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Weather Risk and Household Participation in Off-farm Activities in Rural Ethiopia

Abera Birhanu Demeke and Manfred Zeller

University of Hohenheim, Stuttgart, Germany

Abstract

This study examines the effects of weather shock on households' decision to engage in different types of off-farm work in rural Ethiopia. A multinomial logit model is applied to household data collected in 1999 and 2004. The regression results show that the level and variability of rainfall has a significant effect on the decision by households to engage in any type of off-farm work. The probability of a household deciding to participate in low-return, off-farm activities increases with lower levels and higher variability of rainfall, suggesting that households engage in those activities as a strategy for coping with adverse weather shock. Contrary to this, we find that participation in high-return activities increases with the level of rainfall and tends to decrease with rainfall variability, suggesting a strong correlation between off-farm activities and agricultural production.

Keywords: off-farm participation, rainfall risk, coping, Ethiopia, multinomial logit

JEL: J22, Q12

1 Introduction

Agricultural production in Ethiopia, as in many developing countries, is subsistence oriented and highly dependent on the mercy of the elements of nature. More so than in the developed world, farmers are vulnerable to different forms of risks (weather variability, pests and diseases, among others) and their production is subject to larger fluctuations. Very often, in rural settings, the markets for formal insurance, credit and other agricultural services function poorly or are non-existent (MORDUCH, 1995). Households have fewer options to cope with shocks and as a result their livelihood is vulnerable. A considerable body of research shows that rural households in developing countries try to minimize their risk exposure through crop diversification (JUST and CANDLER, 1985; DERCON, 1996), use of credit markets (ESWARAN and KOTWAL 1989; UDRY 1995), asset diversification (ROSENZWEIG and BINSWANGER, 1993; CARTER and MAY, 1999), non-agricultural income diversification (ITO and KUROSAKI, 2006; KOCHAR, 1999; ROSE, 2001; DAVIS et al., 2010) and other mechanisms.

In this paper, we focus on the labour supply response of households. Specifically, we look into whether farm households participate in extra activities away from their farm as a response to weather risk. Several authors have investigated the role of household labour market participation in coping with production risks in developing countries. For instance, KOCHAR (1999), in a study of villages in rural India, reports the responsiveness of the earnings from day labour to household-specific production shocks. The study finds that male household members increase their hours of market work, and thus earnings, in response to unexpected fluctuations in crop profits. Research by ROSE (2001) in India indicates the strong relationship between risk and labour markets. The paper concludes that Indian farmers facing drastic rainfall shocks allocate less labour to risky own-farm production and more to alternative, less risky off-farm activity in the labour market. More recent work by KIJIMA et al. (2006) in rural Uganda shows households tend to increase their low skilled labour supply in response to negative agricultural shocks so as to compensate for declines in agricultural income. In Kenya, MATHENGE (2008) reports farm households participate in off-farm work in response to weather risks. KEIL et al. (2007) identify off-farm employment as a major coping strategy of Indonesian rural households affected by drought. The role of off-farm income as an adaptation strategy to climate change is also investigated by DERESSA et al. (2009) in Ethiopia. HAILE et al. (2008) indicate in the northern Ethiopian region of Tigray, limited and variable rainfall increases the probability of household off-farm labour supply. They concluded that off-farm labour supply is indeed an income smoothing strategy which households use to adapt to rainfall abnormality. Other studies in India have also provided evidence that Indian households that face greater volatility in farm production and profits use off-farm labour supply to mitigate the adverse effects of shocks (ROSENZWEIG and STARK, 1989; LAMB, 2001). BABATUNDE and QAIM (2010) find that off-farm income has a positive net effect on food security and nutrition. The prevalence of child stunting, underweight, and wasting was found to be lower in households with off-farm income than in households without (BABATUNDE and QAIM, 2010).

With the background of the aforementioned studies, this paper examines the effects of weather shock on households' participation decision in off-farm activities in rural Ethiopia. Even though several studies have been done on the determinants of participation in off-farm employment activities in Ethiopia, there is little empirical work available that specifically investigates the relationship between weather risk and households' decision to do off-farm work. Moreover, many of the existing studies do not account for the variation between the different forms of off-farm activities; most analyse a range of off-farm activities together as a group, masking many differences between them. In most cases the data used is region- or village-specific which limits their broader applicability. Given these limitations of past research, this study attempts to highlight the role of weather shock in rural households' decisions to participate in

different off-farm activities and to model them using representative household level data that covers a wide range of Ethiopian agroecosystems. This study helps policy makers design relevant interventions to help households in coping with risk.

The paper is structured as follows: section 2 provides data used in the study and describes the characteristics of sample households, section 3 and 4 describe the theoretical and empirical models, respectively. Section 5 presents empirical results and section 6 summarizes important findings and provides recommendations.

2 Data and Households Characteristics

The data for the empirical analysis is drawn from the Ethiopian Rural Household Survey (ERHS), which provides a longitudinal data conducted in six rounds from 1994 to 2004 by the Department of Economics of Addis Ababa University in collaboration with International Food Policy Research Institute (IFPRI) and the Centre for the Study of African Economies of University of Oxford. The dataset consists of around 1477 households, in four major regions and 15 rural Ethiopian villages or Peasant Associations¹ (PAs). The selected villages are intended to represent the diverse farming systems and cultural settings of Ethiopia, not including pastoral areas (DERCON and HODDINOTT, 2004). For the current study we used the fifth and sixth rounds of the ERHS data which were conducted in 1994 and 2004, respectively. We chose these rounds because they are the most recent and their surveys were conducted in approximately the same months (MANI et al., 2010). Moreover, between these years Ethiopia experienced a severe drought (in 2002/03) which resulted in a widespread, disastrous impact on household welfare (WORLD BANK, 2007). The study's villages are characterized by heavy dependence on rainfed agricultural production. Mean annual rainfall varies from 1417 mm in Adado (southern region) to less than 600 mm in Geblen and Haresaw (Tigray region). The topography of the sites is rugged and their elevation ranges from 1200 m to 2900 m. Table 1 shows major characteristics of the different survey sites.

With regard to the sampling procedure, prior to sampling, the numbered list of households in each PA was fixed in close consultation with the *Woreda*² officials. Based on this frame, households were randomly selected and structured questionnaires were completed. The data provides information on wide-ranging issues such as agricultural production, food consumption and expenditure, shocks, assets, technology adoption, off-farm employment, and personal and demographic characteristics of households.

¹ PA is the smallest unit of local government in Ethiopia. One or more villages are collected together to form a PA.

² *Woreda* is an administrative division composed of a number of PAs

Table 1. Characteristics of the study areas

Survey site	Location	Wealth	Technology	Main crops	Mean rainfall (mm)	Nearest town in (km)	Average land holding (ha)	Remarks
Addado	Sidamo (Dilla)	Mixed	Hoe, a few ox ploughs	Coffee, 'enset'	1,417	11	0.67	Densely populated
Adele keke	Hararghe	Rich	Ox plough, irrigation	Millet, maize, coffee, 'chat'	748	13	1.1	Highland
Aze Deboa	Shoa (Kembata)	Mixed; migration dependent	Hoe, ox plough	'Enset' coffee, maize, 'teff', sorghum	1,509	4.5	0.83	Densely populated
Debre Berhan	N. Shoa	Usually self-supporting	Ox plough	'Teff', barley, beans	919	10	2	Highland, near town
Dinki	N. Shoa	Vulnerable	Ox plough, irrigation	Millet, 'teff'	1,664	10	1.25	Not easily accessible
Doma	Gamo Gofa	Vulnerable	Irrigation, ox plough	'Enset', maize	1,150	3.5	1.24	Resettlement area
Gara Godo	Sidamo (Wolayta)	Vulnerable	Ox plough, axe, spade	Barley, 'enset'	1,245	13	0.5	
Geblen	Tigray	Vulnerable	Ox plough, water/soil conservation techniques	Cereals	504	18	0.25	Formerly wealthy
Haresaw	Tigray	Vulnerable	Ox plough	Cereals	558	17	1.8	Densely populated
Imdibir	Shoa (Gurage)	Migration dependent	Hoe, rare ploughing	'Enset', 'chat', coffee, maize	2,205	1	0.75	
Korodegaga	Arsi	Vulnerable	Ox plough	Cereals	874	25	4.8	Close to rich valley
Shumsha	S. Wollo	Vulnerable	Ox plough	Cereals	654	12	1.5	Near airport
Sirbana Godeti	Shoa	Rich	Ox plough, tractors, solar pump	'Teff'	672	15	4	Targeted by agricultural policy
Turfe Kechema	S. Shoa	Rich	Ox plough	Wheat, barley, 'teff', potatoes	812	12	0.83	
Yetmen	Gojjam	Rich	Ox plough	'Teff', wheat, beans	1,241	0	1.05	

Source: BEVAN and PANKHURST (1996) cited in DERCON and HODDINOTT (2004)

Observations from the two rounds of data were pooled in the interest of having greater variability in the weather data, which is necessary for econometric analysis.

Basic Household Characteristics and Incidence of Off-farm Participation

The data shows that most of the households are headed by males. Female-headed households only constitute 23.2% of the sample. The average age of the household head is 49.8 years, and only 34.8% of the heads are able to read and write. The average household size is 5.2 members. The average number of economically active household members between the ages of 15 and 65 is 2.8, resulting in a dependency ratio of 0.43. Around 29.3% of the sample households have at least one member who has completed primary school.

The area of land cultivated varies among households. The majority (65.6%) cultivate a hectare or less, reflecting the extremely small sized household land holdings in the study samples. Livestock plays a considerable role in the households' agricultural economy by serving multiple purposes. Oxen, cows, sheep and goats are the most important animals owned.

Looking at credit use and participation in local savings groups, about 52.5% of households used credit from either formal or informal sources during the year prior to the survey, and only 15.5% of households belong to an *equb*¹. On average the distance to the nearest town is 10.2 km.

The majority of rural household in Ethiopia make a living through agriculture, the country's number one employer. Apart from farm production, rural households are involved in a wide range of income generating activities. In the survey, households were asked whether any of their members did off-farm wage work and whether they engaged in self-employing activities. Households that reported participation were asked to list the types of activities in which they are involved. The results show that although 42.8% of households are involved solely in their own farm's production (do not engage in any off-farm activity), indeed 57.2% of the households have at least one member who engages in a variety of wage work, self-employment or a combination of the two.

With regard to wage work, around 30.3% of the sample households are involved in wage employment. Major wage activities include working as labourers on other farm, food-for-work, and working as unskilled casual workers. Apart from wage employment,

¹ Equb is an Amharic word for a special type of informal savings group. It is a traditional revolving savings association which is prevalent in both rural and urban Ethiopia. For an extensive description of how these groups function see DEJENE (1993).

about 38.8% of sample households are involved in and derive income from self-employment activities such as grain and livestock trade, selling of firewood, making dung cakes and straw, weaving, pottery, and handicrafts like making and selling farm implements. These two broad categories of off-farm activities are further classified into two sub-classes each, based on their expected return. Unskilled labourers, domestic servants, and food-for-work participants are classified as low paying wage labourers. Those that are professionals, like teachers and health workers as well as skilled labourers, like builders and masons are classified as high paying wage labourers. Similarly, self-employment activities such as collecting and selling firewood, making straw and dung cakes, weaving, and spinning are categorized as low yielding self-employing activities, while those activities like crop and livestock trading, making and selling farm implements, and providing transport services (using pack animals) are classified as high yielding self-employment activities. We established eight categories of off-farm activities and a household is said to participate in one of the eight if it has at least one member therein occupied. Table 2 shows household participation in different categories² of off-farm activities in 1999 and 2004. The table reveals that in 1999, high earning self-employment was the most important type of off-farm activity with 24.9% involvement. In 2004, low paying self-activity became more important and was undertaken by 22.2% of households. The second and third most important activities in 1999 were low paying self-employment (13.6%) and a combination of low paying wage work and high paying self-activities (9.0%). In 2004, the second most important activity with 15.9% household participation was high paying self-activity followed by a combination low paying wage and high paying self-activities.

Table 2. Participation in off-farm activities by sample households

Activity description	Code	1999 N=1,452	2004 N=1,366
		%	%
Solely agricultural production (not involved in off-farm work)	0	40.1	43.6
Participates in low paying self-employment or in low paying wage and low paying self-employment	1	10.1	8.2
Only participates in high paying self-employment	2	24.9	15.9
Only participates in low paying wage-employment	3	13.6	22.2
Participates in low paying waged work and high paying self-employment	4	9.0	8.1

Source: EHRS data 1999 and 2004 rounds

² Since there is a very small number of observations of participation in the high paying wage category and in the category that combines high pay wage work with self-activities, we exclude them from further analysis. On the other hand, participation in the category of low paying self-activity and wage work are merged with low paying self-activities.

Households' participation in off-farm activities differs across survey sites (table 3). Households that live in places where agricultural production is suitable (Yetmen, Adado) participate mainly in their own agricultural production. Households in areas where food insecurity is prevalent (Shumsha, Geblen, Haresw) are more likely to be involved in low paying wage activities, and those that are located close to urban areas (Sirbana, Godeti) engage more in high-yielding self-employment activities.

The data (1999 round) shows most household members participate in off-farm wage activities temporarily and not on a permanent basis. Accordingly, only 2.0% are engaged in the activities year round, while 20.6% do so temporarily.

Table 3. Household participation (%) in off-farm activities by survey sites

Activity	Study sites							
	Haresaw	Geblen	Dinki	DebreB	Yetmen	Shumsha	Sirbana	Adele
1	6.8	5.5	37.6	28.5	4.3	4.1	27.9	4.5
2	11.7	4.1	25.9	39.0	80.4	13.4	46.5	22.4
3	56.3	86.3	28.2	20.3	6.5	60.3	11.6	64.2
4	25.2	4.1	8.2	12.2	8.7	22.2	14.0	9.0
N	103.0	73.0	85.0	123.0	46.0	194.0	86.0	67.0

Activity	Study sites						
	Korodeg	Turfe	Imdibir	AzeD	Adado	GaraG	Doma
1	63.2	0.0	1.0	0.0	1.3	2.8	17.4
2	16.1	65.3	52.5	39.3	66.9	69.4	38.4
3	14.5	22.2	19.8	24.7	19.2	12.0	33.7
4	6.2	12.5	26.7	36.0	12.6	15.7	10.5
N	193.0	72.0	101.0	89.0	151.0	108.0	86.0

Source: EHRS data 1999 and 2004 rounds

3 Theoretical Model

Rural households participate in off-farm activities for various reasons, which can be broadly defined as either distress-push or demand-pull. According to MÖLLERS and BÜCHENRIEDER (2005), the term “distress-push” indicates a situation in which inadequate agricultural income drives household members to seek poorly paid off-farm employment. Distress-push situations can arise because of adverse weather conditions or because landholdings are too small. The term “demand-pull” describes a situation in which a household responds to an emerging economic opportunity and takes advantage

of it. Demand-pull situations can be a result of growth in commercial agriculture or proximity to urban areas. This paper is focused on assessing the link between weather risk (an important push factor) and households' participation in off-farm activities in rural Ethiopia. Below, we describe the conceptual model applied for the study.

The theoretical off-farm labour supply model used for this study follows the model used in the MATHENGE (2008) study of off-farm employment in Kenya. The model assumes that a farm household combines production, consumption and labour supply decisions. Consider the following labour supply function to the off-farm labour market:

$$(1) \quad L_o = L_o(W_o, P, I, H, G)$$

Where P represents economic incentive in the form of farm input and output prices faced by the household at the farm level. I stands for household wealth status and H for household characteristics. G represents the state of the local economy and its labour market characteristics. For rural households, the model assumes that wages received off the farm depend on human capital endowment, the level of the local economic development, the demand for labour (D_L), which is derived from the demand for the off-farm goods and services (D_G) and labour supply in the local area (S_L). Thus the wage offer equation is given by:

$$(2) \quad W_o = f(H, G, D_L, S_L)$$

Demand for off-farm goods and services (D_G) depends on the total income level in the area. Income in agrarian economies in turn largely depends on the performance of the agricultural sector in the short and long term. Accordingly, agro-ecological conditions and weather related risks affect the environments in which the rural farm households operate and are central to the overall rural economy. The local labour supply (S_L) will be influenced by labour absorption capacity of the agricultural sector which is again dependent on the weather and other agro-ecological conditions. We characterize the environmental situation in which the agricultural sector operates using mean rainfall (R) and its deviation from long-term average (V). Plugging the above factors into equation (1) above, the off-farm labour supply function can be rewritten as:

$$(3) \quad L_o = L_o(W_o \{H, G, D_L [D_G(R, V, M)], S_L(R, V, N)\}, P, I, H, G)$$

Where M and N are other potential factors expected to affect D_G and S_L , respectively. Following MATHENGE (2008), the effect of weather shock, which is our main variable of interest regarding the supply of labour to the off-farm market, can be obtained by

solving for first order conditions with respect to R and V . This yields the following equation:

$$(4) \quad \frac{\partial L_o}{\partial R} = \frac{\partial L_o}{\partial W_o} \left[\frac{\partial W_o}{\partial D_L} \frac{\partial D_L}{\partial D_G} \frac{\partial D_G}{\partial R} + \frac{\partial W_o}{\partial S_L} \frac{\partial S_L}{\partial R} \right]$$

$$(5) \quad \frac{\partial L_o}{\partial V} = \frac{\partial L_o}{\partial W_o} \left[\frac{\partial W_o}{\partial D_L} \frac{\partial D_L}{\partial D_G} \frac{\partial D_G}{\partial V} + \frac{\partial W_o}{\partial S_L} \frac{\partial S_L}{\partial V} \right]$$

The two equations reflect mathematical representations of a simple demand and supply framework. In both equations, the first term on the right-hand side represents the responsiveness of the quantity of labour supplied to changes in local wage levels. The change in local wage rate is shown in parentheses and is represented as the sum of changes due to a shift in the demand for labour³ and the change due to a shift in the supply of labour, each in response to our main variables of interest: mean annual rainfall in equation (4) and deviation of annual rainfall from its long-term average in equation (5). Looking at the effect of V , adverse rainfall shock is expected to affect farm production negatively and shift back the effective demand for off-farm goods and services. This in turn leads to a reduction in the demand for off-farm labour, which results in a decline in off-farm wage levels. Alternatively, adverse rainfall shock might serve as a coping strategy and households will increase the supply of labour to the local off-farm labour market in the event of shock. As the labour supply in the local market increases, off-farm wage rates decrease as long as the demand curve is negatively sloped. Consequently, we recognize that the overall impact of a negative rainfall shock, operating through the demand and supply of labour, is a reduction in local wage levels. This reduction influences the quantity of labour supplied off-farm, but depends on the demand and supply elasticities of labour and the magnitude of the shift in demand and supply of labour (MATHENGE, 2008).

4 Econometric Model

The above conceptual model is then implemented using the econometric specification outlined below. In empirical practice, to identify the factors associated with households' off-farm labour supply decisions, supply functions are commonly estimated using observed off-farm employment hours as a dependent variable. In our case, however, because the data has limitations in providing information about hours spent in off-farm activities by households, participation in off-farm activities are used to represent off-farm supply decisions as influenced by weather risk and a host of other

³ This shift is mainly driven by a change in demand for local goods and services (MATHENGE, 2008).

hypothesized factors. We identify eight groups of alternative off-farm activities available for sample households which we reorganize into four groups (see section 2) for operational and interpretational ease and model the probability of households' participation choices in these categories. Suppose that $\Pr(y=j|x)$ represents the probability associated with the five activity categories available for a given household with:

- j=0 if the household engages in agricultural production only
- j=1 if the household participates in low paying self-employment or in low paying self-activities and low paying wage work
- j=2 if the household participates in high paying self-employment
- j=3 if the household participates in low paying wage activity
- j=4 if the household participates in wage work and high paying self-employment

We employ a pooled multinomial logistic regression model to estimate the probability that a household will decide to participate in a particular activity, because households can choose between more than two alternatives which have no meaningful ordering among them. The model, however, works under the assumption of Independence of Irrelevant Alternatives (IIA). The assumption is that the choice of one alternative over another is not affected by the presence of further alternatives (HILBE, 2009: 396). If this assumption is violated in a situation, then the model is invalid and will no longer be an option. An alternative specification without the restrictive IIA assumption is a multinomial probit model. Following HILBE (2009) the multinomial logistic regression model is expressed as:

$$(6) \quad \Pr(y=j|x) = \frac{\exp(x'\beta_j)}{\sum_{j=0}^4 \exp(x'\beta_j)}$$

Where $\Pr(y=j|x)$ is the probability that a given household has outcome j given its characteristics, x . Households that engage only in agricultural production activity (Outcome 0) are taken as a base category (and hence we set β_0 for this activity into 0). The model simultaneously measures the change in the odds of belonging to other categories $j(1,2,3,4)$ with respect to the base category. The model then takes the form:

$$(7) \quad \Pr(y=0|x) = \frac{1}{1 + \sum_{j=1}^4 \exp(x'\beta_j)} \quad (\text{For the base category}) \text{ and:}$$

$$(8) \quad \Pr(y = j | x) = \frac{\exp(x' \beta_j)}{1 + \sum_{j=1}^4 \exp(x' \beta_j)} \quad (\text{For the remaining categories})$$

We have five activity options, and because we set the first category (solely agriculture) as the reference category, we will have four equations: one for each outcome relative to the reference category. The model is estimated with the maximum likelihood estimation approach.

Our main interest lies in testing the hypothesis that adverse weather conditions, such as rainfall shock, have an effect on household participation in off-farm employment. To test this hypothesis, we model the probability of a given household's participation in a particular type of off-farm work as a function of weather shock and several other relevant household and farm characteristics. The definition of these variables and their summary statistics are provided in table 4. A gender dummy for the head of the household is included, and we expect male-headed households to participate more in off-farm activities. The age of the head is included since it is assumed to serve as a proxy for experience, which might increase the probability of employment in the off-farm sector. To control for life cycle effects, the squared value of the household head's age is included as well. Past research shows that education an important factor affecting households' off-farm participation decisions. Here, education is represented by a household head's literacy and the presence of a household member who completed at least primary school. We expect that probability of participation in high paying activities is expected to increase with higher levels of human capital. Several authors have also confirmed this proposition (BARRETT et al., 2001a; 2001b; BLOCK and WEBB, 2001).

Demographic variables, representing the number of economically active members and dependents, are also included in the model. More dependents in the household might increase resource needs and drive the pursuit of extra income from off-farm work. Alternatively, having more dependents than active productive members in the household reduces participation in the off-farm sector as there are fewer labourers to allocate to the additional job. So, the direction of the impact is not possible to state a priori. The number of adult household members who are economically active, however, is hypothesized to increase the likelihood of participation in off-farm jobs.

Table 4. Descriptive statistics of the variables used in econometric models

Variables	Description	Mean	SD
Weather risk factors			
Mean rainfall (mm)	Average annual village rainfall (mm)	948.40	308.25
Rainfall deviation	The deviation of annual rainfall from its long-run mean	-44.00	202.88
Household characteristics			
Gender	A dichotomous variable, value 1 if the head is male, 0 if otherwise	0.77	0.42
Age	Age of the household head in years	49.75	15.02
Literacy	Dummy, =1, if the head can read and write, 0 if otherwise	0.35	0.48
Education	Dummy, =1, if at least one household member has completed primary school, 0 if otherwise	0.29	0.46
Adult labour	Number of household members who are economically active (i.e. aged 15-64)	2.82	1.57
Dependents	Number of dependents in the household (i.e. aged <15 or >64)	2.55	1.73
Land	Area of land cultivated by the household in hectares	1.43	1.16
Livestock	Number of livestock owned by the household in tropical livestock units	1.83	1.67
Other controls			
<i>Equb</i>	Dummy, =1 if any member in the household belongs to <i>equb</i> , 0 if otherwise	0.16	0.36
Credit	Dummy, =1 if any member in the household has received credit from either formal or informal sources in the past 12 months, 0 if otherwise	0.53	0.49
Town	Distance to the nearest town (km)	10.25	6.72

Source: calculated from EHRS data 1999 and 2004 rounds

The amount of land cultivated can affect the decision to participate in off-farm activities. A smaller amount of cultivated land may not allow households to make a sufficient living from farm production alone, causing them to look for supplementary income. An alternative hypothesis is owning more land signifies relative wealth and thus less financial constraint for engaging in high paying off-farm activities. Many studies have shown a negative correlation between the amount of land owned/cultivated and the decision to participate in off-farm activities (cf. CORRAL and REARDON, 2001; VAN DEN BERG and KUMBI, 2006) while others have found a positive correlation (RUBEN and VAN DEN BERG, 2001). The influence of livestock ownership on off-farm participation decision is unclear. Households who possess more livestock require more

labour on the farm and allocate more time to livestock management and husbandry. On the other hand, those who own more livestock could be more financially secure and therefore more likely to engage in off-farm work.

We use two variables to measure rainfall shock, which is the most frequent weather risk affecting rural life in Ethiopia. First, we use the annual level of rainfall in each village proxied by mean rainfall recorded in nearby weather stations. We expect an inverse relationship between this variable and off-farm participation if households increase their participation as a result of rainfall shortages. As an additional risk factor, we include rainfall variability measured by deviation from a long-run (30 year) annual average. We expect that the likelihood of households' participation in the off-farm sector increases with higher rainfall variability (i.e. greater production risk).

A household's proximity to an urban centre can influence the likelihood that it will participate in off-farm work. To assess this effect, we include the distance of the household to the nearest town. It is assumed that the further a household is from a town, the lower the likelihood of participation in the high paying off-farm sector. Access to credit and membership in an *equb* are hypothesized to positively influence participation into high paying off-farm self-employment. This a priori expectation is drawn from a study by ZELLER (2001) that emphasizes the role of credit in enhancing the level of households' productive capital, and the role of savings in the accumulation of assets, which provide capital for the income earning process. Thus, with the necessary capital, credit and *equb*, households engage self-employment activities. Year dummies are also included in the model to control for some time specific factors.

5 Econometric Results and Discussion

The results of the multinomial logit regression model are presented in table 5. The likelihood ratio test shows the estimated model is statistically significant at the 1% level. In addition, the hypothesis that alternatives can be collapsed was rejected at the 1% level of significance by the same test. The multinomial logit model is appropriate only when the assumption of independence of irrelevant alternatives (IIA) holds. We tested whether this assumption holds in the model by employing both the Hausman-McFadden test and Small Hsiao test. The two tests produce consistent results and the assumption of IIA is not violated. Appendix 2 reports the results of the tests.

An important result is that both the level and the variability of rainfall have a significant effect on the decision of households to engage in all types of off-farm work. Households that have experienced lower levels of rainfall and those that are faced with higher output risk as a result of rainfall variability are more likely to engage in off-farm activities that are not high-paying. These households tend to allocate more

labour to low paying off-farm activities. The theoretical model presented in the forgoing section implies that weather risk is the main factor in affecting household labour supply decisions. The result corresponds to this theoretical exposition and our a priori expectations and suggests that engagement in off-farm work might serve as a strategy for households coping with weather shocks, a notion which is widely recognized in agricultural economics literature. The result is also consistent with previous studies in Ethiopia (HAILE et al., 2008; BEZABIH et al., 2010) and elsewhere (KOCHAR, 1999; ROSE, 2001; MATHENGE, 2008) that found households increase their participation in off-farm activities in response to weather shocks. Similarly, we find that participation in high paying activities increases with the level of rainfall and tends to decrease with rainfall variability. This result is plausible given that these activities (grain trade, livestock trading, crafting farming implements, etc.) are highly dependent on agricultural production. In addition, the result might reflect the fact that households located in villages where weather conditions are favourable for agricultural production tend to have the resources necessary for involvement in high paying self-activities. These households also enjoy relatively higher demand for the off-farm goods and services as a result of the better income position of those localities.

Looking at other results, we find that the number of economically active household members positively and significantly influences the likelihood of household participation decision in low-paying self-activity and/or wage work and high paying self- and wage employment. This expected result indicates that the availability of a higher number of adults in the household may serve as an incentive to participate in off-farm employment activities. This result corresponds with those of ABDULAI and DELGADO (1999) for Ghana, DAMITE and NEGATU (2004) for Ethiopia and MATSHE and YOUNG (2004) for Zimbabwe. The studies reported that households endowed with a larger active labour force are more likely to participate in off-farm employment and to diversify their livelihood. The number of dependents is found to be negatively correlated with participation in low paying self-employment and wage activity and suggests that households with more dependents have lower probability of participation in these classes of activities. The results show that having a literate household head has a positive and significant effect only in wage activity; it has no statistically significant effect on other off-farm activity.

On the other hand, the presence of educated members in a household has a negative and significant influence on participation in low paying self- and/or wage work and wage employment, suggesting that the educated households are less likely to work for wages and/or be involved in low yielding activities. Male-headed households are more likely to participate in wage employment while the likelihood of engagement in high-paying self-activities and a combination of activities containing high paying self-activity and wage employment is relatively higher for female-headed households.

Access to credit is found to have no statistically significant effect on the probability of households' participation in any type of off-farm work. RUBEN and VAN DEN BERG (2001) also found no significant relationship between credit access and participation in wage or self-employment in Honduras. Membership in an *equb* on the other hand, is found to have positively and significantly affected the probability of participation in high paying self-employment. This result highlights the essential role played by local savings associations in facilitating engagement in high paying self-employing activities through provision of financial capital, which is essential for starting up and running one's own business and is often a fundamental constraint in rural Ethiopia

Table 5. Estimation results of the multinomial logistic regression model

	Low paying self-or waged activity		High paying self-activity		Low paying waged activity		High paying self-and waged activity	
	Coef.	z	Coef.	z	Coef.	z	Coef.	z
Household characteristics								
Age	0.030	0.67	-0.008	-0.29	0.041	1.23	0.045	1.03
Age squared	-0.001	-1.15	0.000	0.07	-0.001*	-1.69	-0.001	-1.45
Sex	-0.250	-1.06	-0.601***	-3.60	0.471**	2.38	-0.524**	-2.37
Literacy	0.117	0.55	0.054	0.34	0.339**	2.14	0.267	1.34
Members education	-1.465***	-5.28	0.143	0.93	-0.543***	-3.16	0.018	0.09
Adult members	0.171***	2.80	0.079	1.54	0.067	1.39	0.183***	3.07
Dependents	-0.185***	-3.26	0.003	0.08	-0.085**	-2.14	-0.022	-0.39
Land (ha)	1.889***	8.15	0.373*	1.89	-0.434**	-2.00	-0.862***	-2.99
Livestock (TLU)	-0.008	-0.13	-0.289***	-5.35	-0.051	-1.01	-0.338***	-4.11
Weather risk factors								
Mean rainfall (mm)	0.136	0.33	1.281***	5.23	-1.356***	-5.94	-0.597**	-2.09
Rainfall deviation	0.003***	4.00	-0.001***	-3.32	0.001***	3.50	0.002***	3.49
Other controls								
Credit	-0.010	-0.05	0.087	0.67	0.109	0.81	-0.049	-0.28
Equb	0.127	0.40	0.755***	4.30	-0.002	-0.01	0.291	1.15
Distance to town (Km)	0.042***	3.14	-0.022*	-1.86	0.048***	4.12	-0.011	-0.81
Year 2004	-0.480**	-2.51	-0.940***	-6.31	0.787***	5.43	-0.189	-0.95
Constant	-4.274	-1.37	-8.453***	-4.54	6.834***	3.92	3.082	1.40
Number of obs = 2,010								
Wald chi2(60) = 570.23								
Prob > chi2 = 0.0000								
Pseudo R2 = 0.1280								

Note: Engagement in pure farm production is taken as a reference category. ***, **, and * show the coefficients are statistically significant at 1%, 5%, and 10%, respectively.

Source: calculated from EHRS data 1999 and 2004 rounds

The amount of land cultivated was found to have a negative and significant effect on participation in wage work and mixed activities containing wage and high paying self-employment. The negative coefficient implies that scarcity of land may trigger participation in such types of off-farm occupations. Differing results with regard to the impact of land holding size on household off-farm participation decision can be found in the literature. For example, CORRAL and REARDON (2001) find that the number of acres owned reduces an individual's engagement in non-farm wage labour in Nicaragua. Similarly, LANJOUW (2001) in El Salvador and VAN DEN BERG and KUMBI (2006) in Ethiopia find that households with larger land holdings are less likely to be employed in the non-farm sector. While RUBEN and VAN DEN BERG (2001) find the opposite empirical outcome for Honduras. Nevertheless, cultivated land was found to be positively associated with a combination of low-paying self- and/or wage employment, which is contrary to our expectation. As indicated in the economic modelling section, we created this category by merging those households that have been observed to participate only in low paying self-activities and those who combine this with wage work. Self-employment seems in part to drive the result as the effect of the land variable is negative and significant in the wage employment model. This might be one possible reason for the result. Land also remains positive and significant for high-return self-employment.

A larger number of livestock is associated with a lower probability of household members' participation in high paying self-employment and a combination of wage and high-paying self-activities. Consistent with our expectations and other studies elsewhere, the greater the household distance to the nearest town, the less likely members are to participate in high paying self-employment. On the other hand, for households located in areas further from local town centres, the probability of working for wage and/ or engaging in low paying self-employment activities is higher. This may be due to the fact that households located in areas closer to the centres have better chances of finding markets for their products and enjoy lower transaction costs. Similarly, ESCOBAL (2001) in rural Peru showed that access to public assets can help households to expand both their self-employment and their wage employment into the non-farm sector.

6 Summary and Conclusion

In Ethiopia, recurrent weather-related shocks and their adverse effects are a serious threat to rural livelihood. Hence, the main purpose of this study was to investigate whether participation in off-farm activities serves as a risk coping strategy among rural Ethiopian households. We utilized household data collected from several rural villages that largely represent the major agroecologies of the country. Distinguishing four types

of alternative off-farm activities and employing a multinomial logistic regression model we estimated the probability of a given household's participation in a particular type of off-farm activity as a function of weather risk factors, controlling for several other relevant household and farm characteristics.

The results of the empirical analysis reveal that several factors are relevant in determining households' participation in off-farm activities. Of major importance is the result that households experiencing a low level and high variability of average rainfall exhibit a higher probability of engaging in all forms off-farm work, except high paying self-business activity, reflecting the potential benefit of these activities in mitigating households' weather risk in rural Ethiopia. However, participation in high paying self-employment is associated with higher levels of rainfall and lower variability, suggesting a strong correlation between farm production and off-farm activities. Furthermore, uncovering important peculiarities among the activities, the results assert the importance of disaggregating off-farm employment into its sub-components.

The results suggest that weather risk drives households to low paid off-farm income sources. This underlies the need for insurance mechanisms to support households in dealing with weather risk. Furthermore, the results show that membership in an *equb* increases the likelihood of participation in high paying self-employment activities, implying the role of financial resources therein. Hence, interventions that aim at encouraging the expansion of savings groups in rural areas to serve as an alternative financial source for smallholders remain important.

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Appendix

Appendix 1. Small-Hsiao tests of IIA assumption (N=2,010)

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

Omitted	lnL(full)	lnL(omit)	chi2	df	P>chi2	evidence
1	-1,034.543	-1,009.373	50.341	48	0.381	for Ho
2	-781.444	-757.967	46.954	48	0.516	for Ho
3	-839.773	-809.232	61.082	48	0.097	for Ho
4	-982.680	-953.286	58.787	48	0.137	for Ho

Source: calculated from EHRS data 1999 and 2004 rounds

Appendix 2. Wald tests for combining alternatives (N=2,010)

Ho: All coefficients except intercepts associated with a given pair of alternatives are 0 (i.e. alternatives can be combined).

Alternatives	tested	chi2	df	P>chi2
1-	2	182.599	15	0.000
1-	3	154.182	15	0.000
1-	4	147.574	15	0.000
1-	0	146.091	15	0.000
2-	3	273.964	15	0.000
2-	4	80.854	15	0.000
2-	0	146.422	15	0.000
3-	4	92.185	15	0.000
3-	0	156.633	15	0.000
4-	0	75.991	15	0.000

Source: calculated from EHRS data 1999 and 2004 rounds

Contact author:

Abera Birhanu Demeke

University of Hohenheim, Department of Agricultural Economics and Social Sciences in the Tropics and Subtropics, 70593 Stuttgart, Germany

e-mail: birhanu@uni-hohenheim.de