Participation in Off-Farm Employment, Risk Preferences, and Weather Variability: The Case of Ethiopia

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Abstract

This article assesses the relative importance of risk preferences and rainfall availability on households' decision to engage in off-farm employment. Devoting time for off-farm activities, while it helps households earn additional incomes, involves a number of uncertainties. Unique panel data from Ethiopia which includes experimentally generated risk preference measures combined with longitudinal rainfall data is used in the analysis. An off farm participation decision and activity choice showed that both variability and reduced availability of rainfall as well as neutral risk preferences increase the likelihood of off-farm participation.From policy perspective, the results imply that expanding off farm opportunities could act as safety nets in the face of weather uncertainty. In addition, policy initiatives geared towards encouraging income diversification through off farm employment need to address underlying factor that condition risk bearing ability of households.

Keywords: Off-farm employment, labor supply, rainfall variability/reduced availability, risk preferences, GLLAMM, Ethiopia

JEL Classification: Q13, D81, C35, C93

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1. Introduction

In very poor countries with dominant agrarian economy, off-farm employment can be an important source of alternative income (Reardon, 1997; Bryceson and Jamal, 1997; Chuta and Liedholm, 1990). Off-farm income has been generally positively correlated with farm income (Haggblade and Hazell, 1989; Hazell et al., 1991; Chikwama, 2004)[1] and non-farm activities indicate a positive broader role in poverty reduction, household income, and household wealth (Reardon 1998; Lanjouw and Lanjouw 2001; Davis 2003; Barrett et al. 2001).

Since participation in off-farm activities is dependent on family labour, which is also used on farm activities, the complementary nature of off farm employment to farm employment depends on agricultural conditions as well. In the face of acute weather variability, off farm activities could become attractive adaptation options to agricultural activities.

In addition, although rural households tend to participate in off-farm activities to fulfill their needs and mitigate income shortfalls, participation appears to be constrained by capital assets—human, social, financial, physical. In their study of off farm employment participation in Honduras, Ruben and van den Berg (2001) show that educated and wealthier households tend to participate in off farm activities, indicating the importance of human and physical capital. In addition, in their study of off farm employment in Columbia, Deininger and Olinto (2001 Show that investment in a single income source is the most beneficial to capital constrained households with limited education/human capital. The limiting roles of access to credit and lack kof education are also highlighted by Escobal's (2001) study of income diversification in Peru.

[1] The positive relationship between off-farm and farm incomes, in particular, has drawn significant attention from those studying this area. It has been used in a number of studies1 to argue in favour of a widely held view, which asserts that rural off-farm income is important for agricultural development as it assists households in overcoming cash constraints when making farm investments. This view, if accurate, would be very important for agricultural development in developing countries, especially given the widespread evidence for institutional failures in rural capital markets. For this reason, the idea has attracted a great deal of attention from many non-governmental organisations (NGOs) and development agencies working in developing countries in their work to improve the agricultural potential in these areas (von Braun and Pandya-Lorch, 1991; Bernstein et al., 1992; Ellis, 1998; 2000). (Chikwama, 2004).

As such, as off-farm employment may be dependent on the household's assets, it could be seen as an investment by households, and their risk preferences might come into play in their decision to engage in off-farm activities. While off farm employment could be seen as an opportunity to cope with anticipated risks, its investment requirements may make households, especially poorer ones, not necessarily opt for it. Indeed risk preferences affect whether people can maintain assets and endowments, how these assets are transformed into incomes via activities and how these incomes and earnings are translated into broader development outcomes such as health and nutrition. In line with this a number of studies show that households use sophisticated strategies to manage or reduce risk ex-ante which includes asset diversification, migration patterns and specialization into low-risk activities (e.g. Murdock, 1995; Dercon, 2002; Dercon and Christiansen, 2007).

In sum, rainfall variability –an external source of agricultural income risk, and households' ability to diversify income into off-farm employment-dictated partly by risk preferences, could be both important factors in understanding the determinants of off-farm employment. While the impact of rainfall on off farm employment is assessed by a few studies (e.g. Bezu et al., 2009; Nidhiya, 2009), to our knowledge there are no studies that we are aware of, that combine covariate risks associated with rainfall and individual risk preferences in the assessment of participation in off-farm employment.

This analysis is based on the premise that participation in off-farm employment is driven by the availability or variability of rainfall and risk preferences of households, among other factors. Accordingly, we investigate the potential of involvement in non-farm activities as an adaptation option to climate change and its determinants and ability to reduce farmers' vulnerability. We also analyze the link between participation in off-farm employment and risk preferences.

The rest of the paper is organized as follows. In section 1, we briefly review the literature on participation in non-farm activities. Section 2 provides the theoretical framework and model specification. Section 3 discusses the survey and data used. Section 4 presents a discussion of our results, and section 5 concludes with some policy implications.

2. Rainfall, Poverty and Risk in Ethiopia

Understanding the relationship between off-farm employment, rainfall variability and risk preferences has particular relevance to the hugely agricultural Ethiopian economy. With a population greater that 72 million, the country has high poverty and about two thirds of the population lives on less than $2 a day (World Bank, 2008). Ethiopia is one of the most food-insecure countries in the world, as manifested by chronic hunger and famine. The country is renowned for its high dependence on agriculture—about 74% of the population of the country derives its livelihood from agriculture—which is entirely dependent on rainfall. Of the 4.3 million hectares of potential irrigable agricultural land, only 5% is currently farmed (Kebede 2003). Smallholder farmers dominate the sector, cultivating about 95% (Adenew 2006). The dependence on rainfall and its erratic pattern has largely contributed to the food shortages and crises that farmers are constantly faced with. Even in good years, the one-time harvest or crop may be too little to meet the yearly household needs; as a result, the majority of Ethiopia's rural people remain food insecure (Devereux 2000).

To address the food security problems, the Ethiopian government designed and implemented different interventions to improve agricultural productivity, such as irrigation schemes and food security policies, among others. Nevertheless, focusing on agricultural production alone may not be enough to combat the population's vulnerability to shocks and the resulting food insecurity. Therefore, non-agricultural or non-farm activities may be of paramount importance for people's livelihoods in the face of climate change. Promoting non-agricultural activities as sources of alternative income, particularly in drought-prone areas and the degraded northern Ethiopian highlands, may be vital for rural livelihoods (e.g., Devereux 1995; von Braun 1995; Clay et al. 1999, Jalan and Ravallion 2001; Hagos 2003).

With agriculture highly dependent on rainfall, rain rules the lives and wellbeing of many rural people in Ethiopia. That is, it determines whether they will have enough to eat, be able to provide basic necessities and earn a living. Rainfall contributes to poverty both directly, through actual losses from rainfall shocks, and indirectly, through responses to the threat of crisis (Barret et al. 2007). The direct impacts particularly occur when a drought destroys a smallholder farmer's crops. Under such circumastances not only will the farmers and their families go hungry, but also will be forced to sell or consume the plough animals they may own in order to survive, making them significantly worse off than before because they can no longer farm effectively when the rains return. These impacts may also last for years in the form of diminished productive capacity and weakened livelihoods. The indirect impacts are also not less serious. People tend to be excessively risk-averse when faced with the threat of a possible weather shock. They also tend to be shy of innovations that could increase productivity, as these innovations may also increase their vulnerability or exhaust the assets they would need to survive a crisis. Moreover, farmers will be credit constrained as creditors may not be willing to lend for fear of drought might result in widespread defaults, even if loans can be paid back easily in most years. This, in turn, critically restricts access to agricultural inputs and technologies, such as improved seeds and fertilizers. The threat of the disaster is enough to block economic vitality, growth and wealth generation during all years – good or bad, even though a drought (or a flood, or a hurricane) may happen only once in five years. Ethiopia has experienced at least five major national droughts since 1980, along with literally dozens of localized ones (World Bank, 2008). These cycles of drought create poverty traps for many households, constantly dwarfing efforts to build up assets and increase income. Evidence shows that about half of all rural households in the country experienced at least one major drought during the five years preceding 2004 (Dercon, 2009). The evidence also suggest that these shocks are a major cause of transient poverty. That is, had households been able to smooth consumption, then poverty in 2004 would have been at least 14% lower a figure that translates into 11 million fewer people falling below the poverty line.

Pure risk preferences of farmers also matter in decisions pertaining to activity choice, investment and technology adoption. For example, exposure to risk and risk aversion have often been associated with low technology adoption rate, low income, and continuing poverty traps in many poor countries like Ethiopia (Rosenzweig and Binswanger, 1993). Dercon et al. (2007) argue that by pushing farmers away from adopting certain high return technologies, risk has been a growth-dampening factor in Ethiopia thereby perpetuating poverty. That is, it results in risk-induced poverty traps by causing farmers to be less willing to undertake activities and investments that have high expected returns but carry with them risks of failure or downside risk (Just and Pope, 1979; Moseley and Verschoor, 2005).

3. Participation in Non-farm Activities: Literature Review

Over the last three decades, the non-farm economy has been gaining a wider acceptance in issues of rural development, due to its positive implication in poverty reduction and food security (Reardon 1998; Ellis 1998; Lanjouw and Lanjouw 2001; Davis 2003). Participation in non-farm activities is one of the livelihood strategies among poor rural households in many developing countries (Mduma and Wobst,2005). Empirical research has found that non-farm sources contribute 40%–50% to average rural household income across the developing world. For example, according to a World Bank report (2008), non-agricultural activities account for 30%–50% of income in rural areas. In Ethiopia, according to Davis (2003) and Deininger et al. (2003), some 20% of rural income originates from non-farm sources. In some parts of Ethiopia, off-farm or non-farm labor income accounts for up to 35% of total farm household income (Woldehanna 2000).

The rural non-farm sector plays a critical role in promoting growth and welfare by slowing rural-urban migration, providing alternative employment for those left out of agriculture, and improving household security through diversification (Lanjouw and Lanjouw 1999). For example, Barrett et al. (2001) found that non-farm activity is typically positively correlated with income and wealth (in the form of land and livestock) in rural Africa, and thus appears to offer a pathway out of poverty—if non-farm opportunities can be seized by the rural poor. However, this key finding appears to be a double-edged sword. The positive wealth/non-farm income correlation may also suggest that those who begin poor in land and capital face an uphill battle to overcome entry barriers and steep investment requirements to participation in non-farm activities that are capable of lifting them from poverty (ibid.).

Decisions by rural households concerning involvement in non-farm activities depend on two major factors: incentives offered and household capacity (Reardon et al. 2001). Some poor rural households will make a positive choice to take advantage of opportunities in the rural non-farm economy, taking into consideration the wage differential between the two sectors and the riskiness of each type of employment. Rising incomes and opportunities off-farm, however, reduce the supply of on-farm labor. Other households are pushed into the non-farm sector due to a lack of on-farm opportunities, for example, as a result of drought or small size of land holdings (Davis 2003). One of the components of rural non-farm activities in which the poor can participate—because it does not require any complementary physical capital—is wage employment (Mduma and Wobst 2005). Hagos (2003) looked at the effect of program credit on participation in off-farm employment. He found that the effect of program credit was positive and statistically significant in the case of change in the level of income derived from self-employment, but that it had no significant effect in the case of wage employment. He also emphasized that this underscored the heavy impact of lack of access to capital on self-employment.

Different studies have investigated the determinants or factors that most influence the decision to participate and the choice of activity, as well as the extent of rural household participation, in non-farm activities. For example, Mduma and Wobet (2005) found that education level, availability of land, and access to economic centers and credit were the most important factors in determining the number of households that participated in a particular rural local labor market and the share of labor income of total cash income. Bezu et al. (2009) also looked at the activity choice in rural non-farm employment. They found education, gender, and land holding to be the most important determinants of activity choice.

A number of conclusions can be drawn from the literature in this review. First, non-farm sources contribute a significant part, about 40%–50%, to average rural household income across the developing world. In addition, involvement in rural non-farm activities, as a livelihood strategy among poor rural households, plays a vital role in promoting growth and welfare and offers a pathway out of poverty if non-farm opportunities can be seized by the rural poor. Second, both "push-and-pull" factors appear to be involved in decisions by rural households to participate in rural non-farm activities. For example, some might be attracted by the incentives offered and labor availability whereas others might be pushed into the non-farm sector due to a lack of opportunities on-farm (for example, as a result of drought or smallness of land holdings). However, little or no empirical analysis has been done on whether or not, and to what extent, participation in off-farm employment is determined by variability in climatic factors or weather conditions.

4. Estimation Methods and Empirical Strategy

The main objective of the empirical analysis is to assess the impacts of rainfall availability and risk preferences on participation in off-farm employment and activity choice. The analysis is based on the premise that participation in off-farm employment is driven by, among other factors, the availability of rainfall. The pattern of rainfall is crucial because a majority of Ethiopian farmers are land owners, and labor supply and participation in off-farm employment are dependent on the agricultural conditions. Similarly, risk preferences are important determinants of participation in off farm employment. Based on this, we hypothesized that rainfall variability and reduced availability may reduce activities on the farm and increase off-farm employment. In addition to participation, out analysis also explores the impact of rainfall and risk preferences on the choice between different kinds of off-farm activities.

4.1 Estimation of the Decision to Engage in Off-Farm Employment

The estimable equation of the determinants of off-farm employment is specified as:

$$P_i = \begin{cases} 1\, if\;\; \alpha + \psi X_i + \lambda Z_i + \gamma R_i + \xi_i \succ 0 \\ 0\; otherwise \end{cases} , \quad (1)$$

where X_i is a measure of household socio economic and farm characteristics, and manure; Z_i is a measure representing climatic factors, such as rainfall; R_i stands for the risk preference variables, α is a constant; ψ is a vector of parameters corresponding to the socioeconomic characteristics; and λ is a vector of parameters corresponding to the rainfall variables,

γ represents the coefficients of the risk preference variables and ξ_i is household-specific random error term.

4.2 Estimation of Off-Farm Activity Choice

To estimate the choice of off-farm activity, we followed the multinomial logit approach to consider farmers who choose their occupation conditional on their characteristics. Assume that farmer *i*'s utility of choosing labor force status among *j* alternatives 0, 1, … *j* is:

$$U_{ij} = \beta_j X_i + v_{ij} \quad , \tag{2}$$

where X_j denotes individual characteristics, β_j denotes a vector of coefficients specific to state *j*, and v_{ij} is a random error term. Let P_{ij} denote the probability that state *j* is chosen. If the v_{ij} terms are independently and identically distributed with the type I extreme-value distribution, utility maximization leads to the multinomial logit model of the form (Judge et al. 1985, 770):

$$P_{ij} = \frac{\exp(\beta_j X_i)}{\sum_{k=0}^{j} \exp(\beta_k X_i)} \quad . \tag{3}$$

Setting $\beta_0 = 0$ to normalize, the multinomial logit model can be rewritten as:

$$P_{ij} = \frac{\exp(\beta_j X_i)}{1 + \sum_{k=0}^{j} \exp(\beta_k X_i)}, \; i = 1, 2, 3, ..j \text{ and}$$

$$P_{i0} = \frac{1}{1 + \sum_{k=0}^{j} \exp(\beta_k X_i)}, \; i = 1, 2, 3, ..j \; .$$

4.3 Estimation Concerns and Choice of Estimation Strategy

Sample selection is a concern whenever the response variable is observed, only if a selection condition is met. If unobserved factors affecting the response are correlated with unobserved factors affecting the switch/selection process, standard regression techniques result in biased and inconsistent estimators (Heckman 1979; 1978). Accounting for sample selection in the case of binary, count, and ordinal responses, however, or endogenous switching is essentially complicated by the fact that we used a non-linear model to fit the data calling for maximum likelihood (ML) techniques or two-stage method of moments (Miranda and Rabe-Hesketh 2005).

A recent development of new methods to incorporate the hierarchical structure of data includes generalized linear latent and mixed models (GLLAMM) developed by Rabe-Hesketh and Skrondal (2004; 2005).[2] In this study, a multinomial Logit model is estimated with the GLLAMM specification to predict the likelihood of a household choosing an off-farm employment activity on the condition that the household participates in an off-farm activity. As per the classification in the survey questionnaire, the off-farm employment was classified into five categories: farm laborer, daily laborer, food-for-work employment worker, permanent off-farm trade, and other employment.

5. Survey and Data Description

Data used in this analysis were taken from Sustainable Land Management Survey in the central highlands of Ethiopia, conducted by the Environmental Economics Policy Forum for Ethiopia in collaboration with Addis Ababa University in the years 2002 and 2005. In each year, approximately 1,500 farm households in 12 villages, located in two districts of the Amhara Regional State of Ethiopia, were randomly selected and interviewed. The primary focus of this survey was to understand production, consumption, labor, and input use, soil and water conservation and use activities. In addition, the survey consisted of hypothetical risk preference questions aimed at eliciting risk preference measures. We combined data from this survey and rainfall data from the Ethiopian Meteorology Service Agency collected at the local meteorological stations. Average annual rainfall values were assigned to each village using measurements taken from the stations closest to each village.

The dependent variable, the average participation in off-farm employment in the years 2002 and 2005 was 0.633 and 0.565, respectively. This indicates that in favorable years farmers tended not to work off the farm. It also appears that off-farm work was negatively associated with the variance of the rainfall since the standard errors of off farm participation were 0.482 and 0.496, respectively.

We calculated the risk preferences from the risk experiment data in our survey. The questions were set up as choice experiment questions with hypothetical pay-offs and losses. The enterprise under consideration was a hypothetical farm, which depending on nature would lead to losses or gains of output. The risk preference variables consist of six categories in order of increased risk aversion: neutral, slight, moderate, intermediate, severe and

[2] GLLAMMs are a class of multilevel latent variable models for (multivariate) responses of mixed type, including continuous responses, counts, duration/survival data, dichotomous, ordered and unordered categorical responses, and rankings. The latent variables (common factors or random effects) can be assumed to be discrete or to have a multivariate normal distribution. Examples of models in this class are multilevel generalized linear models or generalized linear mixed models, multilevel factor or latent trait models, item response models, latent class models, and multilevel structural equation models (Rabe-Hesketh et al. 2004).

extreme. The other important set of explanatory variables, average rainfall and its coefficient of variation were calculated by using monthly rainfall measures as point values.

To take the market and natural environmental characteristics into account is important because it is generally believed that these factors are significant determinants of access to, and ability to participate in, off-farm work. The variable that identifies these effects is the location variable. The quality of soil was identified by the farmers in terms of fertility, soil color, and plot slope. Three variables were specified to represent local environmental characteristics, aggregated on the *kebele*[3] level.

Because rainfall variables are based on observations by local meteorological stations, rainfall measure is likely to be correlated with village-level effects that vary across villages. Factors that are bundled up in these measures include access to markets, and access to inputs and technology, as well as agro-ecological variations.

Other variables were roughly constant across years, indicating that there was little social mobility by farmers within the study villages. This pattern was repeated for farm characteristics and conformed to the land-tenure pattern in Ethiopia, where virtually no land is exchanged through sale or due to the recent freeze in land redistribution in many parts of the country.

Although an average annual amount of rainfall fell during the study periods, ownership of irrigation equipment was not included in the analysis because farming technology is homogenously rudimentary in rural Ethiopia. Descriptions of the variables used in the regression and the basic descriptive statistics of the variables used in the regression are presented in tables 1 and 2, respectively.

<< Table 1 here>>

<< Table 2 here>>

6. Discussion of Results

To estimate the determinants of participation in off-farm employment, a random effects probit model was estimated. The regression results are reported in table 3. Demographic characteristics, such as age and gender, are insignificant determinants of participation in off-farm employment. However, the results suggest that households with larger number of male

[3] A *kebele* is like a ward or a formal neighborhood association and is the smallest administrative unit of local government in Ethiopia.

and female household members participated more than households with less. This could be due to the fact that participation in off-farm activities is critically dependent on labour availability. Among other household characteristics, ownership of livestock and oxen also has an significant impact on participation in off-farm activities. However, the non-linear variables corresponding to the household characteristics seem to explain participation better. Participation is negatively and significantly affected by the squares of male and female labor implying that households with too few or too many labor available tend to participate in off farm activities. In addition, households with relatively large land assets or those with no land tend to participate in off-farm.

Of the rainfall variables, the coefficient of variation of rainfall had a significant positive impact on off-farm participation, confirming the argument that rainfall variability increases participation of household members in off-farm activities. Similarly, the rainfall variable (annual total rainfall) had an inverse impact on off-farm participation, implying that agricultural households facing weather risk tend to divert more labor to off-farm work. This complements the arguments that off-farm activities serve as a conditional alternative in cases of weather shock to compensate households' income shortfalls.

In addition, the effect of risk attitudes and preferences of farmers on the decision to participate in off-farm activities shows that their impact on off-farm participation is only marginal. Indeed, households with neutral risk preferences tend to participate in off-farm employment than households in other risk preference categories, although the significance of the coefficient is only modest.

Table 4 reports the off-farm employment activity choice of households using a multinomial logit model. The four important off-farm activities that were considered in the analysis include farm worker, daily laborer, food-for work participant, and permanent and other forms off off farm employment. The fourth category is used as a base case. Overall, factors such as location, number of oxen and livestock, and weather condition turned out to be most important determinants of activity choice in all the cases considered amid variations in the sign, level of significance and magnitude of the coefficients.

The influence of risk preferences on activity choice operates by directly discouraging the uptake of risky activities like off-farm employment as less risk averse households are likely to adjust more easily to financial and labour demands. In addition, annual rainfall is also uniformly significant across the off farm activities indicating that it is an important factor in activity choice. However, except for agricultural labour, all other forms of activities are negatively affected by total annual rainfall. Similarly, the coefficient of variation of rainfall, in the case of food for work, and agricultural labour has a negative impact while it turned out positive and significant in the daily labourer activity choice of household. An important result from this analysis is that both rainfall and risk preferences tend to have no significant differential impacts on off farm employment conditional on the type of employment activity.

The coefficients of farm size are significant at 0.05% and more for the different off farm categories. While the positive impact of farm size on off farm employment could be puzzling, as it could be related to more on-farm work, it could be explained by the fact that land size could measure household net-worth enabling households to dispose a portion of their incomes on as start up costs of off-farm employment. The t-statistic for the livestock variable for the farm workers is 2.32, for daily labourers 2.34 and for food for work participants at 2.35. This means that a the impact of livestock ownership has almost identical impact on participation in the different off farm activities. The significane of the remaining variables, fertility, and slope are generally small in magnitude and are also insignificant.

Female headed households are less likely to engage in food for work activities. This negative impact of gender may reflect some labour market discrimination. Alternatively, the existence of female-specific tasks might discourage female headed households from taking part in food for work employment. This might also indicate the ability of male headed households are able to easily adjust to the demands of tasks with the exception of other employment opportunities where there are no differences between male and female headed households. Older households tend to be good matches for agricultural labour jobs while age is not significant in the other job categories. In general, increases in the distance between locations of off farm employment and ones farm an important factor to discourage taking off farm employment.

7. Conclusions and Policy Implications

This paper investigated the likely impact of weather shock, as measured by availability and variability of rainfall, and risk attitude and preference, on the participation of household members in off-farm activities. Our basic premise is based on the fact that a majority of farmers are land owners in Ethiopia, and labor supply and participation in off farm employment is dependent on the agricultural conditions.

To mitigate the dangers of food insecurity in Ethiopia due to the effects of the vagaries of nature on the rainfall-dependent agriculture, smallholder households tend to find employed in various kinds of off-farm activities. The results in this paper depict the likely impact of weather shock, as measured by availability or variability of rainfall, on the participation of household members on off-farm activities. The results also confirmed that households use off-farm employment as a coping mechanism for weather shocks.

In the wake of dramatic climate changes and with the agricultural sector bearing the brunt of these costs, alternative coping mechanisms have been increasingly sought, often more seriously than before. Although off-farm employment is intended to augment farm income, few evaluations of off-farm employment have investigated whether the role of off-farm employment is critical in response to weather variability. In low-income rural economies with little infrastructure and thin supplementary markets, the potential of off-farm opportunities as full-fledged alternatives to on-farm employment may be limited. In the context of climate change, this paper assesses what role off-farm employment can play. We found that participation in off-farm income is determined by weather conditions, measured in terms of average total annual rainfall and its coefficient of variation.

In general, the rainfall variables support the hypothesis that rainfall availability increases agricultural activities leading to lower participation while variability leads to increased off farm participation. The results confirmed that households use off-farm employment as a coping mechanism of weather shocks. In addition, we also found that the off-farm activity choice of households is also influenced by climatic factors or weather conditions. Indeed, results in this paper show that risk attitudes rather do not matter; rather, it is weather conditions that matter most in the off-farm participation decision of farmers.

The multinomial logit estimation the effects on the probability of employment in different off-farm opportunities. It is unclear if this reflects the correlation between risk preferences and rainfall variability or if it is a manifestation of unmeasured individual propensity or simply an intertemporally correlated error structure. However, the type of farm employment taken up by a household member is sensitive to the location of the off farm employment. This is particularly true with off farm workers who choose to engage in food for work employment.

The test statistic shows that the multinomial logit specification provides significant explanatory and insights into the decision to engage in any kind of off-farm employment.

Both increases in rainvall variability encourage taking up off farm employment. Increases in the availability of male and female labour increase the tendency to engage in all sorts of of farm activities. A similar trend exists for the physical farm characteristics..

The fit of the models indicates that The R2 criteria lie between .32 and .43. Total holdings of farm have a a negative effect on off farm employment. These effects are consistent with the known physical farm characteristics too.

An important implication of our findings is that off-farm employment can be regarded as a feasible option or alternative in climate-change adaptation policy. In addition, identifying and targeting of off-farm employment opportunities by governments in the face of climate change must take adequate account of climatic variables.

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Table 1: Description of variables used in the regression

Variable	*Description*
participation in off-farm activity	whether a household member participated in off-farm activity (yes=1; 0=otherwise)
type of off-farm activity	Off farm activity the household participated in (1=; 2=; 3=; 4=; 5=)
gender of household head	Gender of the household head (0= male; 1=female)
age of household head	Age of the household head (in years)
average annual rainfall	Village-level annual rainfall (in mm)
literacy level of household head	The level of education of household head (1= illiterate;2=Read only; 3= Read and write)
number of oxen	The number of oxen owned by the household (head count)
number of livestock	Livestock owned by the household (Tropical livestock units)
coefficient of variation of rainfall	The mean variance ratio of annual village level rainfall
number of adult males	The number of adult male members of the household
number of adult females	The number of adult female members of the household
risk attitude/preference of head	1=risk neutral; 2=slightly risk averse; 3=intermediate; 4=severe; 5=extreme
location of off-farm employment	The location of off-farm employment (1=within the village; 2=within the peasant association; 3=within the woreda;4= in the nearest woreda; 5= in the nearest town; 6=other)

Table 2: Descriptive statistics on the variables used in the regression

Variable	*2002*		*2005*	
participation in off-farm activity	0.633	0.482	0.565	0.496
type of off-farm activity	3.084	1.816	3.626	1.397
gender of household head	1.150	0.357	1.160	0.367
age of household head	48.575	15.694	50.254	15.514
average annual rainfall	1228.840	172.140	1049.530	219.080
literacy level of household head	1.847	0.952	1.903	0.962
number of oxen	1.013	0.822	1.129	0.878
number of livestock	6.506	4.482	7.256	4.709
coefficient of variation of rainfall	0.704	0.111	0.656	0.092
number of adult males	2.840	1.608	3.111	1.632
number of adult females	2.677	1.370	2.986	1.442
location of off-farm employment	1.201	0.468	1.661	0.938
extreme	0.010	0.101	0.015	0.121
severe	0.019	0.137	0.007	0.082
intermediate	0.160	0.367	0.232	0.422
moderate	0.097	0.295	0.061	0.239
slight	0.246	0.431	0.218	0.413
neutral	0.490	0.500	0.469	0.499

Table 3 Random effect probit model estimates of the determinants of off-farm employment

	Random effects probit model				Mundalak's Fixed effects probit model			
Participation in off farm employment	Coef.	Std.	t-stat	pval	Coef.	Std.	t-stat	pval
average annual rainfall	-0.002	0.000	-10.920	0.000	-0.002	0.000	-11.150	0.000
coefficient of variation of rainfall	0.641	0.234	2.740	0.006	0.588	0.237	2.480	0.013
neutral risk preference	0.063	0.058	1.100	0.273	0.067	0.058	1.150	0.251
slight risk preference	0.070	0.068	1.030	0.302	0.069	0.068	1.020	0.309
age of household head	-0.011	0.002	-6.410	0.000	-0.001	0.007	-0.120	0.907
gender of household head	0.076	0.077	0.990	0.323	0.084	0.077	1.080	0.280
literacy level of household head	0.049	0.056	0.870	0.384	0.049	0.056	0.880	0.381
number of oxen	0.059	0.021	2.880	0.004	0.030	0.029	1.020	0.309
number of adult males	0.161	0.054	3.010	0.003	0.264	0.068	3.900	0.000
number of adult females	0.133	0.061	2.170	0.030	0.150	0.073	2.050	0.041
Farm size	0.343	0.070	4.930	0.000	0.300	0.079	3.800	0.000
plot fertility	0.053	0.012	4.590	0.000	0.054	0.012	4.640	0.000
flat slope plot	0.425	0.130	3.280	0.001	0.435	0.130	3.340	0.001
moderate slope plot	0.309	0.121	2.560	0.011	0.319	0.121	2.630	0.009
plot distance	-0.001	0.001	-1.720	0.086	-0.001	0.001	-1.760	0.079
red plot	-0.094	0.109	-0.860	0.390	-0.108	0.109	-0.990	0.323
black plot	0.006	0.113	0.050	0.958	-0.003	0.114	-0.020	0.980
Number of livestock	0.001	0.000	1.930	0.053	0.000	0.000	0.580	0.560

number of adult males	-0.018	0.007	-2.400	0.016	-0.020	0.008	-2.660	0.008
number of adult females	-0.016	0.009	-1.810	0.070	-0.017	0.009	-1.900	0.058
oxen square	0.127	0.066	1.940	0.053	0.116	0.066	1.760	0.078
farm size square	-0.074	0.016	-4.670	0.000	-0.071	0.016	-4.470	0.000
_Iethye~1999	1.423	0.103	13.840	0.000	0.048	0.041	1.180	0.237
constant	0.153	0.433	0.350	0.725	0.050	0.059	0.840	0.403
Average oxen					0.001	0.001	1.130	0.258
Average farm size					-0.011	0.007	-1.630	0.103
Average livestock					-0.119	0.045	-2.630	0.008
average age					-0.018	0.048	-0.370	0.709
Average number of adult males					1.538	0.127	12.100	0.000
Average number of adult females					0.250	0.436	0.570	0.567

n	1637
Log likelihood function	-963.674
Wald Chi squared(8)[b]	105.74
Prob> Chi2	0.000

[a] *** indicates statistically significant at 1% level (or better).

[b] value in parenthesis stands for the degree of freedom.

Table 4: Multinomial Logit/GLLAMM estimates of the determinants of off-farm labor supply

Dependent Variable: Off-farm activity

	Agricultural labour			Daily labourer			food for work		
activity	Coef.	Std.	Err.	Coef.	Std.	Err.	Coef.	Std.	Err.
average annual rainfall	0.001	0.000	3.340	-0.002	0.000	-4.650	-0.001	0.001	-1.940
coefficient of variation of rainfall	-1.672	0.707	-2.370	3.625	0.764	4.750	-1.876	0.820	-2.290
neutral risk preference	0.626	0.229	2.730	0.507	0.256	1.980	0.558	0.306	1.830
slight risk preference	0.485	0.277	1.750	0.486	0.310	1.570	0.345	0.365	0.950
age of household head	0.019	0.008	2.360	0.003	0.009	0.350	0.020	0.010	1.920
gender of household head	-0.224	0.293	-0.760	0.197	0.314	0.630	-0.116	0.388	-0.300
literacy level of household head	0.020	0.228	0.090	-0.225	0.255	-0.880	-0.114	0.294	-0.390
number of oxen	0.196	0.128	1.530	0.183	0.135	1.360	-0.115	0.138	-0.840
number of adult males	0.322	0.216	1.490	-0.104	0.243	-0.430	0.560	0.280	2.000
number of adult females	-0.069	0.293	-0.240	-0.838	0.320	-2.610	0.260	0.374	0.690
Farm size	1.144	0.276	4.150	0.824	0.357	2.310	2.641	0.513	5.150
location	-1.514	0.136	-11.110	-0.625	0.144	-4.340	-2.349	0.400	-5.870
plot fertility	-0.065	0.042	-1.550	0.071	0.046	1.550	-0.128	0.059	-2.160
flat slope plot	0.804	0.545	1.480	-0.509	0.593	-0.860	0.932	0.668	1.390
moderate slope plot	0.851	0.550	1.550	-0.315	0.590	-0.530	1.919	0.646	2.970
plot distance	0.000	0.004	0.090	-0.003	0.004	-0.590	0.001	0.004	0.320
red plot	-0.222	0.395	-0.560	-0.342	0.443	-0.770	-1.301	0.539	-2.410
black plot	0.266	0.431	0.620	0.217	0.473	0.460	0.025	0.553	0.050
Number of livestock	0.100	0.043	2.320	0.101	0.043	2.340	0.102	0.043	2.350
number of adult males	-0.054	0.030	-1.780	0.005	0.035	0.160	-0.066	0.037	-1.790
number of adult females	-0.019	0.049	-0.380	0.084	0.053	1.590	-0.062	0.059	-1.060
oxen square	0.182	0.292	0.620	0.098	0.323	0.300	1.284	0.363	3.530
farm size square	-0.230	0.058	-3.980	-0.310	0.101	-3.080	-0.667	0.149	-4.480

Number of observations	
Number of off farm participants	1672
Log Likelihood	2474.83
Chi-square	0.0000
Pseudo R2	0.4598

[a] *** , **, and * indicate statistically significant at 1% , 5% and 10% levels respectively.
[b] value in parenthesis stands for the degree of freedom.