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Determinants of Household Demand for and Supply of Farm Labour in Rural Ethiopia

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Abstract

Typical farm households in rural areas of developing countries allocate their labour resource among own-farm work and off-farm (market) activities in response to different factors. This study examines determinants of household demand for and supply of farm labour in rural western Ethiopia using household sample survey data collected during 2010/11 agricultural season. The instrumental variable estimation technique used to analyse the data indicates the importance of shadow wage, shadow income, and demographic factors at influencing farm labour supply. Similarly, the demand for farm labour is significantly affected by farm attributes, off-farm income and family composition. The findings with regards to farm labour supply imply that measures taken to influence returns to labour on farm may produce different results for labour market participant and non-participant households. Moreover, increasing the off-farm employment opportunities can help release the liquidity constraint and thus promote increased use of hired farm labour.

JEL Classification: J220, J230, J430

1. Introduction

Typical farm households in rural areas of developing countries usually allocate their time among own-farm work and off-farm (market) activities. Accordingly, they engage in a number of production activities which are both market oriented and subsistence in nature. Combining on and off-farm work at household level is indeed an efficient way of households' labour resource use because it allows income levels compatible with farm survival as it takes into account income opportunities stemming from the farm and alternative employment opportunities (Corsi and Salvioni, 2006). Such labour allocation decision (behaviour) of households received significant attention in

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agricultural economics literature because of its importance for agricultural and rural development policies. Therefore, the fact that farm activity is the dominant sector in most developing countries and that non-farm activity is an important supplement to farm work has become a central issue in designing appropriate farm and overall rural development policies that considers the non-farm sector.

Farm labour is a major source of employment opportunity for the labour force in rural Ethiopia. As in the case of most developing countries, the structure of labour force employment in Ethiopia is mainly composed of sizable amounts of unpaid family work and self-employment (CSA, 2005). This indicates that the farm sector is still a major source of livelihood and employer of the rural people in Ethiopia. However, another fact is that farm households in rural Ethiopia are engaged in farm labour market activities even though the market is imperfect and the income generated from such a market is only limited. Farm labour market is characterized by absence of large commercial farms and engagement of smallholder farmers both in hiring and selling labour to other farmers in their locality (Amsalu *et al*., 2013). Participation of households in labour exchange can be due to initial differences in absolute and relative factor endowments. Thus, shortage in farm labour supply, particularly in peak seasons, maybe one reason for households to hire farm labour. The other reason could be supply of labour to off-farm activities by households engaged in farming as those households allocating their labour to off-farm activities and hiring farm labour simultaneously may be beneficial.

In the study area, the decision of households to supply labour to own farm work and to hire farm labour depends on the seasonal nature of agriculture along with many other socio-economic features. During peak agricultural seasons, there is a tendency to hire farm labour and allocate more to farm activity. Shortage of farm labour supply may lead to low farm productivity, a situation which has been considered a major problem especially in some developing countries. The strategies suggested to deal with such problem were the development of capital intensive agricultural technology and use of labour intensive technology that required an increase in farm labour supply (Gebremedhin and Switon, 2001). Some of the labour intensive technologies introduced would require more labour, thus creating peak labour demands at planting and harvesting, while other labour intensive technologies create peak labour demands by increasing regularity of operations (Anim, 2011).

On the other hand, lack of adequate farm labour could be a barrier to the adoption of more sustainable labour intensive farming system. The strategy of labour intensive farming system was to offer the potential to increase productivity and farm incomes through the employment of intensive farm labour, yet it has been generally overlooked and overshadowed instead by myriads of research on off-farm labour (Tegegne *et al*., 2001). Therefore, given that smallholder farmers lack adequate resources, the limited access to labour may impose constraint on their production and management capacity. This combined with the growing phenomenon of off-farm employment among farm households necessitates examining the availability and use of labour by smallholder farmers as well as the possible factors that could affect household demand for and supply of labour to guide labour market interventions to the benefit of farm households.

This paper examined factors that affect household supply of and demand for farm labour in rural Ethiopia. A two-step procedure was used to estimate farm labour supply and demand functions. In the first step, marginal product of family farm labour is estimated and the shadow wages are obtained through analysis of the production function. In the second step, the estimated shadow wage and income are used to fit farm labour supply and demand functions. The paper is organized as follows. In section 2, the theoretical framework for analysing the determinants of farm labour supply and demand as well as the empirical strategies for estimating the parameters are presented. Section 3 introduces the data set used in the analysis of farm labour supply and demand functions. Section 4 presents empirical results and makes discussion on the main findings and finally, section 5 provides policy implications and concludes.

2. The modelling approach

An overview of the theoretical framework

The main intent of this paper was to analyse the factors that affect households' demand for and supply of farm labour. The theoretically appropriate framework for such analysis is the agricultural household model. Given the household characteristics (Z^h), the farm household derives utility (U) from consumption goods (C), on farm labour (L_f) and market labour work (L_m). Since consumption has a positive impact on utility and farm and off-farm labour has negative impacts on utility, we can write the utility function as below following Lopez (1984), Singh *et al*. (1986) and Tassew (2000):

$$\text{Max } U(C, -L_f, -L_m; Z^h) \tag{1}$$

The cash constraint in terms of full income is expressed as:

$$Y = P_c C \leq \pi(q, L_{fj}, A) + \sum_{j=1}^{m} W_{mj} L_{mj} + v \tag{2}$$

where P_c is price vector of consumption goods, q is price vector on net output, L_{fj} is vector of on farm labour hours supplied by the j^{th} household member, A is fixed input (land, capital and technology) and farm characteristics, W_{mj} is the market wage rate received by household member j, L_{mj} represents off-farm labour hours supplied by the j^{th} household member, v is non-labour non-farm income, Y is full income and $\pi (q, L_{fj}, A)$ is restricted farm profit.

The fact that farm profit affects household income and thus household consumption decision and that the consumption preferences in turn affect production as well as labour supply decisions make decision process non-separable. The interdependence arises because the shadow wage rate of farm labour is endogenous. Another important concern in the theoretical framework is that the budget constraint is non-linear so that it is not possible to use standard demand theory. To solve this problem the budget constraint is approximated around the optimal level of on-farm labour.

$$P_c C \leq Yo + \sum_{j=1}^{m} W_{mj} L_{mj} + \sum_{j=1}^{m} W_{fj} L_{fj} + v \tag{3}$$

Where W_{fj} is the shadow wage rate of farm labour of the j[th] household member, which is given as:

$$W_{fj} = \frac{\partial \pi(q; L_{fj})}{\partial L_{fj}}, j = 1, 2, - - -, m \quad (4)$$

and the shadow income is given as:

$$Y_o = \pi(q; L^*_{fj}, Z) - \sum_{j=1}^{m} W_{fj} L^*_{fj}, j = 1, 2, - - -, m \quad (5)$$

The budget constraint can be rearranged for convenience as:

$$P_c C - \sum_{j=1}^{m} W_{mj} L_{mj} - \sum_{j=1}^{m} W_{fj} L_{fj} = Y_O + v \equiv S \quad (6)$$

Where, S is termed as unearned income.

Substituting the linear budget constraint in to utility function we can obtain the following Langragengian function:

$$L = U(C, -L_{fj}, -L_{mj}; Z^h) + \mu[P_c C - \sum_{j=1}^{m} W_{fj} L_{fj} - \sum_{j=1}^{m} W_{mj} - S] \quad (7)$$

Where, μ is the marginal value of income.

The functions actually to be estimated are in reduced forms and should include demand for farm labour (L_d) from production side and on farm family labour supply (L_{fj}) on the consumption side.

Specification of the empirical model

The shadow wage rate (the return to family farm labour) is one of the key variables considered to be important in empirical studies of household farm labour supply decisions. Since the labour market in developing countries is imperfect, the true market wage cannot be observed and if it is observed, it may not be used as a valid measure of the actual reward to labour service. Therefore, in empirical studies it is common to use shadow wage and shadow income as proxy variables in estimating determinants of farm labour supply of households (Kien, 2008). But, how to estimate the shadow wage remains to be an important question. Practically, the marginal product of labour obtained from estimated household agricultural production function is used to predict shadow wage which can then be used for estimating farm labour supply. Yet, how to derive the marginal product of labour and the corresponding shadow wages using the production function is another concern. Some studies use Cobb-Douglas form of production function (Abdulai and Regmi, 2000; Mduma and Wobst, 2007) while others use translog function (Jacoby, 1993). There are some empirical studies that estimated labour supply functions using shadow wages derived from Cobb-Douglas functional form. The result of most of the findings revealed that labour supply is sensitive to changes in shadow wages and income (Bagamba *et al*., 2009; Martin, 2001).

Empirical studies that used log-linear functional form to estimate the demand function for total and hired farm labour found out that the demand for total farm labour

is significantly influenced by farm characteristics and natural and environmental conditions indicated by location dummies. They also found that demand for hired farm labour depends on location dummies, family composition variables and farm attributes (Bagamba *et al*., 2009). Moreover, the empirical study on demand for and supply of labour in rural China by Xiaobing (2007) indicated that the accumulation of productive assets, the development of livestock production and agricultural prices had increasing effects on labour demand but reducing effects on a household's off-farm labour supply.

In this paper, a two-step procedure was used to estimate farm labour supply and demand functions. First, an estimate of marginal product of family farm labour and thus the shadow wages and shadow income are obtained through analysis of the Cobb-Douglas production function. The aggregate household production function is specified in a Cobb-Douglas functional form. The Cobb-Douglas specification is used because it is linear and homogenous. Even if it is more restrictive than other such as translog function, it has an advantage in that its result can easily be interpreted in economic terms. Moreover, it gives a reasonable estimate of the marginal productivity of family farm labour and mostly used in many empirical studies in Ethiopian context. The coefficient of an input in the function represents the production elasticity of that input. For that matter, the translog functional form of the production function was estimated, but most of the coefficients were found to be against theoretical relationship. Besides, the functional test conducted favours the use of Cobb-Douglass production function instead of translog function. In the second step, the estimated shadow wages and income are used to estimate the farm labour supply and demand functions.

The production function is specified as:

$$\ln Y_i = \sum_{j=1}^{n} \beta_j \ln X_{ij} + \sum_{k=1}^{m} \alpha_k D_{ik} + CD + IND + \varepsilon_i \tag{8}$$

where Y_i represents the total monetary value of farm output produced by household i, X_{ij} is a vector denoting the quantity of input j used by farmer i, D_k is a vector of location and other dummies that represent some specific characteristics which may affect output; CD is crop diversification index, *IND* is income diversification index, α_k and β_j are parameters to be estimated and ε_i is an error term summarizing the effects of omitted variables.

Since diversification can directly affect the efficiency of production, both crop and income diversification is included in the production function. Crop diversification may reduce farm productivity because of inefficiency in farm management and competition for complementary inputs to farm production. However, income diversification increases agricultural productivity through relaxing credit or liquidity constraints. Finally, for actual estimation of the production function instrumental variable estimation technique was employed. The observed marginal product of labour estimated from the production function was used to predict shadow wage by the formula:

$$W^*_i = \frac{\hat{Q}(.)}{L_F}\beta_f \text{ where, } i=1, 2 \tag{9}$$

Where $\hat{Q}(.)$ is the predicted (fitted) value of output by farm household *i*; L_F is family labour supplied by household i, and β_f is estimated coefficient of family labour in the production function.

The shadow wage was also used to calculate household's shadow income as defined by Skoufias (1994). He defined shadow income as the full income augmented by restricted farm profits plus non-labour income. The restricted farm profit is calculated as crop value less expenditure on hired labour, fertilizers and value of family labour.

Shadow income is expressed as:

$$V^* = \pi_F^*(W^*, W_h, A) + V \tag{10}$$

where π_F^* is the restricted farm profit given by $\pi_F^* = \Gamma(L_F;A) - W_hL_h - W^*L_f$, which represents farm income with all expenses (costs) properly deducted out, *V* is the income earned off-farm plus non-labour income which consists of mainly remittances. Since the shadow wage and shadow income are determined together with labour supply, household labour supply was estimated as a function of shadow income and shadow wages to remove the problem of endogeneity. Both supply and demand functions were specified in Cobb-Douglas functional form and estimated using single equation instrumental variable (two-stage) estimation technique. The functions actually estimated are total and hired farm labour demand (on the demand side), which is influenced more by demand factors than by supply factors and the family farm labour supply incorporating supply determining factors (on the supply side). The analysis is made for the whole sample households and for labour market participants separately. The functional form specified for estimation is given as:

$$\ln L_{sj} = \alpha + \beta_1 \text{Lnw}^* + \beta_2 \text{Lnw}_{of} + \beta_3 \text{LnV}^* + \varphi Z_i + \varepsilon_{si} \text{ where } _j = 1, 2 \text{ and } i = 1, 2, 3 \text{ -----n} \tag{11}$$

$$\ln L_{dj} = \beta_o + \alpha_1 \text{Lnw}^* + \alpha_2 \text{Lnw}_{hi} + \alpha_3 \text{LnV}^* + \theta Z_i + \varepsilon_{di} \text{ where } _j = 1, 2 \text{ and } i = 1, 2, 3 \text{ -----n} \tag{12}$$

where the dependent variable Ls_j represents the total annual number of hours allocated to farm work by household *i*, *j* represents the activity choice (1 = farm work and 2 = off-farm work). The explanatory variables are the instrumented shadow wage (*w**), shadow income (*V**), off-farm wage (w*of*), and wage rate for hired labour (w*hi*) and (*Z*) a vector of individual, household and farm characteristics which influence labour supply and demand. L_{dj} is the total farm labour hours demanded by household *i*, α and β_o are the constants, the β*'s*, α*'s*, θ*'s* and φ*'s* are the parameters to be estimated and εsi and εdi are the error terms summarizing the influence of unobservable variables on labour supply and demand functions respectively.

The observed family labour time allocated to farm work is the result of the interaction between the demand for and supply of farm labour making it important to identify variables that may shift the demand and supply sides. Therefore, factors such as non-farm income that may relax farmers' liquidity constraint, availability of family labour (or household composition variables), amount of farm inputs used that may affect the expected farm output, location dummies and returns to family labour are included as farm labour demand shifting factors. Similarly in the supply

side we included household characteristics, family composition variables, location dummies and the returns to family labour on and off the farm. We incorporated the returns to family labour (off-farm wage and shadow wage) because they are important factors that determine farm labour allocation decisions of households as long as the households have the opportunities to work off the farm. Thus, family labour used on the farm is affected more by supply factors than by demand factors providing the possible to identify the demand for and supply of farm labour.

One of the main challenges in using instrumental variable estimation technique for cross-sectional data is the difficulty of finding appropriate instruments; the set of instrument correlated with the endogenous variable but uncorrelated with the error term. For this purpose previous empirical studies (Tassew, 2000; Awudu and Punya, 2000; Jacoby, 1993) were consulted to identify instrumental variables to be included in the model. The instrumented (endogenous) variables are farm input and family farm labour as they are determined together with household farm production decision.

The set of instruments used for production function, farm labour supply and demand functions are the number of young children aged between 10 and 15, number of children aged between five and nine years, numbers of children aged below five years, adults above 60 years old and adult daily field wage for hired labour were used as instruments for family farm labour supply. Similarly, production shifters such as fraction of land owned, home ownership dummy (one if corrugated, zero otherwise), water source dummy (zero if from river, one otherwise), light source dummy (one if electric, zero otherwise) and cooking fuel dummy (zero if use wood, one otherwise). Moreover, community level prices such as average village level price for the main crop produced (maize in our case) were used as instruments for variable farm input.

3. The data set

This study is based on household survey data collected during 2011 agricultural season in Western Ethiopia. The survey data is obtained from 324 randomly selected sample households in three districts (Guto Gida, Gida Ayana, and Jima Arjo) of West Wollega Zone. The districts were selected based on their diversity in terms of access to off-farm work opportunities and experience and exposure to labour market participation (particularly, variations in the nature and extent of participation). Moreover, they represent broad climatic condition reflecting high land and low land areas, population density, access to information, market, and socio-economic infrastructure. Sample households were interviewed using structured questionnaires that require short recall period. The data collection process took almost one year (July 2010 to April 2011), conducted in three round surveys following main agricultural seasons in the study area. The first round represents ploughing and weeding seasons (May 2010 to October 2010), the second round harvesting and threshing seasons (November 2010 to February 2011) and the third round off-agricultural season (February 2011 to April 2011). Round surveys are used to get more reliable annual data on time allocation and are designed to capture variations in prices that may account for changes in income and consumption expenditure of households.

The survey data consists of seasonal allocation of family labour to farm work and off-farm activities, individual and household characteristics and farm characteristic. Data on fixed individual, household and farm attributes were collected

once during the first round survey, whereas, data on seasonal time allocation were obtained in three round surveys because the information on these factors are likely to change following the agricultural seasons.

The value of farm output is computed as the sum of the values of all crops harvested during 2010/11 agricultural season. First, the value of each crop is estimated using village level average prices reported by farmers (the price that farmers indicate their crops would currently fetch on the market) and aggregated for all crops grown by a farmer. The use of village level average prices would avoid the problem of using the same set of prices for all farms. Cultivated land is the amount of land actually cultivated by the household during the survey year measured in hectares. The value of variable farm input indicates the sum of the value of fertiliser, improved seed, insecticides, hired labour and livestock inputs used in farm production and that of farm equipment is mainly traditional equipment used for ploughs, harvesting and farm activities.

The definition of variables used in regression analysis is provided in table 1. Age and education are used as proxy variables for experience of a given household. Education of the head represented by years of schooling is also used as an indicator of the potential productivity of the individual provided that better education improves management skill and thus raises efficiency of the individual. The average household head spent about four years in school. Family composition variables such as family size, number of adults and dependents, farm and household characteristics are also included in estimation.

The average family size in the study area is 5.95, which is slightly higher than the national average (5.15) and the average number of dependents is 3.05. Almost all farm households have access to land ranging from minimum of 0.2 to 10 hectares with an average land holding size of 2.63 hectare per household. On average, land cultivated per household during the survey year was about 2.45 hectares. The agricultural activities practiced in the study area include crop production, livestock husbandry and combination of both (mixed farming). The farming technology in general is traditional with simple hand tools, oxen driven implements, and use of labour. Labour is one of dominant type of farm input used where most of it comes from the family labour. The average annual household level family and hired labour used on farm (for all crops cultivated during all seasons) are 1137 and 179 hours respectively and the share of shared labour is very small.

The average hourly off-farm wage rate for male adults is 2.40 Birr and for females 2.11 Birr, whereas, the average village level hourly wage paid to male hired labour is 2.02 and it is 1.99 for females (n.b. the Birr is the Ethopian currency $1AUD=17 Birr).

Table 1 - Definition, mean and standard deviation of variables used in the estimation

Variable	*Definition of variables*	*Mean*	*St.Dev*
Farm output value	Total value of all crops produced in 2010/11	15938	16235
Land cultivated	Total land cultivated in hectares	2.47	1.43
Farm animal service	Number of oxen owned	2.13	1.44
Variable farm input	Total value of all variable farm inputs used	920.79	1278.21
Farm implement	The value of all equipment for farm production	408.65	184.78
Head's age	Age of household head in years	39.79	10.53
Head's education	Years of schooling of head	4.38	3.13
Family size	The number of all members of the household	5.95	1.99
Dependents	Number of dependents in the family	3.05	1.79
Distance	Distance to the nearest market centres in kms	4.79	4.27
Off-farm equipment	Value of off-farm equipment owned	252.61	907.96
Family labour hours	Total annual family labour hours used on farm	1136.81	638.33
Hired labour hours	Total annual hired labour hours used on farm	178.73	205.94
Male wage hours	Male labour hours supplied to off-farm wage work	456.11	819.81
Female wage hours	Female labour hours supplied to off-farm wage work	108.55	290.39
Male Self hours	Male labour hours supplied to self-employed work	559.43	823.50
Female Self hours	Female labour hours supplied to self-employed work	175.92	343.16
Male wage	Hourly male off-farm wage rate	2.40	1.75
Female wage	Hourly female off-farm wage rate	2.11	1.46
Male hired wage	Village level hourly wage paid to male hired labour	2.02	0.80
Female hired wage	Village level hourly wage paid to female hired labour	1.99	0.80
Animal wealth	Total animal wealth in tropical livestock unit	5.43	3.87
Permanent crops	1 if had perennial crops, 0 otherwise	0.31	0.46

Source: Own computation from household survey data (2011).

Agricultural activities in the study area are vastly seasonal and crops are usually cultivated only once a year based on rain. One cropping calendar can be divided into different seasons such as ploughing, planting, weeding, harvesting and threshing, of course some of which may overlap to each other. There are seasonal variations in the use of family, hired and shared labour for different farm activities. For instance, weeding takes the highest proportion of farm labour from each source followed by harvesting, ploughing and then threshing. In the study area there are no permanent labour contracts in the farm labour market except that only three households reported for crop sharing arrangement where the labourers provide their labour service and share the crop at the end of the agricultural season.

4. Results and discussions

Determinants of household farm labour supply

Since the shadow wage is endogenously determined together with farm labour supply decision of households, the farm labour supply was estimated as a function of instrumented shadow wage. The OLS and Instrumental variable estimation results for the Cobb–Douglas production function are provided in table 2. All the explanatory variables, except the dummies, head's age and education are in logarithmic form.

As indicated in the table, the production function fits the data quite well because the variables included jointly explained about 82 per cent of the variation in the value of farm output. The first column of the table reports the OLS results along

with their marginal effects and the second column shows IV estimation results. Even though most of the coefficients carry the expected sign, it may be the case that the estimated results from OLS may be biased as farm inputs such as family labour and farm variable input are likely to be endogenous to household production decision. As a result instrumental variable technique was applied to estimate the production function. The variables considered endogenous in the instrumental variable estimation are family labour hours and variable farm inputs. The variables used as instruments in the estimation process are identified and listed under section 2. The Hausman exogeneity test was conducted and the test statistics obtained is 13.2 against a critical value of $\chi^2_{(8,0.05)}$ indicating that the instruments are exogenous in the estimation process.

The explanation given below and calculation of shadow wage and shadow income are based on the IV estimation. The result indicated that head's education, family farm labour, hired farm labour, farm variable input, land cultivated and permanent crop dummy appear to be significant variables at influencing value of farm output produced. The level of education of the head expressed by years of schooling has positive and significant impact on farm output which confirms the widely accepted role of human capital in improving efficiency of farmers. The head's age has a positive but insignificant effect on output. As shown in the table the use of family labour has larger impact on farm output than hired labour. This evidence may support the premise that family members have stronger work incentives compared to hired labour. Family labour has the largest output elasticity of all farm inputs (0.338). This means, when the family labour input increases by one per cent, farm output will increase by about 0.34 per cent. The responsiveness of farm output to changes in hired labour even if significant is very low as compared to family labour. That is, one percent increases in the use of hired labour leads to only 0.04 per cent increase in farm output on average.

Land cultivated and variable farm input have positive and significant effects on the value of output and their marginal effects are 0.14, and 0.18 respectively. The impact of farm equipment and farm animals on output is not significant. Moreover, farm animal service influences output negatively, which is not as expected.

Since diversification can directly affect the efficiency of production, both crop and income diversifications are included in estimation of the production function. Crop diversification may reduce farm productivity because of inefficiency in farm management and competition for complementary inputs to farm production. However, income diversification increases agricultural productivity through relaxing credit or liquidity constraints. The analysis showed that both crop and income diversifications have significant impact on farm output. But the effect of crop diversification index is negative in sign indicating that it leads to inefficiency in production. The impact of income diversification effect even if positive and small in magnitude, it is statistically different from zero. The analysis showed that an increase in crop diversification index by 10 per cent reduces the value of output by about 1.8 per cent, but if income diversification index increases by 10 per cent output will increase by only 0.6 per cent. Finally, permanent crop dummy is also an important variable at influencing farm output. It affects output positively and significantly with marginal effect of 0.129. The effect of whether crop field is located on flat or hilly area does not make any difference; however, location dummies are important in capturing expected environmental differences which affect farm production.

Table 2 - Cobb-Douglas production function estimates (Dependent variable: Ln value of farm output (N= 324))

	OLS regression			*IV regression*[b]		
Explanatory variables	*Coefficient*	*St.Er.*	*Marg.eff*	*Coefficient*	*St.Er*	*Marg.eff*
Ln (land cultivated)	0.204 **	0.073	0.124	0.208 **	0.062	0.136
Ln (farm equipment)	0.081	0.101	0.051	0.075	0.118	0.050
Ln (value of farm input[a])	0.215 ***	0.046	0.168	0.286 ***	0.102	0.176
Ln (total family farm labour[a])	0.393 ***	0.081	0.292	0.442 **	0.191	0.338
Ln (total hired farm labour)	0.091 *	0.013	0.025	0.117 *	0.061	0.044
Ln (farm animals)	-0.096	0.056	-0.011	-0.105	0.059	-0.012
Crop diversification index	-0.481 ***	0.146	-0.184	-0.473 ***	0.161	-0.184
Income diversification index	0.096 **	0.039	0.060	0.092 *	0.047	0.060
Permanent crop dummy	0.231 ***	0.060	0.129	0.231 ***	0.057	0.129
Crop field location	0.036	0.054	0.020	0.030	0.054	0.020
Head's age	0.003	0.002	0.001	0.004	0.002	0.001
Head's education	0.064 *	0.014	0.049	0.062 ***	0.016	0.049
Dummy for Gida Ayana	0.236 ***	0.071	0.116	0.246 ***	0.084	0.116
Dummy for Guto Gida	0.057	0.076	0.079	0.076	0.100	0.079
Constant	4.501 ***	0.758		4.228 ***	0.737	
Adjusted R-square		0.822			0.823	

Source: Own computation from household survey data (2011).
Note: [a] Endogenous variables; [b] Wu-Hausman test statistic is 13.2 against the critic $\chi^2(8) = 15.5$.

As pointed out in methodology part, the instrumental variable estimation technique is used and all instruments identified above in the estimation of production function are also used here. Skoufias (1994) defined shadow income as the full income augmented by restricted farm profits plus non-labour income. The restricted farm profit is calculated as crop value less expenditure on hired labour, fertilizers and value of family labour. The estimation result for farm labour supply is summarised in tables 3.

The value of Wald statistics for both labour supply functions (all sample households and for labour market participants) are 42.36 and 47.36 respectively, with a critical value of $\chi^2_{(15.0.01)} = 30.58$. The Wald statistics being greater than the critical value provides an evidence for rejecting the null hypotheses that all non-intercept coefficients are statistically equal to zero. The exogeneity of the set of instruments used in estimation was tested, for which the values of Wu-Hausman statistics are given in the table 3. The Wu-Hausman test statistics for all sample households and market participants are 6.02 and 6.97 respectively against critical value of $\chi^2_{(3,0.05)} = 7.81$ suggesting that the instruments can be considered exogenous in the labour supply functions. Moreover, the appropriateness of instruments has been tested using the Sargan test for the null hypothesis that all the instruments are uncorrelated with the residuals. As pointed out by Guajarati (2004), the Sargan test follows χ^2 distribution. The χ^2 value computed for all households and for labour market participants are 3.17 and 4.01 with p-value 0.255 and 0.191 respectively. Both statistics are not significant at any reasonable level indicating the failure to reject the null hypothesis. Therefore, all of the instruments are valid.

The estimated result indicates that farm labour supply is significantly influenced by the shadow wage, shadow income, age of the head, family size and number of adults. The estimated own-wage effect is positive, significant and slightly

less than unity for all sample households. This is consistent with previous empirical findings by Jacoby (1993), Tassew (2000) and Abdulai and Regmi (2000). However, in this study the own-wage elasticity is higher than that estimated by Jacoby and Abdulai and Regmi. Separate result for market participant households indicates that the influence of shadow income is negative and significant for the whole sample and for participants. A 10 per cent increase in the shadow income induces 1.2 per cent reduction in farm labour supply for the whole sample households and 4.1 per cent for off-farm labour market participants which imply that leisure is a normal good for both groups. This finding is similar with other previous findings; however the magnitude of the effect is higher in this case as compared to others.

Table 3 - Farm labour supply estimate using shadow wage and shadow income

	All sample households		*Labour market participants*	
Explanatory variables	*Coefficients*	*St.Er.*	*Coefficients*	*St.Er.*
Ln (predicted shadow wage rate)[a]	0 .856 ***	0.207	-0.184	0.153
Ln (predicted shadow income)[a]	-0.119 **	0.049	-0.413 **	0.206
Age of the head	0.039 **	0.019	0.029 **	0.014
Age square	-0.031	0.046	-0.033	0.032
Head's education	0.039	0.027	0.019	0.023
Family size	0.212 ***	0.076	0.291 ***	0.092
Number of dependents	-0.145	0.128	-0.188 **	0.100
Number of adult members	0.273 ***	0.118	0.103 *	0.059
Dummy for Gida Ayana	0.267	0.235	-0.011	0.234
Dummy for Guto Gida	0.362	0.503	0.141	0.134
Constant	5.661 ***	1.125	2.907 ***	0.706
Adjusted R-square	0.349		0.387	
Wald $\chi^2(15)$	42.33		47.36	
Wu-Hausman test statistics[b]	6.02		6.97	
Sargan test statistics[c]	3.17		4.01	
Prob> chi^2	0.000		0.000	

Source: Own computation from household survey data (2011).
Note: [a] Endogenous variables; [b] Critical value of $\chi^2(3) = 7.81$; [c] p-value for all households = 0.255 and for labour market participants = 0.191.

Age and age square represent a combination of experience and life-cycle effects on labour supply. The coefficients suggest that more experience initially tends to increase the labour supply of individuals, although at a decreasing rate. The impacts of age and age square on labour supply are 0.039 and -0.031 respectively.

Education of the head is not statistically insignificant at influencing farm labour supply. This may be an indication of the fact that the most important impact of education on labour supply is indirect through its effect on farm profitability and marginal productivity of time in farm production. Family composition variables such as family size, the number of dependants and number of adult household members have expected signs. Farm labour supply increases with both family size and number of adult labourers in the household and the result is significant in both cases. However, an increase in the number of dependents reduces household farm labour supply but

the estimate is significant for labour market participants only. Finally, there is no significant location difference in farm labour supply of rural households.

Some important differences can be obtained by comparing the coefficients for all sample households with that of households participating in the labour market. The most notable differences are; first, the effect of shadow wage is very large, positive and significant for all sample households, but it has insignificant negative effect on participants. Although an increase in predicted shadow income induces significant decrease in farm labour supply in both groups, its impact is larger for households who participate in the labour market. A 10 per cent increase in the shadow income induces a larger (4.1 per cent) reduction in supply of labour for labour market participants. This suggests that households which sell labour off-farm consume more leisure. The effect of the number of dependents is significant for sellers of labour but not for the whole sample. We can find similar results using average market wages and non-labour income. Table 4 shows farm labour supply function re-estimated using the average market wage rate and non-labour income. The test results indicate that the instruments are exogenous and appropriate.

Table 4 - Labour supply estimate using average market wages and non-labour income (Dependent variable: Ln (total family labour used on-farm work in hours))

	All sample households		*Labour market participants*	
Explanatory variables	*Coefficients*	*St.Er.*	*Coefficients*	*St.Er.*
Ln (predicted market wage)	-1.205 ***	0.386	-0.957 ***	0.304
Ln (non-labour income)	-0.462	0.776	-0.478	0.550
Head's age	0.078	0.153	0.002	0.081
Age square	0.137 **	0.068	0.036	0.122
Head's education	0.079 **	0.038	0.086 **	0.039
Family size	0.037	0.197	0.097	0.178
Number of dependents	-0.095 *	0.055	-0.087 *	0.049
Number of adult members	0.151 ***	0.065	0.203 ***	0.058
Dummy for Gida Ayana	0.279	0.359	0.492 *	0.266
Dummy for Guto Gida	0.045	0.380	0.175 *	0.094
Constant	8.039 ***	1.730	6.417 ***	1.330
Adjusted R-square	0.298		0.30	
Wald - $\chi^2(15)$	29.58		21.81	
Sargan test statistics($\chi^2(3)$)[a]	4.44		3.89	
Prob>χ^2	0.000		0.000	

Source: Own computation from household survey data (2011).
Note: [a] p-value for all households = 0.165 and for labour market participants = 0.282.

Since market wages are endogenous variables, we used wages predicted from wage offer equation in estimating the labour supply functions (the result of wage offer equation estimated is not provided here for space). This re-estimation is used to check whether the estimates under the assumption of non-separability differ from the usual separability assumption. It can be seen from the table that the estimates obtained using market wages differ from those with shadow wages discussed above. Specifically, the coefficients for the wage and income variables are both negative and much higher

in this case suggesting that separability assumptions are critical in labour supply estimations (Skoufias, 1994; Tassew, 2000).

Determinants of farm labour demand

The estimated result for total and hired farm labour demand are reported in table 5 with the first column indicating the total farm labour demand and the second shows the demand for hired farm labour. The dependent variable is the logarithm of farm labor (in hours) used by the household during the survey year. The Wald χ^2 values of the estimated result given in the table are very high and significant at 1 per cent or less for both functions indicating the overall significance of the model used.

Most of the explanatory variables included in the model significantly influenced the demand for total and hired farm labor. The total farm labor demand responded positively and significantly to size of land cultivated, off-farm income, age of the household head, education level of the head; and negatively to age square and family size. Land cultivated has the highest significant effect on the demand for total farm labor as compared to other factors. For instance, one percentage increase in land cultivated increases the demand for total farm labor by about 0.28 per cent. The shadow wage rate has negative significant impact of total farm labor demand, where 1 per cent increase in shadow wage induces 0.51 reduction off-farm income has also positive significant effect on total farm labor demand. One per cent increase in off-farm wage induces 0.09 per cent increase in the total farm labor demand.

Table 5 - Determinants of total and hired farm labor demand (IV estimation result)

	Dependent variable: Ln (Total labor used on the farm in hours)		*Dependent variable: Ln(Total hired labor used on the farm in hours)*	
Explanatory variables	*Coefficients*	*St.Er.*	*Coefficients*	*St.Er.*
Ln(shadow wage)	-0.198	0.111	-0.258 ***	0.103
Ln(shadow income)	-0.004	.024	0.077	0.104
Ln(off-farm income)	0.092 **	0.046	0.124 ***	0.042
Ln(land cultivated)	0.281 ***	0.081	0.596 ***	0.199
Ln(value of farm input)	-0.163	0.108	1.169 ***	0.382
Ln(animal wealth)	-0.029	0.036	0.088	0.048
Age of the household head	0.030 *	0.017	-0.066	0.065
Age square	-0.031 *	0.019	0.072	0.074
Education of the head	0.065 ***	0.025	0.189 **	0.097
Family size	-0.042 *	0.023	-0.035 *	0.019
Number of dependents	0.015	0.033	0.129 **	0.064
Dummy for Guto Gida	0.085	0.082	0.313	0.320
Dummy for Gida Ayana	0.058	0.067	0.153	0.335
Constant	5.779 ***	0.627	-2.570 **	0.920
Wald ~$\chi^2(14)$	182.3		189.02	
Prob>χ^2	0.000		0.000	

Source: Own computation from household survey data (2011).

Similarly, both age and education level of the head have positive and significant effects on total farm labor demand at 10 per cent and one per cent levels of significance, respectively. The number of dependents, shadow wage, shadow income, animal wealth and location did not exert significant influence on total farm labor demand.

The second column of table 5 provides the estimated result for hired farm labor demand. As shown in table, shadow wage rate and family size significantly reduced the demand for hired farm labor at 10 and one per cent level of significance. But area of land cultivated, off-farm income, the value of variable farm input, education level of the household head and the number of dependents have positive significant effects on the demand for hired farm labor. The most significant effect is accounted for by the value of variable farm input followed by size of cultivated land. For instance, the demand for hired labor is unitary elastic with respect to variable farm input.

An increase in shadow wage rate significantly reduced the demand for hired farm labor because higher shadow wage encourages family members to work more on the farm, which reduces the need for hired labor. This may be due to the fact that family labor and hired labor are not perfect substitutes. The effects of land cultivated and variable farm inputs on hired farm labor are large, positive and significant implying that the expended use of such inputs may require expansion of efforts which will demand more labor. The hired farm labor demand responds positively to changes in off-farm income as expected. Theoretically, if there is no constraint in borrowing, off-farm income will not have an effect on demand for total and hired farm labor. However, households with borrowing constraint may depend on off-farm income to finance the hiring of farm labor during peak agricultural season. Therefore, the positive effect of off-farm income on the demand for hired labor supports the view that farmers face borrowing constraint to finance farm activities.

Similarly, an increase in education level (years of schooling) of the head has a positive significant effect on hired farm labor demand may because as the level of education increases, the household's exposure to modern agriculture technology and use of inputs will increase which in turn raises farm productivity. As a result, the household may be encouraged to use more input and thus hire more labor for farm activity. Finally, variables such as shadow income, age, animal wealth and location do not affect hired labor demand significantly. Generally, one can observe from the table that quite different estimates (in terms of sign and magnitude) are obtained in response to changes in shadow wage, farm variable input, age of the household head, family size and number of dependents for total and hired farm labor demands.

5. Conclusions and policy implications

Farm households in rural Ethiopia often face imperfect or partly absent labour markets which are constrained by different factors. Under such labour market conditions, farm households face a shadow wage rate that depends both on production and consumption preferences. As a result, it is relevant to examine how their farm labour supply decision is affected by changes in shadow wage and income. Using two-step estimation procedure, this study analyses the determinant of supply of and demand for farm labour for households in western Ethiopia emphasizing on the impact of economic incentives. First marginal product of family farm labour was estimated and the shadow wage was predicted through analysis of the production function. In the

second step estimated shadow wages and income are used to estimate the farm labour supply and demand functions.

The determinants of households' farm labor supply and demand were analyzed using instrumental variable estimation method. The findings revealed that farm labor supply is mainly affected by economic factors, family composition and location attributes and quite different estimates of farm labor supply were observed for labor market participant households. Farm labour supply function re-estimated using the predicted average market wage rate and non-labour income indicated the importance of non-separability in the estimation of farm labour supply function. Similarly, the demand for hired farm labor is mainly influenced by expenditure on variable farm input, size of land cultivated, off-farm income, number of dependents, education of the head, and family size.

The findings could serve as an input for policy makers to take measures that have different policy implications. In case of farm labor supply, changes in economic incentives such as shadow wage and shadow income affect labor market participants in a way different from non-participants implying that measures taken to influence returns to labor on farm may not be successfully applicable to labor market participant households. Moreover, the coefficients of the market wage rate and income in the farm labor supply function re-estimated using the average market wage and non-labor income are both negative and much higher than those based on shadow wage and shadow income which imply that non-separability assumptions are critical in labor supply estimations.

With regards to farm labour demand, the finding that higher expenditure on variable farm input makes significant contribution to the increased use of hired labor imply that measures taken to promote the expanded use of farm input could serve as an instrument for expanding the market for hiring labor. Moreover, higher off-farm income leading to increased use of hired labor implies that increasing the off-farm employment opportunities can help release liquidity constraint of farmers. Therefore, in general, increased use of farm inputs such as fertilizer can help to promote on-farm employment (or the demand for hired labor) and thus could help to absorb idle family labor on the farm sector.

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