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Participation in Off-Farm Employment, Rainfall Patterns, and Rate of Time Preferences

The Case of Ethiopia

Mintewab Bezabih, Zenebe Gebreegziabher, Liyousew GrebreMedhin, and Gunner Köhlin

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Participation in Off-Farm Employment, Rainfall Patterns, and Rate of Time Preferences: The Case of Ethiopia

Mintewab Bezabih, Zenebe Gebreegziabher, Liyousew GebreMedhin, and Gunnar Köhlin

Abstract

Devoting time to off-farm activities, while complementing agricultural incomes, may be constrained by labor availability and financial capacity. This paper assesses the importance of rainfall patterns, which condition the availability of agricultural labor, and financial constraints on off-farm employment decisions. Using panel data from Ethiopia, which include experimental rate-of-time preference measures, we found that these and rainfall are significant determinants off-farm employment. Rural development policies should take into account the financial capacity of households and the role of off-farm opportunities as safety nets in the face of weather uncertainty.

Key Words: off-farm employment, rainfall variability, reduced availability of water, rate-of time-preferences, multinomial logit, Ethiopia

JEL Classification: Q13, D81, C35, C93

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Introduction

In very poor countries that have a 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 generally been positively correlated with farm income (Haggblade and Hazell 1989; Hazell et al. 1991; Chikwama 2004), and non-farm activities show a positive, broader role in poverty reduction, total household income, and household wealth (Reardon 1998; Lanjouw and Lanjouw 2001; Davis 2003; Barrett et al. 2001).

Because participation in off-farm activities is dependent on family labor, which is also used for on-farm activities, the complementary nature of off-farm employment to farm employment is likely to depend on agricultural conditions. In the face of acute weather variability, off-farm activities could become attractive adaptation options to agricultural activities.

Although rural households tend to turn to off-farm activities to meet their needs and offset income shortfalls, participation appears to be constrained by capital assets—human, social, financial, and physical. In their study of off-farm employment participation in Honduras, Ruben and van den Berg (2001) showed that educated and wealthier households take advantage of their human and physical capital by participating more in off-farm activities. In addition, in their study of off-farm employment in Columbia, Deininger and Olinto (2001) showed that investment in a single income source is the most beneficial to capital-constrained households with limited

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education and other human capital. The limitations from access to credit and lack of education are also highlighted by Escobal's (2001) study of income diversification in Peru.

Because off-farm employment may be dependent on a household's assets, it can be seen as an investment by households, and their financial conditions may play a role in their decision to engage in off-farm activities. While off-farm employment can be an opportunity to cope with anticipated risks, the requirements to invest in it may be beyond the reach of poorer households, who will not necessarily opt for it. Indeed, financial constraints affect whether people can maintain assets and endowments, how these assets are transformed into income via activities, and how these incomes and earnings are translated into broader development outcomes, such as health and nutrition. Market discount rates may be able capture such financial constraints to the extent that individuals have full access to financial resources in the credit market. However, with notoriously imperfect rural credit markets, subjective discount rates are likely to be far greater than market interest rates and more accurate predictors of financial constraints (Yesuf 2004; Pender 1996; Holden et al. 1998).

While the impact of rainfall patterns on off-farm employment has been previously assessed by a few studies (e.g., Bezu et al. 2009; Nidhiya 2009), to our knowledge, there are no studies that combine covariate risks associated with rainfall and individual discount rates in the assessment of participation in off-farm employment. Our analysis is based on the premise that participation in off-farm employment is driven by the availability or variability of rainfall and financial constraints of households, among other factors. Accordingly, we investigated 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 analyzed the link between participation in off-farm employment and financial constraints, as measured by rate-of-time preferences or individual discount rates.

The rest of the paper is organized as follows. In section 2, we briefly review the literature on participation in non-farm activities. Section 3 provides the theoretical framework and model specification. Section 4 discusses the survey and data used. Section 5 presents a discussion of our results, and section 6 concludes with a summary of the findings of the study with some policy implications.

1. Background: Rainfall, Poverty, and Risk in Ethiopia

Ethiopia has a population greater than 72 million, two-thirds of whom live on less than US$ 2 a day (World Bank 2008a). It is one of the most food-insecure countries in the world, as

manifested by chronic hunger and famine. Ethiopia is also known for its ultra-agriculture-dependent economy—about 74 percent of its citizens derive their livelihoods from agriculture—which is entirely dependent on rainfall. Of the 4.3 million hectares of potential irrigable agricultural land, only 5 percent is currently farmed and smallholder farmers dominate the sector, cultivating about 95 percent (Adenew 2006).

With agriculture so completely dependent on rainfall, rain rules the lives and well-being of many rural Ethiopians. It determines whether they will have enough to eat and whether they will be able to provide basic necessities and earn a living. Indeed, the dependence on rainfall and its erratic pattern has largely contributed to the food shortages and crop 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).

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 circumstances, not only will the farmers and their families go hungry, but they also will be forced to sell or consume their plough animals in order to survive. They are then significantly worse off than before because they can no longer farm effectively when the rains return. These impacts may last for years in the form of diminished productive capacity and weakened livelihoods.

Indirect impacts are equally serious. People tend to be excessively risk-averse when faced with the threat of possible weather shock. They also tend to shy away from innovations that could increase productivity because these innovations may also increase their vulnerability or drain the assets needed to survive a crisis. Moreover, farmers face credit constraints if creditors are not willing to lend for fear that drought might result in widespread defaults—even if loans can be paid back easily most years. This, in turn, critically restricts access to agricultural inputs and technologies, such as improved seeds and fertilizers.

The threat of 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 2008b). These cycles of drought create poverty traps for many households, constantly consuming any build up of assets and increase in 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 suggests that these shocks are a major cause of transient poverty. That is, had Ethiopian households been able to smooth consumption, then poverty in 2004 would have been at least 14 percent lower, which translates into 11 million fewer people falling below the poverty line.

To address the food security problems, the Ethiopian government has designed and implemented different interventions to improve agricultural productivity, such as irrigation schemes, fertilizer promotion, soil and water conservation, extension services, 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 as sources of alternative income may be of paramount importance for people's livelihoods in the face of climate change, particularly in drought-prone areas and the degraded northern Ethiopian highlands (e.g., Devereux 1995; von Braun 1995; Clay et al. 1999, Jalan and Ravallion 2001; Hagos 2003).

2. A Literature Review of Participation in Non-farm Activities

Over the last two decades, the nonfarm economy has increasingly become the central focus of attention in rural development policy, due to its positive contribution to poverty reduction and food security (Reardon 1998; Ellis 1998; Lanjouw and Lanjouw 2001; Davis 2003). Participation in nonfarm activities is one of the livelihood strategies among poor rural households in many developing countries (Mduma and Wobst 2005). Empirical research has shown that nonfarm sources contribute 40–50 percent to average rural household incomes across the developing world (World Bank 2008a). In Ethiopia, according to Davis (2003) and Deininger et al. (2003), some 20 percent of rural income originates from nonfarm sources. In some parts of Ethiopia, off-farm or nonfarm labor income accounts for up to 35 percent of total farm household income (Woldehanna 2000).

The rural nonfarm 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 nonfarm activity typically correlates positively 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* nonfarm opportunities can be seized by the rural poor. However, this key finding appears to be a double-edged sword. The positive wealth–nonfarm 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 nonfarm activities that are capable of lifting them from poverty (ibid.).

Decisions by rural households concerning involvement in nonfarm 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 nonfarm 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 nonfarm sector by a lack of on-farm opportunities, for example, resulting from drought or small size of land holdings (Davis 2003).

One of the components of rural nonfarm 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 in nonfarm activities and the choice of activity, as well as the extent of rural household participation. 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 nonfarm employment. They found education, gender, and land holding to be the most important determinants of activity choice.

In sum, involvement in rural nonfarm 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 nonfarm 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 nonfarm activities. For example, some might be attracted by the incentives offered and labor availability (when households have more than enough laborers for their farm), whereas others might be pushed into the nonfarm sector due to a lack of opportunities on the farm (for example, from drought or insufficient 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.

3. Estimation Methods and Empirical Strategy

The main objective of the empirical analysis is to assess the impacts of rainfall patterns and financial constraints on participation in off-farm employment and activity choice. The pattern of rainfall is crucial because the majority of farmers are land owners[1] in Ethiopia, and labor supply and participation in off-farm employment is dependent on the agricultural conditions. Similarly, financial constraints, measured in terms of rate-of-time preferences, are important determinants of participation in off-farm employment, due to the human and physical capital required for participation in off-farm employment. In addition to participation, our analysis also explores the impact of rainfall and rate-of-time preferences on the choice between different kinds of activities both on- and off-farm.

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

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

$$S_{it} = \begin{cases} 1 \, if \;\; \alpha + \psi X_{it} + \lambda Z_{it} + \gamma R_{it} + \xi_{it} \succ 0 \\ 0 \, otherwise \end{cases} \quad , \tag{1}$$

where, for individual *i* and time *t*, S_{it} is a dichotomous variable indicating whether or not a household engages in off-farm employment;[2] Z_{it} is a measure of household socioeconomic and farm characteristics; X_{it} is a measure representing climatic factors, such as rainfall; R_i stands for the rate-of-time 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 rate of time preference variables; and ξ_i is a household-specific random error term.

[1] While land rentals form significant sources of farm land in Ethiopia, the egalitariain land redistribution system in place ensured that almost all farmers operate (at least a portion of) their own farm. This implies that off farm employment activities need to be balanced with agricultural activities.

[2] It should be noted that it is members of a household who engage in off-farm employment (as opposed to the household as a whole). However, since there were not many observations with multiple members within a housheold engaging in off-farm employment, and since household characteristics are likely to affect such decisions, the analysis was carried out at the household level.

3.2 Estimation of Rural Activity Choice

Our empirical model is based on random utility theory, where at time *t*, individuals *i* who report in the questionnaire that a member of their household has participated in on-farm or off-farm employment are assumed to choose the alternative *j* with the highest utility. Individuals choose between four alternatives: agricultural work, daily labor (agricultural work on other people's farms), food for work, and other off-farm work (including permanent off-farm employment):

$$U_{ijt} = \beta_j X_{it} + v_{ijt} \quad , \tag{2}$$

where X_{jt} denotes individual characteristics, β_j denotes a vector of coefficients specific to state *j*, and v_{ijt} is a random error term. The assumption here is that the decision whether or not to engage in an off-farm activity at all, and the choice of which type to engage in, is taken simultaneously; thus they are close substitutes. This implies that the decision to participate in off-farm employment is also influenced by the expected utility of off-farm participation from each alternative. So, if the expected cost of leaving farm activities is greater than the benefit from any of the off-farm activities, then the household might choose only agricultural activities on its own farm. The probability of choosing a treatment alternative $j \in J, P_{ijt}$ is therefore:

$$P_{ijt} = \frac{\exp(\beta_j X_{it})}{\sum_{k=0}^{j} \exp(\beta_k X_{it})} . \tag{3}$$

Let P_{ijt} denote the probability that state *j* is chosen. With the assumption that the v_{ijt} terms are independently and identically distributed with the type I extreme-value distribution, equation (3) follows a multinomial logit specification.

Estimation of equation (2) needs to take into account an additional outstanding estimation issue of the possible existence of unobserved farm-level heterogeneity, which can be seen by rewriting the error term in equation (2) as:

$$v_{it} = \alpha_i + u_{it} \quad .$$

This is composed of a normally distributed random error term, $u_{ij} \sim$ n(0, σ_u^2), and an unobserved household specific effects, α_i. In the case of the violation of the assumption underlying the random effects specification that $E(p_{ijt} \mid X_{it} = 0)$, Mundlak (1978) suggested explicitly modeling the relationship between time-varying regressors X_{it} and the unobservable effect α_i in an

auxiliary regression, such that unobserved heterogeneity could be controlled for by adding the means of time-varying observed covariates. This approach is commonly known as the pseudo fixed effects or the Mundlak-Chamberlain random effects model.

4. Survey and Data Description

Data used in this analysis were taken from a survey of households in the central highlands of Ethiopia, conducted in the years 2005 and 2007. Approximately 1,500 farm households in 12 villages, located in 2 districts of the Amhara Regional State of Ethiopia, were randomly selected and interviewed in each of the years. The primary focus of this survey was to understand production, consumption, labor, input use, and soil and water conservation and use activities. In addition, the survey consisted of hypothetical rate-of-time preference questions aimed at eliciting discount rate measures. We combined data from this survey with rainfall data from the Ethiopian Meteorology Service Agency collected at the local meteorological stations. Rainfall values were assigned to each village using measurements taken from the stations closest to the villages.

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.

The rate-of-time preference for each household was calculated from the hypothetical rate-of-time preference experiment information in our survey. The questions were set up as choice experiment questions about a hypothetical sum of money given to respondents at the time of the survey or 12 months from the date of the survey.[3]

The other important set of explanatory variables, rainfall abundance and variability, were calculated by using monthly rainfall measures as point values. Accordingly, the total annual rainfall is the sum of the monthly observations. The coefficient of variation is computed as the ratio of the mean over the 12 months to the corresponding variance. Because rainfall variables

[3] Seven categories from six sets of choices were constructed, each representing the rate-of-time preference or the discount rates of the respondents.

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, access to inputs and technology, and agro-ecological variations.

The additional independent variables that were included in the regressions are socioeconomic and physical farm characteristics of the household. Specifically, we considered age, gender of the household head, and whether the household head is able to read and write as important measures of demographic characteristics. We also included livestock ownership (converted into the number of tropical livestock units) as a proxy for wealth. Oxen ownership and the number of male and female adults per household were also used as indicators of draught animal and human labor availability, respectively. Measures of physical farm characteristics included were share of flat plots, plots with fertile and black soil, average plot distance from homestead, average plot size, and total land farmed.

Since many of the job characteristic measures were not uniform across different off-farm activity options, except for job location, we opted to use this variable as the only job characteristic measure. 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. 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 (activity choice)	Off-farm activity (1 = daily laborer; 2 = food for work; 3 = permanent or other off-farm activities)
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)
Education of the 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
Farm size	Total farm size (in hectares)
Average number of fertile plots	Fertile plot (1 = fertile; 0 = otherwise)

Average number of flat slope plots	Flat plot (1 = flat; 0 = otherwise)
Average number of black plots	Black plot (1 = black; 0 = otherwise)
Time preference category 1	A dummy variable indicating a household belongs to the lowest rate of time preference category
Time preference category 2	A dummy variable indicating a household belongs to the second lowest rate of time preference category
Time preference category 3	A dummy variable indicating a household belongs to the third lowest rate of time preference category
Time preference category 4	A dummy variable indicating a household belongs to the fourth lowest rate of time preference category

A *woreda* is an administrative unit of local government in Ethiopia, similar to a district. Woredas are made up of a number of *kebele*, which are similar to neighborhood associations or small groups of like individuals or households.

Table 2. Descriptive Statistics of the Variables Used in the Regression

Variables	**2005**		**2007**	
	Mean	**Std. dev.**	**Mean**	**Std. dev.**
Off-farm participation	0.558	0.497	0.685	0.465
Daily laborer	0.589	0.819	0.711	0.559
Food for work	0.210		0.152	
Permanent and other off-farm activities	0.211		0.137	
Annual rainfall	1,040.868	219.033	1,503.570	172.96
Coefficient of variation of rainfall	1.180	0.147	1.196	0.098
Age of household head	50.573	15.649	51.226	14.960
Gender of the household head	0.159	0.366	0.191	0.393
Household head able to read	0.075	0.263	0.056	0.231
Household head able to write	0.333	0.471	0.361	0.480
Household head illiterate	0.569	0.499	0.485	0.495
Number of oxen	1.501	1.551	2.001	0.053
Adult male labor	3.129	1.666	1.860	0.981
Adult female labor	2.953	1.440	1.642	0.845
Farm size	1.506	0.941	1.655	1.092
Avg. number of fertile plots	2.011	2.073	2.771	2.476
Avg. number of flat slope plot	0.673	0.352	0.712	0.288
Avg. number of moderately sloped plot	0.320	0.355	0.227	0.268
Avg. plot distance from homestead	16.214	15.895	18.047	13.486
Avg. number of black plots	0.431	0.357	0.457	0.361
Avg. number of red plots	0.381	0.346	0.356	0.329

Number of livestock squared	4.154	3.134	4.258	3.223
Adult male labor squared	12.563	12.841	4.423	4.724
Adult female labor squared	10.793	10.489	3.410	3.860
Number of oxen squared	0.626	0.484	0.123	0.329
Time preference category 1	0.045	0.207	0.170	0.376
Time preference category 2	0.056	0.230	0.044	0.205
Time preference category 3	0.073	0.260	0.001	0.024
Time preference category 4	0.091	0.287	0.003	0.053

5. Discussion of Results

We estimated a binomial logit model to assess the determinants of participation in off-farm employment. For the activity choice between alternative employments in agriculture and the three variants of non-farm employment (daily labor, food for work, and permanent off-farm employment), a multinomial logit model was estimated. Each of the binomial and multinomial logit models was estimated using random and pseudo-fixed effects specifications (table 3).

Table 3. Binomial and Multinomial Logit Estimates of the determinants of Off-Farm Employment and Activity Choice

Variable	Binomial logit estimates	Activity choice: Multinomial logit estimates		
	Off–farm participation	***Daily laborer***	***Food for work***	***Permanent off-farm employment***
Annual rainfall	-0.003*** (0.000)	-0.002*** (0.000)	-0.003*** (0.001)	-0.005*** (0.001)
Coefficient of variation of rainfall	1.220** (0.468)	0.155 (0.521)	15.295*** (1.444)	-2.957** (0.944)
Rate of time preference 1	0.395* (0.166)	0.441** (0.168)	-0.956 (0.527)	-0.122 (0.487)
Rate of time preference 2	-0.295 (0.204)	-0.327 (0.217)	-0.13 (0.412)	-0.127 (0.429)
Rate of time preference 3	-0.603* (0.252)	-0.768** (0.295)	-0.465 (0.535)	-0.785 (0.459)

Rate of time preference 4	0.248 (0.223)	0.095 (0.245)	0.118 (0.489)	0.57 (0.327)
Age of household head	-0.023*** (0.003)	-0.025*** (0.004)	-0.025*** (0.007)	-0.015* (0.008)
Household head able to write	0.081 (0.150)	0.082 (0.161)	0.672** (0.239)	-0.771 (0.397)
Gender of the household head	-0.026 (0.108)	-0.033 (0.113)	0.016 (0.204)	-0.198 (0.236)
Number of oxen	0.091 (0.059)	0.1 (0.064)	0.327* (0.140)	-0.095 (0.112)
Adult male labor	0.367*** (0.106)	0.360** (0.115)	0.152 (0.205)	0.695** (0.246)
Adult female labor	0.313* (0.124)	0.298* (0.131)	0.128 (0.292)	0.445 (0.281)
Farm size	0.289 (0.161)	0.505** (0.171)	0.07 (0.356)	-0.091 (0.363)
Avg. number of fertile plots	0.100*** (0.023)	0.096*** (0.024)	0.146*** (0.036)	0.023 (0.056)
Avg. number of flat slope plot	0.978*** (0.246)	1.002*** (0.263)	0.696 (0.508)	0.607 (0.487)
Avg. number of moderately sloped plot	0.762** (0.234)	0.657** (0.250)	0.738 (0.504)	1.074* (0.440)
Avg. plot distance from homestead	-0.004 (0.003)	-0.003 (0.003)	-0.008 (0.006)	0 (0.006)
Avg. number of black plots	-0.348 (0.209)	-0.403 (0.221)	-0.078 (0.366)	-0.929* (0.469)
Avg. number of red plots	-0.099 (0.218)	-0.189 (0.230)	0.164 (0.364)	-0.102 (0.454)
Number of livestock squared	0.013 (0.019)	0.019 (0.020)	-0.034 (0.040)	-0.049 (0.053)
Adult male labor squared	-0.043** (0.015)	-0.044** (0.017)	-0.002 (0.033)	-0.079* (0.031)
Adult female labor squared	-0.035 (0.019)	-0.032 (0.020)	-0.006 (0.053)	-0.058 (0.040)
Number of oxen squared	0.17 (0.124)	0.017 (0.131)	0.297 (0.230)	1.101*** (0.270)
Farm size squared	-0.076* (0.033)	-0.113** (0.035)	-0.132 (0.096)	0.018 (0.071)

Ethyear = 1999	2.393*** (0.206)	2.195*** (0.209)	4.011*** (0.480)	1.023* (0.490)
Constant	0.1 (0.835)	0.341 (0.884)	-19.643*** (2.180)	5.953*** (1.803)
Number of observations	2411	2411	2411	2411
Pseudo R2	0.1321	0.2090	0.2090	0.2090
Log likelihood	-1354.9286	-2104.675	-2104.6757	-2104.6757
Chi square	412.45	1111.91	1111.91	1111.91

*** , **, and * indicate statistically significant at 1% , 5% and 10% levels respectively.

Values in parentheses are standard errors.

The first column in table 3 presents the regression results for off-farm participation. Of the rainfall variables, annual total rainfall had an inverse impact on off-farm participation, implying that abundant rainfall increases the demand for farm activities. Similarly, 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 as a way of mitigating possible agricultural income risk. 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 farmers' rate-of-time preferences on the decision to participate in off-farm activities showed that lower rate-of-time preferences significantly and positively increase participation. This indicates that, overall, financial constraints have a negative impact on the decision to participate in off-farm employment.

Older household heads are less likely to participate in off-farm activities, while gender and education do not have significant impact on participation in off-farm activities. The results also suggest that households with greater numbers of male and female household members participate more in off-farm activities than other households. This could be due to the fact that participation in off-farm activities is critically dependent on labor availability. Among other household characteristics, ownership of livestock also has a significant and positive on participation in off-farm activities, indicating that wealth enhances the tendency to engage in off-farm activities. Plot characteristics with favorable attributes, such as fertility and flat plots, tend to increase off-farm participation. Participation is negatively and significantly affected by the squares of male and female labor, implying that households with too few or too many laborers 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 activities. This indicates the presence of non-linearity corresponding to the household characteristics in their effect on off-farm participation.

The second, third, and fourth columns in table 3 report the rural employment activity choice of households using a multinomial logit model. The four employment activities that were considered in the analysis include on-farm (agricultural) employment, daily labor, food-for work, and permanent and other forms of off-farm employment. The first category agricultural employment was used as a base case. Overall, factors, such as location, number of oxen and livestock, and weather conditions, turned out to be the 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 rate-of-time preferences on activity choice was significant overall. Surprisingly, however, the lowest rate-of-time preference was significant in the daily labor and food-for-work categories, implying that financial constraints are important in these particular categories. In addition, annual rainfall was also uniformly negative and significant across the off-farm activities. This indicates that nonfarm activities tend to be pursued in distinctly drier conditions. The impact of the coefficient of variation of rainfall was far less uniform. In the case of food for work, coefficient of variation had a positive impact, indicating that uncertain rainfall conditions encourage off-farm work. This result was also consistent with the design of food-for-work programs in Ethiopia. The impact of rainfall on the likelihood of choosing permanent off-farm employment was positive, although it was insignificant in the daily labor activity choice of households.

The coefficients of farm size are significant at 0.05 percent and more for the different off-farm categories. While the positive impact of farm size on off-farm employment was puzzling (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 of a portion of their incomes as start-up costs of off-farm employment. The impact of oxen ownership had positive impact on food-for-work employment, while it had no impact on the other categories. The significance of the physical farm variables, fertility, and slope were generally small in magnitude and mostly insignificant.

The impact of gender and age of household head also did not have significant impact on choice of activities. While households with higher male members of the household are more likely to participate in all the categories of off-farm activities, households with more female

members of the household are more likely to have higher participation in the off-farm category. Older household heads tended to be good matches for agricultural labor jobs, while age was not significant in the other job categories. The results from the alternative pseudo fixed effects estimation are presented in appendix 1; they are similar to the standard multinomial logit results in table 3, with slight differences in the magnitudes of the coefficients.

6. Conclusions and Policy Implications

Growing weather uncertainty, particularly in a predominantly agricultural economy like Ethiopia, requires understanding alternative—and accessible—coping mechanisms that enable the smoothing out of incomes and consumption by complementing varying agricultural incomes. This paper investigates the likely impact of weather shock, as measured by availability and variability of rainfall, and rate-of-time preference, on the participation of households in off-farm activities. Our basic premise is 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. Because participation in off-farm activities might be constrained by capital assets (human, social, financial, and physical), households' rate-of-time preferences could be additional crucial determinants of off-farm employment activities.

The analysis starts out by assessing the decision to participate in (any) off-farm activity or not, using a binomial logit model. This is followed by estimation of the activity choice model that includes three off-farm categories, in addition to the agricultural labor category. The estimation results are based on multinomial logit specification and its pseudo fixed effects variants; the results are only marginally different from each other.

In general, the rainfall variables support the hypothesis that rainfall availability increases agricultural activities leading to lower participation, while rainfall variability leads to increased off-farm participation. The results confirmed that households use off-farm employment as a coping mechanism for weather shocks. In addition, we also found that the off-farm activity choice of households is also influenced by climatic factors or weather conditions. Increases in rainfall variability encourage off-farm employment. Increased availability of male and female labor (households have more than enough laborers for the home farm) raised the tendency to engage in off-farm activities, indicating the importance of labor constraints. An important implication of our findings is that off-farm employment can be regarded as a feasible option as a mechanism against weather uncertainty.

In addition, the effect of rate-of-time preferences of farmers on the decision to participate in off-farm activities shows that lower rate-of-time preferences significantly and positively increase participation. This indicates that, overall, financial constraints have a negative impact on the decision to participate in off-farm employment.

The results have important implications for rural policy making. The role of rate of time preferences, and by implication, financial constraints and financial capacity of households in taking up off farm employment underlies the importance of rural credit schemes in expanding non agricultural rural activities. Hence, the study emphasizes that easing capital constraints in rural developing countries not only has the conventional benefits of improving adoption of agricultural technologies, but also assists households in expanding their income opportunities beyond agriculture. In addition, the fact that off farm employment is positively related to rainfall variability emphasizes and the role of off-farm opportunities as safety nets. Accordingly, in the face of increasing weather uncertainty, off farm employment opportunities need to become integral parts of rural development policy design.

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Appendix

Appendix 1. Binomial and Multinomial logit estimates of the determinants of off-farm employment and activity choice (pseudo fixed effects estimation)

	Binomial logit estimates	**Activity Choice: multinomial logit estimates**		
	Off –farm participation	***Daily laborer***	***Food for work***	***Permanent off farm employment***
Annual rainfall	-0.003***	-0.002***	-0.003***	-0.005***
	(0.000)	(0.000)	(0.001)	(0.001)
Coefficient of variation of rainfall	1.270**	0.225	14.836***	-3.050**
	(0.473)	(0.525)	(1.433)	(0.951)
Rate of time preference 1	0.367*	0.417*	-1.041	-0.171
	(0.167)	(0.169)	(0.532)	(0.498)
Rate of time preference 2	-0.335	-0.365	-0.194	-0.173
	(0.206)	(0.219)	(0.424)	(0.436)
Rate of time preference 3	-0.586*	-0.746*	-0.563	-0.76
	(0.254)	(0.298)	(0.552)	(0.467)
Rate of time preference 4	0.204	0.054	-0.03	0.552
	(0.224)	(0.246)	(0.500)	(0.329)
Age of household head	0.005	0	0.016	0.014
	(0.013)	(0.014)	(0.022)	(0.025)
Education of household head	0.126	0.126	0.738**	-0.814*
	(0.153)	(0.164)	(0.247)	(0.402)
Gender of household head	0.245	0.221	0.103	0.495
	(0.218)	(0.229)	(0.404)	(0.468)
Number of oxen	0.123	0.126	0.344*	0.383
	(0.083)	(0.088)	(0.169)	(0.312)
Adult male labor	0.666***	0.679***	0.477	0.593
	(0.136)	(0.145)	(0.246)	(0.316)
Adult female labor	0.274	0.253	0.017	0.28
	(0.149)	(0.158)	(0.331)	(0.322)
Farm size	0.193	0.325	0.712	-0.228
	(0.187)	(0.196)	(0.410)	(0.437)
Avg. number of fertile plots	0.104***	0.098***	0.157***	0.023
	(0.023)	(0.025)	(0.037)	(0.056)
Avg. number of flat slope plot	0.975***	0.993***	0.741	0.592
	(0.248)	(0.265)	(0.516)	(0.489)
Avg. number of moderately sloped plot	0.790***	0.672**	0.846	1.040*
	(0.236)	(0.253)	(0.511)	(0.444)

Avg. plot distance from homestead	-0.004	-0.003	-0.008	0
	(0.003)	(0.004)	(0.006)	(0.006)
Avg. number of black plots	-0.366	-0.427	-0.084	-0.975*
	(0.210)	(0.222)	(0.369)	(0.471)
Avg. number of red plots	-0.09	-0.178	0.236	-0.137
	(0.220)	(0.232)	(0.366)	(0.458)
Number of livestock squared	-0.066	-0.054	-0.142	-0.119
	(0.036)	(0.038)	(0.082)	(0.070)
Adult male labor squared	-0.054***	-0.058***	-0.009	-0.079*
	(0.016)	(0.017)	(0.030)	(0.032)
Adult female labor squared	-0.033	-0.029	-0.002	-0.053
	(0.019)	(0.020)	(0.053)	(0.040)
Number of oxen squared	0.099	-0.045	0.284	1.032***
	(0.126)	(0.132)	(0.233)	(0.277)
Farm size squared	-0.070*	-0.105**	-0.124	0.015
	(0.034)	(0.036)	(0.092)	(0.073)
Number of oxen (avg.)	-0.065	-0.073	0.078	-1.016
	(0.124)	(0.127)	(0.201)	(0.594)
Farm size (avg.)	0.107	0.222	-1.100***	0.188
	(0.119)	(0.123)	(0.309)	(0.276)
Number of livestock (avg.)	0.153**	0.137*	0.218	0.155
	(0.055)	(0.058)	(0.125)	(0.103)
Adult male labor (avg.)	-0.311***	-0.329***	-0.334*	0.131
	(0.086)	(0.089)	(0.155)	(0.231)
Adult female labor (avg.)	0.03	0.028	0.124	0.173
	(0.090)	(0.093)	(0.156)	(0.232)
Education of household head (avg.)	-0.38	-0.346	-0.162	-0.96
	(0.249)	(0.262)	(0.460)	(0.551)
Ethyear = 1999	2.659***	2.484***	4.193***	0.686
	(0.248)	(0.255)	(0.538)	(0.607)
Constant	0.263	0.483	-18.834***	7.623***
	(0.847)	(0.896)	(2.180)	(1.962)
Number of observations	2411	2411	2411	2411
Pseudo R2	0.1321	0.2090	0.2090	0.2090
Log likelihood	-1354.9286	-2104.675	-2104.6757	-2104.6757
Chi square	412.45	1111.91	1111.91	1111.91