work are interpreted as corner solutions. Second, it is based on a restrictive assumption that both participation and the hours of work decision given the decision to participate are determined by the same set of variables which implies that a variable that increases the probability of participation also increases the number of hours worked (Wooldridge, 2002). Therefore, as an alternative approach, the off-farm labor supply of male and female members of households could be modeled as a two-stage (double hurdle) process. This method provides a general approach to modelling participation and hours of work decision as two stage decision process. Although the approach was widely used in the empirical studies of consumer demand and agricultural technology adoption (Simtowe and Zeller, 2007; Getachew et al., 2009), it has also been used to study labor supply decisions (Innocent and Young, 2004).

Therefore, it has the advantage that it permits the joint modeling of the decision to participate and the intensity of participation (hours of work) in the off-farm labor market (Innocent and Young, 2004). Accordingly, individuals should pass two-step decision processes; first they have to decide to participate in off-farm activity and then they need to work a certain hour in the labor market at a prevailing market wage. Therefore, if we observe a positive hour of work for an individual, the understanding is that he/she has completed a two-stage process. In other words, the zero hours of work observed is either because of the participation decision (not participating) or the hours of work decision (not suplying positive hours of work) or both.

The model works under the assumption that there exist two latent variables: y_1^{**} related with the individual's decision to participate in the off-farm activity and y_2^{**} with his decision on the number of hours worked in off-farm activity (Innocent and Young, 2004). These latent variables are expressed as linear functions of the first and second hurdle regressors, x_1 and x_2, respectively:

$$y_1^{**} = x_1 \beta_1 + \mu_1 \qquad (8)$$

$$y_2^{**} = x_2 \beta_2 + \mu_2 \qquad (9)$$

where x_1 represents the regressors used to explain the participation decision and x_2 those used to explain the hours of work decision. Suppose that an index variable (y_1^*) is expressed as $y_1^* = 1$ if the individual participates and $y_1^* = 0$, otherwise, then we have:

$y_1^* = 1$ if $y_1^{**} > 0$ and

$y_1^* = 0$, if otherwise.

Assuming that the error term u_1 in equation (8) is normally distributed, the first hurdle corresponds to a probit model. Similarly, turning to the hours of work equation, provided that the first hurdle was cleared, y_2^* can also be generated as:

$y_2^* = y_2^{**}$, if

$y_2^{**} > 0$, and

$y_2^{**} = 0$, if otherwise.

This second hurdle takes the form of truncated regression and is capable of generating zero levels of off-farm labor hours, independent of the first hurdle. Finally, the observed (actual) hours of work, y, is determined by the interaction of both hurdles, that is:

$$y = y_1^* y_2^* \quad (10)$$

The double-hurdle model specification assumes a bivariate normal distribution (BVN) of latent variables given as:

$$\begin{pmatrix} \mu_i \\ \nu \end{pmatrix} \sim \text{BVN}\left[0, \begin{bmatrix} \sigma_\mu^2 & \rho\sigma_\mu \\ \rho\sigma_\mu & 1 \end{bmatrix}\right]$$

As indicated by Blaylock and Blissard (1992), this general model nests a number of formulations and extensions based on the assumptions made about ρ. For instance, if ρ=1, the model will be reduced to a standard Tobit model; and it will be an independent double hurdle or Cragg model (1971) if ρ=0.

The use of maximum likelihood method to obtain consistent estimates in this approach is based on normality assumption. However, if this assumption is violated, the maximum likelihood estimates of the model will be inconsistent (Pagan and Vella, 1989). Thus, it is necessary to conduct test of normality assumption besides to covariance tests and Tobit restriction tests.

THE DATA SET AND OFF-FARM ACTIVITIES IN THE STUDY AREA

Description of data set

The source of data used in this study is sample household survey data collected during 2010/2011 agricultural season in the study area (western Ethiopia). The survey consists of 324 randomly selected households in three districts (woredas) namely: Guto Gida, Gida Ayana and Jima Arjo. The districts were selected based on their diversity in terms of access to off-farm work, experience and exposure to labor market participation, variations in the nature and extent of participation in off-farm labor market. Moreover, they represent broad climatic conditions reflecting high land and low land area and different market conditions and socio-economic infrastructure.

Sample households were interviewed using structured questionnaires that require short recall period. The data collection process took almost one year (June 2010 to April 2011) and is conducted in three rounds following main agricultural seasons in the study area. The first round representing ploughing and weeding seasons (from May 2010 to October 2010), the second representing harvesting and threshing seasons (from November 2010 to February 2011) and the final round for off-agricultural season (from February 2011 to April 2011). Round surveys are important to capture the variations in family time allocation because the information on time allocation decisions and also the prices change following the agricultural seasons. Finally, the data representing variables of interest are summed to arrive at annual figures.

Definition and description of variables used in the analysis

The dependent variable measures participation decision (the individual's decision to participate in the off-farm activity which is a dichotomous variable taking the value 1 if the individual participates and 0 otherwise) and the extent of participation which represents the time allocated to off-farm activity conditional on participation and is of truncated nature. A number of explanatory variables used in the analysis include variables representing individual attributes, household composition and characteristics, farm attributes, economic incentives, endowments of physical and livestock resources and location characteristics. The description, mean and standard deviations of variables used in this analysis are reported in Table 1.

Variables such as age, age square and education are included to capture the individual characteristics that proxy experience and human capital status of the individual. The predicted male and female market wage rates are included to examine the response of off-farm labor supply to factors representing the economic incentive. Moreover, since there is a difficulty in calculating disaggregated shadow wage for adult males and females, we could not manage to include them separately, but some exogenous variables such as individual and household characteristics which might affect the shadow wage of time are included.

Off-farm activities in the study area

Farm households in the study area participated in different types of off-farm activities that include both off-

Table 1. Summary of the data used for the analysis (all values are in Birr[1]).

Variable	Description	Mean	S.Dev.
Age	Age of the participant in years	39.19	11.03
Ln (age square)	Ln of age square of the participant	7.30	0.51
Education of head	Education level of the household head	4.75	3.14
Education level	Education of the participant in school years	4.38	3.13
Laborers	Number of laborers in the family (aged 15-64)	3.84	1.70
Elder children	Number of children aged between 10 and 14	1.20	1.07
Dependents	Number of dependents in the family	2.35	1.79
Land cultivated	Total land cultivated in hectares	2. 45	1.43
Transport animal	Number of transport animal owned	0.29	0.70
TLU	Total animal wealth in tropical livestock unit	5.43	3.87
Distance	Distance to the nearest market center in Kms	4.79	4.27
Credit	Amount of credit obtained in Birr	320.26	803.69
Non-labor income	Amount of remittances and rents	219.00	711.87
Off-farm equipment	Value of off-farm equipment owned	252.61	907.96
Farm income	Income obtained from sale of crop & livestock	5,723.8	10235.7
Male hours of work	Male annual off-farm hours of work	705.40	319.81
Female hours of work	Female annual off-farm hours of work	197.61	90.39
Shadow wage	Estimated shadow wage (household level)	2.44	2.79
Male wage	Male off-farm wage rate per hour	2.40	1.75
Female wage	Female off-farm wage rate per hour	2.11	1.66
Guto Gida	Dummy variable for Guto Gida	0.36	0.48
Gida Ayana	Dummy variable for Gida Ayana	0.33	0.47
Jima Arjo	Dummy variable for Jima Arjo	0.31	0.46

Source: Own computation (2012). [1] Birr is Ethiopian currency unit and US$ 1 = Birr 18.418 in February, 2013.

Table 2. Major types of off-farm activities and household participation.

Self-employment activities	%	Wage employment activities	%
Sale of local food and drinks	28.98	Causal agricultural	39.43
Local trade	24.63	Government organization	20.22
Selling firewood and charcoal	14.38	Daily wage work	16.39
Handicraft and weaving	13.36	Religious worker	1.09
Carpentry and forest products	8.30	Food- for-work	0.00
Animal drawn carts	5.12	Private organization	14.67
Milling and tailoring	2.93	Domestic servant	0.55
Traditional hair dressing	1.72	Looking after animals	2.19
Others	0.58	Skilled work	5.46
Total	100	Total	100

Source: Own computation (2012).

farm wage employment and self-employment during the survey year. About 73.5% of the households reported that they participated in off-farm activities (both in wage employment and self-employment), out of which 77% were participants in wage employment and the remaining 23% were in off-farm self-employment.

As shown in Table 2, the most common types of wage employment activities in terms of participation were causal agricultural employment (39.4%) followed by employment in government sector (20.2%), unskilled daily laborer (16.4%), employment in the private sector (14.7%) and the other constitutes the remaining. Similarly, the major types of non-farm self-employment activities include production and sale of local food and drink (28.9%), trade in food grain and manufactured goods (24.6%), collecting and selling firewood, charcoal,

Table 3. Reasons for participating in off-farm activities.

Reasons for participation in off-farm work	%
Limited farm income to support livelihood	75.8
Inadequate land to cultivate	64.5
Off-farm work is more rewarding than farm work	17.4
Large family size	13.5
Availability of off-farm work opportunities	7.3
Seasonal nature of agricultural labor	3.5

Source: Own computation (2012). Note: The percentages do not add to 100 because respondents were allowed to give multiple responses.

Table 4. LR test results of the double hurdle estimation.

Type of test conducted		Adult males		Adult females	
		Computed χ^2	Critical χ^2	Computed χ^2	Critical χ^2
Tobit restriction		389.76	$\chi^2_{(0.05, 18)} = 28.86$	326.28	$\chi^2_{(0.05, 17)} = 27.59$
Covariance test (ρ = 0)		0.69	$\chi^2_{(0.05, 1)} = 3.84$	0.89	$\chi^2_{(0.05, 1)} = 3.84$
Normality Test	Tobit	1.54	$\chi^2_{(0.05, 2)} = 5.99$	1.73	$\chi^2_{(0.05, 2)} = 5.99$
	DHM	3.19	$\chi^2_{(0.05, 2)} = 5.99$	3.44	$\chi^2_{(0.05, 2)} = 5.99$

Source: Own computation (2012). Notes: The LR test statistics was computed as: $\chi^2 = 2(\ln L_{TR} + \ln L_P - \ln L_T)$, where, $\ln L_{TR}$, $\ln L_P$, and $\ln L_T$ stand for the log likelihood of the Truncated regression model, Probit model and Tobit model, respectively.

Computed χ^2 values are 2(218.64 + 161.93 -575.45) = 389.76 for males and 2(218.64 + 161.93 -575.45) = 326.28 for females. DHM – refers to the Double Hurdle Model.

water, grass and straw (14.4%), handicraft, including weaving, making and selling equipment and pottery (13.4), carpentry and sale of forest products not including firewood and charcoal (8.3%) and others constitute 9.7%.

About 75.8% of the respondents reported that they participated in the off-farm activity during the survey year because farm work is not able to generate adequate income for their livelihoods. Thus, on average, a household earned Birr 2,808.2 from all types of off-farm activities during the survey year which is about 32% of the total annual household income. The average incomes from off-farm wage employment and self-employment were 1,765.3 and 1,042.9 respectively which indicate that around 63% of the off-farm income was generated from wage employment and the remaining from self-employment activity. On average, a household received Birr 219 from non-labor income such as remittances and rents which account only 2.5% of the total annual household income. Only 41 sample households (12.6%) reported that they received income from non-labor sources.

The reasons for participating in off-farm activities were also identified and summarized in Table 3.

The two major reasons for participating in off-farm activities as responded by households were limited farm income to support livelihood and inadequate land to cultivate. As shown in the table, most households (75.8%) reported that they were engaged in off-farm activities because farm work is not able to generate adequate income for their livelihoods and also sixty-five percent of participants of the off-farm activity reported that they participated in such activities because they do not have sufficient land to cultivate.

RESULTS AND DISCUSSION

In order to check the relevance of the double hurdle model and estimation results obtained, different types of tests were conducted such as Tobit restriction, covariance test and normality tests. The test results are provided in Table 4. Firstly, the computed LR test statistics (χ^2) for male adults is 389.76 against the critical value of 28.86; and for females, it is 326.28 against the critical value of 27.59. In both cases, the computed χ^2 values are greater than the critical values indicating that the restrictive assumptions implied by the Tobit model should be rejected at 1% or less level of significance. Thus, the participation decision and hours of work decisions are not based on the same set of decision-making process.

Secondly, the significance of the covariance term of the two hurdles, that is, the null hypothesis of zero

Table 5. Determinants of off-farm labor supply decision of adults (the Double Hurdle estimation result).

Explanatory variable	Probit regress for participation decision (Dependent variable: Participation [1/0])				Truncated regress for hours of work (Dependent Variable: Ln [off-farm hours worked])			
	Male		Female		Male		Female	
	Coeff.	St.Er	Coeff.	St.Er	Coeff.	St.Er	Coeff.	St.Er
Age in years	0.056***	0.023	0.096*	0.049	0.048***	0.014	0.057	0.043
Age square (Age*Age)	-0.001***	0.0004	-0.001*	0.0006	-0.999***	0.449	-0.384	0.906
Education of the participant	0.106	0.138	0.089	0.144	0.023	0.041	0.041	0.039
Education of household head	0.019	0.034	0.011	0.034	0.030	0.027	0.053	0.068
Adult laborers (aged 15-64)	0.317***	0.112	0.202***	0.091	0.118*	0.063	0.034	0.055
Elder children (aged 10-14)	0.189**	0.100	0.336***	0.128	0.311	0.109	0.021	-0.049
Dependents	-0.067***	0.027	-0.123*	0.068	-0.009	0.044	0.075	0.068
Land cultivated in hectares	-0.679***	0.190	-0.913***	0.197	-0.230	0.178	0.007	0.110
Transport animals owned	-0.208	0.223	-0.462*	0.268	0.047	0.312	0.323	0.353
Animal wealth in TLU	0.081	0.122	0.038	0.126	0.073	0.148	-0.106	0.105
Ln (non-labor income)	-0.013	0.034	-0.009	0.036	-0.042	0.037	-0.007	0.026
Ln (off-farm equipment)	0.248***	0.039	0.189***	0.037	0.002	0.011	0.020	0.042
Ln (Predicted farm income)	-0.111**	0.046	-0.149***	0.064	-0.186*	0.110	-0.432***	0.128
Ln (Predicted shadow wage)	-0.186*	0.103	-0.432***	0.128	-0.084	0.115	-0.166	0.219
Ln (Predicted male wage)[2]	0.524***	0.167	-1.102**	0.536	0.213***	0.059	-0.189	0.113
Ln (Predicted female wage)[3]	-0.767**	0.325	0.844**	0.419	-0.046	0.084	0.299**	0.140
Dummy for Guto Gida	0.175**	0.088	-0.018	0.231	0.477**	0.221	-0.238	0.211
Dummy for Jima Arjo	0.091**	0.048	-0.176	0.230	0.149**	0.075	-0.162	0.269
Distance to market in Kms	-0.024	0.019	-0.027	0.021				
Ln (Credit)	0.043*	0.025	-0.005	0.029				
LR (Wald) chi[2]	93.43		68.73		25.73		72.42	

Source: Own computation (2012). Log likelihood for male and female hours of work is -233.192 and -99.617, and Pseudo R^2 for participation is 0.279 and 0.272 respectively. Note: ***, **, and * refer to significance at 1, 5, and 10% levels respectively. [2]Own wage elasticity of male off-farm wage = 0.13. [3]Own wage elasticity of female off-farm wage = 0.22

covariance term of both hurdles ($\rho = 0$), is tested to see the relevance of double hurdle specification. The computed values of χ^2 being less than the critical values for both sexes imply that the hypothesis of zero coefficient of the covariates cannot be rejected for the given degree of freedom. This indicates that the independent double hurdle model is preferable than the single equation Tobit specification.

Finally, it is important to underline that the validity of the LR test strongly lies on the assumption that the model is correctly specified. Therefore, it is important to conduct the test of normality assumption. The Pagan and Vella (1989) test for normality is conducted for the Tobit and double hurdle specifications and the results are reported in the same table. Both specifications with computed χ^2 values falling below the corresponding critical values at the given level of significance suggests the absence of non-normality. This may be attributed to the fact that many explanatory variables used in analysis are in the logarithm form which tends to normalize the distribution. Generally, based on the test results, it can be concluded that the double hurdle approach is appropriate as compared to the single equation Tobit estimation.

The joint estimation results for the two equations of the double hurdle for both males and females are given in Table 5. One of the main concerns in applying the double hurdle model is the choice of variables to be included in each of the two hurdles. Since theory did not provide a clear indication of the variables to be included in each stage, selection of variables to be included in each hurdle is made arbitrarily (Innocent and Young, 2004). Therefore, based on previous empirical studies, socio-economic factors which may determine preferences towards work are included. Moreover, it is necessary to impose exclusion restrictions across vectors of explanatory variables in each decision stage so that the parameter estimates can be adequately identified (Ghadim et al., 1999; Innocent and Young, 2004). The total time allocated to off-farm work is measured in annual hours and the wage rate is in Birr per hour. So the hourly wage rate is obtained by dividing annual off-farm income by annual hours worked. The Tobit version of the model is also estimated using similar variables with that of hours of work decision in order to conduct diagnostic tests to see the relevance of Tobit estimation result. The Tobit result is provided in the appendix Table A at the

end of reference.

The double hurdle result given in Table 5 indicates that in general, individual, household, farm and location characteristics play significant role in influencing off-farm labor supply of adults in the study area. With regards to individual characteristics, age (and age square) has significant effect on participation decision of both male and female adults. However, the effects on the number of hours worked are significant only for males. Moreover, positive significant effect of age and the negative sign of age square on participation decision indicate that age shows a quadratic pattern in off-farm work participation. That is, at younger ages, participation in off-farm work increase with age but for older ages it decreases as age increases. This is in line with the predictions of a life cycle hypothesis and most previous empirical results (Tassew, 2000; Innocent and Young, 2004). But as shown in the table, education of the participant and that of the household head, both measured in school years completed, did not show any significant influence on the decision to participate and also on the number of hours worked in both sex groups.

The result further indicates that family composition such as the numbers of adult laborers, elder children (aged 10-14) and dependents in the family significantly affected the probability of participation in off-farm work. An increase in the number of laborers and elder children increased the decision to participate in the off-farm labor market, but number of dependents significantly reduced participation decision. This justifies that more number of adults and less dependents in the family increases the capacity of the household to participate in off-farm work and thus diversify its income generating activities. Even if family compositions included are significant in affecting participation decision, their effect on the number of hours worked is not significant at any level except for adults.

With regards to farm attributes, the impact of land cultivated on the off-farm participation decision is negative and significant for both sexes. The negative impact shows that farm households who have smaller farm size depend to a large extent on off-farm activities in order to supplement farm income and escape out of poverty. The negative sign shows an increase in the reservation wage for both males and females which induces them to look for off-farm activity due to push factors such as shortage of land. However, the size of land cultivated is not significantly important at influencing the hours worked. The animal wealth of the household measured in TLU, number of transport animals owned, non-labor income and distance to the nearest market center has no significant impact both on the level and extent of participation for both sexes.

The result further indicates that variables indicating economic incentives such as farm income, shadow wage and market wage are important determinants of the decision to participate in the off-farm labor market. Specifically, the result revealed that an increase in the estimated shadow wage and farm income significantly reduced the tendency to participate in off-farm activity. Although the shadow wage rate did not significantly affect the hours of work decision, the estimated farm income significantly reduces off-farm hours of work decision for both sexes, which may be due to the substitution and income effects. This is because farm income increases the shadow value of farm labor and makes farmers devote more time on farm work. An increase in farm income may also increase the demand for leisure thereby reducing the time allocated to working off-the farm.

Similarly, male and female off-farm wage rates are also important factors that influence the decision to participate. As indicated in the table, an increase in the predicted male off-farm wage rate increases the probability of male adults' decision to participate in the off-farm activity, but it reduces that of females. In the same way, an increase in female wage rate increases the likelihood of females to participate in off-farm activity but reduces that of males. The predicted market wage rates also significantly influence the hours of work decision. The own wage effects for males and females are positive and significant suggesting an upward sloping labor supply curve. However, the responsiveness of off-farm labor supply to changes in market wage rate is higher for female members than males. For instance, the own wage elasticity of male adult is estimated to be 0.13, while for females it is 0.22 (see the footnote under Table 5). That is, one percent increase in predicted male wage rate increases male off-farm hours worked by about 0.13%, but the same percent increase in female wage rate increases female off-farm labor hours supplied by about 0.22%. Another important observation in connection to this is that an increase in the wage rate of adult male members has a negative and significant effect on female adults' off-farm labor supply and vice versa.

Theoretically, financial constraints such as limited access to credit are major constraints in expanding off-farm activities in rural areas. The result obtained in this analysis partly supports this theoretical observation. The amount of credit (in Birr) obtained is significant at affecting participation decision for only male adults at 10% level of significance. Non-labor income is not statistically significant at influencing both participation decision and hours of work decisions at any reasonable level. An increase in the value of off-farm equipment owned significantly increases the probability of participation in off-farm work for both sex groups, but did not show any significant effect on hours worked.

Finally, the estimated result also revealed that off-farm work participation and the extent of participation differ significantly across locations for male participants. This is clear from statistically significant coefficients of dummy variables for Guto Gida and Jima Arjo. Accordingly, adult males participate more in off-farm work and also they supply more hours in Guto Gida and Jima Arjo districts than in Gida Ayana. For instance, the level and the extent

of participation in off-farm work in Guto Gida district is higher than that of Gida Ayana (base category) by about 0.175 and 0.477 units respectively. Various reasons worth mentioning are the availability of off-farm work opportunities and relatively higher wage paid to laborers.

CONCLUSIONS AND POLICY IMPLICATIONS

In this study, efforts were made to analyze the determinants of off-farm labor supply decision of adult male and female members of households using two stage double hurdle process. The relevance of this approach for analyzing the off-farm labor supply decision of adult members of households in the study area was justified using the data at hand and econometric methods, where the data and econometric methods employed defend the use of the approach as opposed to single equation Tobit model.

Generally, the estimated result confirmed the importance of individual attributes, family composition variables, credit, off-farm equipment, and location factors at influencing the participation decisions; yet, the hours of work decisions are mainly influenced by individual and household attributes, wage rates and location factors. The own wage effects for both male and female adults are positive and significant suggesting an upward sloping labor supply curve. Finally, it was found that the responsiveness of off-farm labor supplied to changes in market wage rate is higher for female adults than their male counterparts.

The findings imply that given the importance of off-farm work in alleviating the problems of low agricultural productivity, income and rural poverty, policy measures should be directed towards promoting non-farm sector. The result of the analysis indicated that family composition and characteristics, and farm and location characteristics are the main factors determining off-farm labor supply decision of male and female adults. These determinants could have important implications for rural development policy. In developing countries such as Ethiopia where agriculture is mainly characterized by low productivity and generates low incomes, increasing opportunities for off-farm work could be one solution that tends to minimize the effects of low productivity and low farm income.

One of the main reasons for participation in off-farm activity was limited farm income to support their livelihoods. Therefore, measures that could promote investment and employment opportunities in rural off-farm activities could help minimize the effects of low agricultural productivity and the resulting low incomes. Since there is a good potential for agricultural production in the study area, value additions on agricultural products, agribusiness activities along with other non-farm activities are some of the important off-farm job opportunities in the study area and therefore, need to be promoted. Moreover, the farmers' access to credit for expanding non-farm activities is limited and whenever credit is available it is tied to expansion of farm activities. Therefore, measures that increase access to credit could promote expansion of non-farm business activities in the study area. Finally, since off-farm work participation and the wage rates received for female adults are significantly lower than that of their male counterparts, measures designed to facilitate female's access to resources and off-farm work opportunity may promote their participation in off-farm activity.

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Annex Table A. Determinants of off-farm labor supply decision of adults (Tobit).

Explanatory variables	Male [Dependent var.: Ln (Male) time allocated to off-farm in hours]			Female [Dependent var.: Ln (Female) time allocated to off-farm in hours]		
	Coef.	St.Er	M.eff	Coef.	St.Er	M.eff.
Age in years	0.092	0.264	0.101	0.366	0.320	0.334
Age square (Age*Age)	-0.001	0.003	-0.001	-0.004	0.003	-0.003
Education of the participant	0.083	0.082	0.111	0.102	0.076	0.132
Education of household head	0.057	0.159	0.062	-0.366*	0.211	-0.337
Adult laborers (aged 15-64)	0.617***	0.192	0.441	0.201***	0.085	0.092
Elder children (aged 10-14)	0.192	0.219	0.238	0.736	0.514	0.951
Dependents	-0.361*	0.202	-0.395	-2.819***	0.775	-2.576
Land cultivated in hectares	-1.429***	0.485	-1.563	-0.158***	0.061	-0.165
Transport animals owned	-2.114*	1.272	-0.386	-1.906	1.860	-1.348
Animal wealth in TLU	0.253	0.703	0.457	0.696	0.941	0.890
Ln (non-labor income)	-0.119	0.129	-0.126	0.048	0.178	0.053
Ln (off-farm equipment)	1.084***	0.148	2.904	-0.001	0.001	-0.000
Ln (predicted farm income)	-0.573***	0.238	-1.461	1.191*	0.711	1.164
Ln (predicted shadow wage)	-0.341***	0.110	-0.088	-0.104***	0.019	-0.073
Ln (predicted male wage)	0.646*	0.359	0.169	-0.947***	0.257	-0.471
Ln (predicted female wage)	-1.473***	0.605	-1.264	0.919***	0.295	0.318
Dummy for Guto Gida	1.762**	0.863	1.927	0.299	1.148	0.173
Dummy for Jima Arjo	0.514	1.157	0.562	0.136	1.508	0.184
Constant	2.783	6.936		-20.554**	9.319	
Pseudo likelihood	-575.45			-422.23		
Pseudo R^2	0.097			0.1825		
F (18,306)	10.58			16.27		
Prob > F	0.000			0.000		

Source: Authors' own computation (2012). Note: ***, **, and * represent significance at 1, 5, and 10% levels respectively.