RURAL NON-FARM SECTOR, AGRICULTURAL SELF-EMPLOYMENT AND WAGE EMPLOYMENT IN AGRICULTURAL HOUSEHOLDS: THE IMPLICATIONS FOR INCOME AND RISK IN RURAL ETHIOPIA

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2016

Paper prepared for presentation at the 56th annual conference of the GEWISOLA (German Association of Agricultural Economists) „Agricultural and Food Economy: Regionally Connected and Globally Successful“ Bonn, Germany, September 28 – 30, 2016

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Abstract
This paper explores the implication of the rural non-farm employment and waged agricultural employment for income and risk mitigation of agricultural households in Ethiopia. We use a nationally representative panel dataset, and employ endogenous switching mixed multinomial logit model. After we control the selection bias that can arise from employment selection in rural households stemming both from observed and unobserved characteristics, we do find an evidence that the non-farm sector improves the income of the agricultural households, and serve as risk mitigation tool in rural Ethiopia. Combining the non-farm sector with hiring labor for agricultural activities at times of labor shortage increases the variance and contributes to positive skewness of income. Finally, we suggest that the rural non-farm sector could serve as a key development pathway for improving livelihood in the predominantly smallholder production system in Ethiopia.

Keywords Ethiopia, income, non-farm sector, self-employment, risk, wage

1. Introduction

Classical economic development theories presume that the growth of non-farm manufacturing and service sectors with economic development can serve as a pull factor for the rural "surplus" labor force (LEWIS, 1954, HARRIS and TODARO, 1970). Nonetheless, with little technological progress and population growth, the labor transition might not bring such a dramatic structural shift (HOLDEN et al., 2004, BEZU and HOLDEN, 2014, DE BRAUW et al., 2014). Even at times when countries show a common phenomenon of gradual shrink of the rural labor with economic development, labor transitions don't follow a universally unique path (BLOCK and WEBB, 2001, WORLD BANK, 2008). There are recent evidences where rural-urban migration has played minimal role in recent growth (KESSIDES, 2007, POTTS, 2009) and negative net migration (BEAUCHEMIN, 2011) in some African countries. As such, the relative importance of the pull and push factors, including the micro-economic components can strongly influence the labor transition process (KESSIDES, 2007, POTTS, 2009, DE BRAUW et al., 2014). When the role of migration is limited, labor allocation is limited to agricultural self-employment, waged agricultural employment and the non-farm sector. Of special interest in this paper is the implication of labor allocation decisions of the household for productivity and risk mitigation of the farm.

In sub-Saharan Africa, the majority of the population lives in rural areas and is predominantly engaged in agriculture (PENDER, 2000, HOLDEN et al., 2004, DE BRAUW et al., 2014). Little technological progress, climate variabilities and land degradation and the declining agricultural land with population growth makes it difficult to improve the livelihood of the rural poor (DERCON, 2004, HOLDEN et al., 2004, PLACE, 2009, DILLON et al., 2011, BEZU and HOLDEN, 2014). Oftentimes, labor is the major resource that rural households could rely on, and the engagement of this resource influence the overall performance of the household (DEJANVRY et al., 1991, DE BRAUW et al., 2014, AYENEW et al., 2015). Given the limited abundance of large-scale commercial farms in sub-Saharan Africa, the employment

opportunities are limited to seasonal and casual off-farm employment and non-farm employment (HAGGBLADE et al., 2010, FAO, 2012, AYENEW et al., 2015).

In the last couple of decades, the rural non-farm sector is seen as a strategic area of rural development. It is often mentioned as a means of livelihood diversification and so as to absorb the growing landless and rural young in sub-Saharan Africa (HOLDEN et al., 2004, REARDON et al., 2008, DILLON et al., 2011, BEZU and HOLDEN, 2014). Non-farm employment could also serve as risk mitigation tool by circumventing dependency in agricultural sector (DEJANVRY et al., 1991, DILLON et al., 2011). Income from the non-farm sector can also be used to intensify and improve the efficiency of agriculture (HOLDEN et al., 2004, REARDON et al., 2008, AYENEW et al., 2015). Furthermore, as households make most of their earnings from the non-farm sector, they have less time for farm production activities and are likely to reduce the pressure on the natural resource base (HOLDEN et al., 2004). On the other hand, these might require more reliance on hired agricultural labor. Nonetheless, the choice is not frictionless in an imperfect factor market setting. These all can have implications on productivity, risk adaptation, food security and overall wealth accumulation (BLOCK and WEBB, 2001, HOLDEN et al., 2004, REARDON et al., 2008, BEZU and HOLDEN, 2014).

The empirical literature to investigate the diverse roles of labor use and employment choice in the household is limited. It gets even scarcer when it comes to sub-Saharan Africa where the role of the rural labor force has strong relationship with food security and livelihood of the poor (BLOCK and WEBB, 2001, BEZU and HOLDEN, 2014, AYENEW et al., 2015). Building on the existing empirical literatures, this paper explores the impacts of employment selection on productivity and risk mitigation in the rural household. Using a panel dataset from Ethiopia, we do find a positive contribution of the rural non-farm sector on the income and risk mitigation potential of farm households. Furthermore, engaging in both the non-farm sector together with hiring at times of labor shortage has an implication on the livelihood.

The rest of the paper is organized as follows. The next section presents the conceptual framework on the paper. The third section highlights on the data and empirical model. The fourth section will present and discuss the findings. The last section concludes.

2. **Conceptual Framework**

Along with the predominant agricultural activity, diversified livelihood in rural areas of sub-Saharan Africa becomes a common phenomenon with population growth and land scarcity (HOLDEN et al., 2004, PLACE, 2009, BEZU and HOLDEN, 2014), increased risk exposure and vulnerability of households with higher dependency in agriculture (DEJANVRY et al., 1991, DERCON, 2004, HOLDEN et al., 2004, DE BRAUW et al., 2014), and with the expansion of rural infrastructure. From a simple livelihood perspective, a farm household has to make a decision on the allocation of resources among the alternative production activities. With regards to labor, the household either engage in agricultural self-employment, or hire from the labor market at times of labor shortage (HAGGBLADE et al., 2010, AYENEW et al., 2015), supply surplus labor to the non-farm sector (BARRETT et al., 2001, BLOCK and WEBB, 2001, REARDON et al., 2008, HAGGBLADE et al., 2010), or migrate either for short duration or permanently (KESSIDES, 2007, BEAUCHEMIN, 2011, DILLON et al., 2011).

A farm household's utility maximization motive in this case covers an optimization plan on the use of labor and other resources so as to maximize the return from these diversified income generating activities. This can be seen as a constrained optimization problem, where the household has to make choices from alternative labor allocation schemes given the possible production and employment activities and resource limitations. This decision is a

function of the households' labor, land, human capital and other endowments and the relative incentive of such labor allocation decisions. Based on theories and empirical evidences in the developing world (DEJANVRY et al., 1991, HOLDEN et al., 2004, REARDON et al., 2008, DILLON et al., 2011, BEZU and HOLDEN, 2014), we consider incentives to be comprised of profit maximization and risk mitigation potentials of these labor use decisions.

Households with a certain landholding and primarily engaged in agricultural production activity can consider non-farm sector as an attractive choice when the returns to input in non-farm sector are higher than the agricultural return (HARRIS and TODARO, 1970, HOLDEN et al., 2004, HAGGBLADE et al., 2007). They also have an option to hire seasonal or other forms of labor when the opportunity cost of hiring is lower compared to agricultural self-employment and the non-farm sector (HAGGBLADE et al., 2010, AYENEW et al., 2015). Nonetheless, these choices are far from being frictionless in an imperfect factor (land, labor, credit markets) and product market conditions in Ethiopia and in many countries in the developing world (LANJOUW and LANJOUW, 2001, HOLDEN et al., 2004, HAGGBLADE et al., 2010). For instance, rural landless and young in will be pushed out of farming if they are unable to acquire land through inheritance or land redistribution (DEININGER and JIN, 2006, BEZU and HOLDEN, 2014). A household can be unable to afford for farm and non-farm investment when the rural credit market does not function well (HOLDEN et al., 2004, REARDON et al., 2008, AYENEW et al., 2015).

Hence, our model extends the empirical approach by combining the profit maximization and risk mitigation objectives of the household integrated with their constrained labor allocation decisions. For this, we need to develop a conceptual approach with a two stage decision model: the first one for the constrained labor allocation decisions of the household and the second one, for the implications of these labor allocation decisions for income and risk mitigation of the household. The labor allocation decision is made given the human capital, asset and other resource endowments of the household. And we model the implication of this decision stage on the overall income and risk mitigation of the household.

3. Data and empirical approach

This paper is based on the analysis from a panel dataset made available by the International Food Policy Research Institute (IFPRI) in collaboration with the Center for the Study of African Economies (University of Oxford) and Economics department of Addis Ababa University. These dataset consists of a wide array of information ranging from farm plot level data to household agricultural and non-farm production and consumption related data collected from four major regions in Ethiopia (Tigrai, Amhara, Oromia and Southern Nations and nationalities and Peoples regions). We use a total of 2452 observations from the 2004 and 2009 rounds for this paper.

The rural household can generate income from farm and non-farm activities, and hence, our outcome variable comprises of the income from these two sources. Since rural households predominantly engage in agricultural production activities, the right hand side of the production function majorly constitutes the agricultural production inputs (seed cost, labor and other intermediate inputs[1]) commonly applied in smallholder production system. We also include other control variables like demographic and human capital elements of the household (age and age squared, family size, education level of the household head), plot characteristics (soil fertility index, slope index, the level of land fragmentation index[2]), production orientation and agriculture (livestock in TLU, concentration index) and access to credit

[1] Intermediate inputs include fertilizer, pesticides and hired labor
[2] Count index is used here to represent for the level of land fragmentation

services. Concentration index captures the household's concentration in agricultural production activities and this is measured with the Ogive index (ALI et al., 1991).

In terms of labor allocation decisions, rural households have a couple of choices. They can engage in agricultural self-employment, or can participate in rural non-farm employment. They can choose to hire labor for agricultural production activities at times of labor shortage or otherwise simultaneously engage in the rural non-farm sector and employ agricultural labor. These discrete choices with other covariates that might influence this selection form a multinomial choice function.
As the research hypothesis is to test the implications of agricultural self-employment, hiring agricultural labor and non-farm sector on income and risk mitigation of the household, we develop an empirical model. This empirical model has to combine the decision of the household on these employment choices (treatment) and full income function and risk mitigation models (the outcome equation).

Starting with a simple rural household production function, where household income at time *t* (π_{it}) is determined as:

$$E(\pi_{it}) = f(X_{it}, P_{it}, C_{it}, H_{it}, Z_{it}) \quad (1)$$

where (π_{it}) is the expected value of income of the household with monetary terms, (X_{it}) is a vector of input variables for agricultural production, (P_{it}) is a vector of farm plot characteristics, (C_{it}) includes household related capital endowments, (H_{it}) include variables on personal characteristics, and (Z_{it}) is a dummy variable representing whether the household is engaged in agricultural self-employment, hire agricultural labor, engaged in non-farm activity or engage in both the rural non-farm sector and employ agricultural labor. This simple household income model is stochastic which can be extended to represent a utility function of a household comprising the expected value and risk component.

$$E[U(\pi_{it})] = U[E(\pi_{it}) - R_{it}] \quad (2)$$

where *U* is households' preferences based on the von Newmann-Morgenstern utility function. Risk premium (R) can be translated to the implicit (when households choose less risky low return investment) or explicit amount of money (the amount of money they are willing to pay for insurance) (PRATT, 1964, ARROW, 1965).

Following the method of moments approach introduced by Antle (1983), we develop an empirical model to capture the first, second and third order income functions of the household. We estimate the income function with respect to the inputs and other covariates (Antle, 1987) as:

$$\pi_{it} = f_1(X_{it}, P_{it}, C_{it}, H_{it}, Z_{it}, \mu, \alpha, \beta, \gamma, \delta) + u_{it} \quad (3)$$

Where u_{it} is the error term of the income function, μ, α, β, γ, and δ are parameters associated with covariates. The specification of the second and third order income specifications will be presented later in this section.

Estimation of these specification could be problematic due to the incorporation of the selection variable (Z_{it}) in the expected value function and one has to control for selection bias. Our selection equation comprises of multiple of choices (household using family labor for agricultural production or self-employment, hire additional labor for agricultural activity, household engaged in non-farm activity, or a combination of hiring labor and engaged in non-farm activity). To appropriately estimate the implication of different employment situations on income and risk mitigation of the household, introduction of a selection equation is crucial.

$$Z_{it} = f_2(P_{it}, C_{it}, H_{it}) + \varepsilon_{it} \quad (4)$$

Nonetheless, this can't automatically solve the selection bias if unobservable characteristics influence the error terms in the income equation and the employment choice equation, and

this results in the correlation of the two error terms. This requires a simultaneous estimation of the income function and the employment selection equation. The classical solution to integrate the two equations by controlling the selection bias requires a two stage multinomial endogenous treatment model.

Each household chooses a treatment from the set of choices (Z_{it}), and this probability for the observed treatment choice can be specified as:

$$pr(Z_{itj} \mid P_{it}, C_{it}, H_{it}, a_{it}) = g(\alpha_1 P_{it} + \beta_1 C_{it} + \gamma_1 H_{it} + \lambda_1 a_{it1}, \alpha_2 P_{it} + \beta_2 C_{it} + \gamma_2 H_{it} + \lambda_1 a_{it2}, \alpha_1 P_{it} + \beta_1 C_{it} + \gamma_1 H_{it} + \lambda_1 a_{it3}) \quad (5)$$

Where g is a multinomial probability distribution of the employment selection equation, and a_{it} represents unobserved characteristics common to household *i*'s employment choice and their utility of expected income. The probability of observing household *i* in one of the labor regimes *j* (i.e. $Z_{itj} = Z_{it1}, Z_{it2} \dots$) can be specified in a mixed multinomial logit structure (MMNL) as:

$$pr(Z_{itj} \mid P_{it}, C_{it}, H_{it}, a_{it}) = \frac{\exp(\alpha_j P_{it} + \beta_j C_{it} + \gamma_j H_{it} + \lambda_j a_{itj})}{1 + \sum_{k=1}^{J} \exp(\alpha_j P_{it} + \beta_j C_{it} + \gamma_j H_{it} + \lambda_j a_{itj})} \quad (6)$$

The expected value of the income function for the household *i*, given the probability of employment choice, is then formulated as:

$$E(\pi_{it} \mid Z_{it}, X_{it}, P_{it}, C_{it}, H_{it}, a_{it}) = \mu_j X_{it} + \alpha_j P_{it} + \beta_j C_{it} + \gamma_j H_{it} + \sum_j \theta_j Z_{itj} + \sum_j \lambda_j a_{itj} + u_{it} \quad (7)$$

is a linear function of the vector of explanatory variables (X_{it}, P_{it}, C_{it}, H_{it}), employment choice dummies relative to the control, agricultural sole self-employment (Z_{it}) and unobserved latent factors (a_{itj}) that determine both employment choice and the income equation. The parameter λ_j represent factor loadings and reflect the correlation between the treatment (employment choice) and outcome (first, second and third order income moments) equations through unobserved characteristics.

We use a quadratic specification – flexible and commonly applied technique in methods of moments approach (GROOM et al., 2008, ZUO et al., 2014). The residual of equation 7 (u_{it}), which is assumed i.i.d (independent and identically distributed) with a zero mean and variance (δ^2), will then be used to estimate the second (variance) and third (skewness) order moments of revenue distribution. The second and third order income functions can then be represented with the same procedure as in equation 7 in a mixed multinomial logit structure (MMNL) as we do for the income function.

$$\hat{u}_{it^2} = h_1(Z_{it}, X_{it}, P_{it}, C_{it}, H_{it}, a_{it}; \mu, \alpha, \beta, \gamma, \theta, \lambda) + \breve{u}_{it}$$

And

$$\hat{u}_{it^3} = h_2(Z_{it}, X_{it}, P_{it}, C_{it}, H_{it}, a_{it}; \mu, \alpha, \beta, \gamma, \theta, \lambda) + \breve{u}_{it} \quad (8)$$

With the assumption that the latent factors follow standard normal distribution, this multi-stage estimation of the employment choice function and income, variance and skewness function can be executed using maximum simulated likelihood estimation approach with STATA "mtreatreg" routine (DEB and TRIVEDI, 2006).

4. Result and discussions

4.1. Household employment selection

Table 2 contains the coefficient estimates of the mixed multinomial logit model (MMNL) for the selection equations. We present the estimation result of the probability of selection towards a non-farm sector, hiring agricultural labor and mixing both non-farm sector and hiring agricultural labor with respect to the control (i.e. using family labor for agricultural

activities) given demographic and human capital, farm characteristics and production and credit constraints.

The result of the labor selection model indicates that livestock holding of the household consistently influence the selection of labor towards non-farm sector, hiring agricultural labor and the combination of the two with respect to agricultural self-employment. Households with higher livestock holding are less likely to engage in the non-farm sector, and have higher propensity to employ labor. Livestock holding is often used as a proxy for asset holding of the smallholder household (BEZU and HOLDEN, 2014). Livestock activity is considered as a risk mitigation strategy at times of crop failure (HILL et al., 2013). Furthermore, livestock production might compete for labor with the non-farm sector and other production activities.
Landholding of the household significantly influence the probability to hire agricultural labor for the production activities. Households with larger plots require hired labor and offer seasonal and casual employment. As these seasonal and casual works are less selective and less skill demanding, unskilled, landless and needy laborers are often engaged in such wage employment options. Family size and the proportion of family members unemployed significantly affect the labor selection equation. At times when there is surplus labor from agricultural activities, the more likely that the surplus labor look for non-farm employment. For big families especially added up with shortage of farmland, there is a strong push factor from agriculture based livelihood. As BEZU and HOLDEN (2014) highlighted, the rural young and landless are being pushed out of agriculture and have to search for non-farm employment opportunities in rural Ethiopia.

4.2. The implication of labor on income and risk mitigation

The kernel density estimation of income of the households with respect to the decision towards alternative labor use choice is illustrated with figure 1. In general, this figure confirms positively skewed income pattern in rural households, despite the variabilities in the employment condition. In addition, the kernel density distribution confirms the difference in the income patterns of households from the production activities, across alternative labor use choices. Households engaged in agricultural production are more concentrated to the left of the mean compared to those with supplementary income from the rural non-farm sector, and those employing agricultural labor.

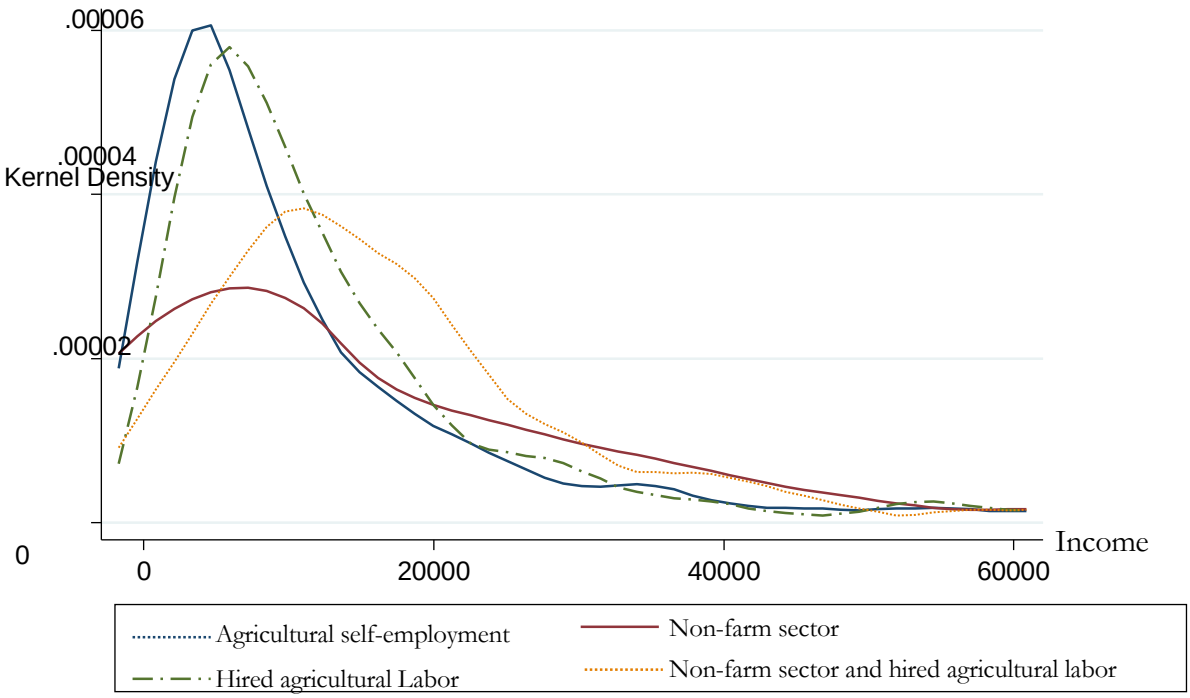

Fig. 1. Kernel density distribution of income

Table 3 presents the results of the MMNL estimation. After we control for the selection of different labor employment regimes and other control variables, we estimate the impact of engagement in this alternative employment options on the mean of the income, variance and skewness of the household. The likelihood ratio test for exogeneity of selection of the employment regimes rejects the joint hypothesis of lambdas (λ's) are equal to zero in the MMNL estimations. Looking at the statistical significance of lambda in most of the estimations, we confirm that there exists correlated unobserved heterogeneity in the income and labor selection model. We control for other sources of variability in the mean, variance and skewness of income (like input allocation, technology, plot and other household characteristics on the model etc.). Treatment coefficients capture the impacts of labor selection of the household in mean, variance and skewness of income.

Agricultural inputs, including their square and interaction terms play a significant role to determine the mean, variability and skewness of the income function of the household. Livestock holding, concentration index and farm plot characteristics also influence the profit moments of the household in rural Ethiopia. In line with the research hypothesis, demographic characteristics of the household, human capital parameters and households access to credit do influence the three income moments of the household.

The estimation result confirms that agricultural households engage in the non-farm sector enjoy higher income, compared to households that are only engaged in agricultural self-employment. In addition to its contribution as a livelihood option to the rural landless population (WOLDENHANNA and OSKAM, 2001, HOLDEN et al., 2004, BEZU and HOLDEN, 2014, AYENEW et al., 2015), the rural non-farm sector significantly contribute to the income of the farm households. The contribution to productivity and income of the households could be higher when the income from the sector is used to intensify the agricultural production activity (HOLDEN et al., 2004, REARDON ET AL., 2008, AYENEW et al., 2015). The associated lambda indicates the negative correlation between the selection and outcome variable. This suggests that rural farm households who are likely to choose the non-farm sector on the basis of their unobserved characteristics earn lower income compared to a random household. Employment in a rural non-farm sector is frequently associated with entry barriers either in terms of financial difficulties or lack of skill (DE JANVRY and SADOULET, 2001, WOLDENHANNA and OSKAM, 2001, BEZU and HOLDEN, 2014). Though farm households could self-select in to non-farm sector, these barriers might impede them to stay in the less paying agricultural activities.

Farm households who are engaged in the non-farm sector experience higher variance compared to those solely engage in agricultural production activities. On the other hand, farm households involve in the non-farm sector have got positively skewed income compared to the control group. Based on unobservable characteristics, households that experience positively skewed income will less likely self-select the non-farm sector. This result indicates that the non-farm sector can be seen as a risk mitigation strategy for the predominantly agrarian population that is engaged in agricultural and natural resource based economic activity in sub-Saharan Africa. Rural non-farm employment opportunities can often reduce dependence in agriculture (de JANVRY et al., 1991, DILLON et al., 2011). LANJOUW and LANJOUW (2001) in their review paper highlight that the rural non-farm sector can help for income smoothing (LANJOUW and LANJOUW, 2001). Furthermore, income from the non-farm sector could serve for consumption smoothing at times when farm households are in short of agricultural production (WOLDENHANNA and OSKAM, 2001, DERCON, 2004, DERCON and CHRISTIAENSEN, 2011). In countries like Ethiopia, the non-farm sector can be seen as a strategic tool to mitigate the adverse effects of climatic and other shocks.

The positive lambda parameter associated to the farm households hiring agricultural labor in the skewness function confirms the presence of positive self-selection. Farm households that are likely to self-select to hire agricultural labor based on their unobservable characteristics are more likely to exhibit positive skewness with respect to their income. Despite the fact that rural off-farm labor is often associated with large scale commercial farms, smallholder farms could also offer seasonal and casual labor to the rural poor and landless (BEZU and HOLDEN, 2014, AYENEW et al., 2015). This seasonal employment is a means of livelihood for rural unskilled and landless (WOLDENHANNA and OSKAM, 2001, BEZU and HOLDEN, 2014), and can contribute to reduce the agricultural production risk linked with labor shortage.

Despite the positive contribution to income, we do find a mixed evidence of risk mitigation potential with respect to the households combine rural non-farm sector and hiring agricultural labor. Households who are likely to self-select to simultaneously engage in the rural non-farm sector and employ agricultural labor based on unobservable characteristics are more likely to exhibit higher income, experience higher variance and positive skewness. With the existence of uncertainties with rural-urban migration, this could be a way towards gradual farm exit for rural farm households. As this evidence suggests, the relative contribution of the two employment options to the overall livelihood activity and hence the pattern of their distribution determine the overall outcome. As such, the contribution of the rural non-farm sector to household income and risk mitigation can be offset by the direct and indirect costs of hiring agricultural labor. In conclusion, the evidence strengthens our assertion that employment choices and labor allocation decisions determine the overall performance of the household.

5. Summary and conclusions

There is a growing literature that investigates the role of the non-farm sector to the livelihood of the rural poor. To the best of our knowledge, this is the first paper that combines endogenous employment selection with the performance indicators in sub-Saharan Africa. This paper analyzes the impacts of employment selection on income and risk mitigation in the farm household using an extensive dataset made available by IFPRI (the International Food Policy Research Institute). We use a mixed multinomial logit model (MMNL) with an exclusion restriction to integrate the employment selection and outcome equations. Based on our empirical evidence, we conclude that the labor selection of the household in rural Ethiopia has an implication on the mean, variance and skewness of the income.

We provide an evidence that the rural non-farm sector improves the income and contributes to positive skewness of income of agricultural households. With this key role, the rural non-farm sector can be seen as a livelihood diversification strategy in rural Ethiopia and elsewhere in the developing world. In countries where agriculture is the base for livelihood of the majority and is often associated with shocks, we argue that the rural non-farm sector could serve as a key strategy for consumption smoothing. With lower technological progress in agriculture, increasing population and land scarcity, inadequate pull factors from other sectors and urbanization in sub-Sharan Africa, the rural non-farm sector can play a significant role.

Despite the classical thought that associates agricultural employment with large scale commercial farms, we do find the role of smallholder farms in providing seasonal and casual employment. We confirm that simultaneous engagement in the rural non-farm sector together with employing hired labor for agricultural practices contribute to income and risk mitigation in Ethiopia. The overall performance of such an employment decision is determined by the relative contributions of the alternative the employment options. Overall, we conclude that employment selection is an endogenous decision and influences the livelihood of the rural farm households in Ethiopia. We suggest future research on the quality of labor across different

employment options and scale of operations in the developing world, and their implications for income and risk of the households.

Table 2: Estimation of mixed multinomial logit model (dep. variable: Probability of choice of employment *j*, control group=agricultural self-employment)

Variables	Non-farm sector Coeff. (Std. err)	Hiring agricultural labor Coeff. (Std. err)	Both non-farm sector and hiring Coeff. (Std. err)
Age	.079**	.019	-.006
	(.040)	(.023)	(.061)
Age squared	-1.1e-03***	-1.6e-04	-2.3e-04
	(3.9e-04)	(2.1e-04)	(6.5e-04)
Family size	.065*	-.128***	.030
	(.036)	(.028)	(.054)
Education	.077***	.106***	.247***
	(.026)	(.024)	(.034)
Concentration index	-.084	.044	.369***
	(.072)	(.054)	(.116)
Land fragmentation	-.027	.113***	.157***
	(.034)	(.021)	(.036)
Livestock in TLU	-.144***	.250***	.103***
	(.040)	(.022)	(.041)
Credit access	.105	.097	.340
	(.153)	(.121)	(.243)
Dummy_2009	-.199	-.503***	-.686***
	(.152)	(.121)	(.249)
Cons	-2.880***	-2.676***	-5.573***
	(.991	(.673)	(1.453)

Table 3: Selectivity- corrected estimation of the mean, variance and skewness of income equations

Variables	Mean Coeff. (Std. err)	Variance Coeff. (Std. err)	Skewness Coeff. (Std. err)
Treatment effects (Control=agricultural self-employment)			
Non-farm sector	.205*	-.231**	.531***
	(.113)	(.104)	(.110)
Hiring agricultural labor	-.548***	.190***	.359***
	(.121)	(.047)	(.085)
Both non-farm sector and hiring	-.607***	-.197***	-.245**
	(.132)	(.065)	(.099)
Lambda_non-farm	-.060	.373***	-.668***
	(.077)	(.042)	(.092)
Lambda_hiring	.659***	-.282***	-.525***
	(.129)	(.044)	(.078)
Lambda_both	.760***	.143***	.135***
	(.087)	(.022)	(.044)
Agricultural inputs			
Seed per hectare	-4.5e-05**	-4.6e-05***	-7.8e-05***
	(2.0e-06)	(1.2e-05)	(2.1e-05)

Labor per hectare	1.5e-03***	6.6e-04***	1.1e-03***
	(2.3e-04)	(2.1e-04)	(3.8e-04)
Input per hectare	7.5e-04***	1.8e-04***	1.9e-04**
	(8.2e-05)	(5.5e-05)	8.7e-05)
Seed*Seed	2.8e-09***	1.9e-09***	3.5e-09***
	(9.7e-10)	(5.2e-10)	(9.1e-10)
Labor*Labor	-2.8e-07***	-1.5e-07***	-2.6e-07***
	(5.1e-08)	(4.4e-08)	(7.8e-08)
Input*Input	-6.1e-08***	-7.2e-09	8.93-11
	(1.1e-08)	(7.2e-09)	(1.3e-08)
Seed*Labor	-1.1e-08	5.9e-09	3.5e-09
	(7.2e-09)	(5.2e-09)	(8.6e-09)
Seed*Input	-1.6e-08***	-1.1e-08***	-1.9e-08***
	(3.5e-09)	(1.7e-09)	(2.7e-09)
Labor*Input	7.5e-08***	3.1e-08***	3.1e-08
	(2.3e-08)	(1.5e-08)	(2.7e-08)
Demographic characteristics and human capital			
Age	-3.3e-03	-.034***	-.059***
	(9.4e-03)	(.008)	(.011)
Age squared	3.9e-05	5.8e-04***	9.7e-04***
	(8.6e-05)	(6.7e-05)	(1.0e-04)
Family size	-2.4e-03	-.043***	-0.065***
	(.012)	(.011)	(.011)
Education	.038***	-.056***	-.091***
	(.009)	(.011)	(.016)
Production orientation and plot characteristics			
Concentration index in production	-.066***	.014	.053
	(.024)	(.018)	(.034)
Fertility index	-.319***	.097***	-.139***
	(.043)	(.023)	(.034)
Slope index	-2.5e-03	-.009	-.050
	(.056)	(.033)	(.053)
Livestock in TLU	-.027***	.084***	.141***
	(.009)	(.005)	(.001)
Other control variables			
Credit access	.149***	-.109***	-.153
	(.054)	(.043)	(.072)
Dummy_2009	.439***	.429***	.637
	(.058)	(.046)	(.076)
Cons	9.833***	2.122***	3.184***
	(.263)	(.206)	(.282)

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