DETERMINANTS OF FARMERS' DEMAND FOR RAINFALL-INDEX INSURANCE: *Evidence from Rural Tigray, Northern Ethiopia*

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Abstract

In agrarian economies, like Ethiopia, rainfall is a major determinant factor of welfare. However, drought risk has been frequently resulting in loss of crops. Tigray (Northern Ethiopia) is one among the regions of Ethiopia which have been highly affected by drought for long time. Since late 2007 Oxfam-America and other partner organizations have come together to launch an innovative climate change resiliency project, called Horn of Africa Risk Transfer for Adaptation (HARITA), in Tigray region. Building access to risk transfer mechanisms through supply of Rainfall-index insurance is among the main components of the project. Rainfall-index insurance contract has been supplied in five villages located in Central, Southern, and Eastern zone of Tigray region. Using cross-sectional data from farm households in the five villages where Rainfall-index insurance has been supplied; this paper presents empirical evidence on determinants of demand for Rainfall-index insurance. In this study, regression analysis has evidenced that factors such as head's sex, head's age, head's education, risk-aversion, owned farm size, knowledge about Rainfall-index insurance, contact with agricultural extension workers, PSNP participation, and location have significant effect on demand for Rainfall-index insurance.

Keywords: Drought, demand, Rainfall- index insurance, HARITA, Tigray, Northern Ethiopia

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1. Introduction

In agrarian economies, like Ethiopia, rainfall is a major determinant factor of welfare. However, drought risk has been frequently resulting in loss of crops. Even more devastating, it has been destroying household key assets including livestock needed to smooth farm life. Extreme drought has been also throwing rural farm households in to a cycle of poverty. Unfortunately, due to lack of access to formal insurance many people have been moving to long term poverty. The 2002 drought in Ethiopia, for example, affected most of the country and led to 12.5 million people requiring food aid (Hazzel, *et al.,* 2010). Therefore, interventions through provision of Rainfall-index insurance to insure rural people who are vulnerable to drought could be right. Index insurance is a financial and technological innovation which made insurance more affordable. Basically, Index insurance allows individual farmers to protect themselves against agricultural production risk by paying out indemnity when an independently observable trigger (such as the level of rainfall at a local weather station) shows that an insurable event has occurred. This approach reduces the cost of providing insurance against weather risk and thereby allows insurance companies to reach poor households (Hill and Torero, 2009). This type of insurance is also getting recognition as an instrument to mitigate drought risk (Skees*et al*., 2006).

In Ethiopia, lion share of the population (i.e., more than 80%) is dependent on smallholder rain-fed agriculture which is highly vulnerable to drought events. Because of frequent drought, Ethiopian farmers have been also food insecure. In order to insure the farmers for drought risk, Index insurance have been experimented in Ethiopia since 2006. It was first introduced by World Food Program (WFP) with the aim of assessing feasibility of using a market related instrument to finance drought risk in the country (See Devereux and Guenther, 2009; Alderman and Haque, 2007; and Hazell, *et al.,* 2010). Tigray is among the regions of Ethiopia which have been highly affected by frequent drought. In 2007, Oxfam America and other partner organizations have come together to launch an innovative climate change resiliency project, called Horn of Africa Risk Transfer for Adaptation (HARITA), in Tigray region. The HARITA project has designed and supplied Rainfall-index insurance in five rural villages of Tigray. The insurance was first supplied in 2008 at Adi Ha, a village located in Central zone of Tigray. Currently, it expanded to another four villages known as Geneta, Hade alga, Awet be kalsi, and Hadushadi. The first two villages are from Southern zone, the third village is from Central zone, and the fourth village is from Eastern zone of Tigray. In May, 2010 the insurance contract was supplied in all these five villages. In addition, the HARITA Rainfall-index insurance allows cash constrained farmers to pay premiums through their labor by link made with Ethiopia's Productive Safety Net Programme (PSNP) which is a social protection programme (HARITA, 2009; and Dinku, *et al.,* 2009).

Rainfall-index insurance has recently received ample attention, both theoretically and empirically. Many studies, however, have been focusing on the technical design aspect and the role of index-insurance (*e.g* Alderman and Haque, 2007; Hess et al., 2oo5; Hess and Syroka, 2oo5; Breustedt et al., 2008; Barnett et al., 2008; Chantarat et al., 2007; Osgood et al., 2007; Skees et al., 2001; Skees and Collier, 2008; World Bank, 2005). Some studies have been also made on factors explaining the demand for Rainfall-index insurance (*e.g.,* Sakurai and Reardon, 1997; McCarthy, 2003; Gine*et al.,* 2007; and Gine and Yang, 2009). However, despite to existing Index-insurances across the world, majority of the studies have been also focusing on willingness to pay for hypothetical Rainfall-index insurance contracts. With specific reference to the HARITA Rainfall-index insurance, to the best of our knowledge, there is no study on the determinants of demand for the insurance. Thus, the objective of this study was to investigate the determinants of farm households' demand for Rainfall-index insurance in rural Tigray, Ethiopia.

For traditional insurance literature main determinant factors of purchasing insurance are the probability of loss, the extent of loss, the insurance premium charged and buyer's risk-aversion (Smith's, 1968; Mossin, 1968; and Schlesinger, 1999). However, Rainfall-index Insurance is different from traditional insurance contracts in terms of its various characteristics; first, it covers rainfall risk (i.e., drought) which is normally a covariate risk. Second, the risk is measured in terms of identified index (level of rainfall at a local weather station). Third, there is no need to estimate the actual loss experienced by the policyholder. Fourth, there is no need to classify individual policyholders according to their risk exposure. Due to these characteristics differences, determinants of demand for Rainfall-index insurance may also differ from determinants of demand for traditional insurance. According to literature on Rainfall-index insurance, factors which influence Rainfall-index insurance are still empirical questions. For Skees*et al.* (2001), wealth, stock of human capital (education level and number of working-age adults), risk-aversion, and access to irrigation are some of the potential factors expected to influence Rainfall-index insurance demand. In addition to this, some studies (Gine*et al.,* 2007 and Gine and Yang, 2009) have shown that household's awareness and understanding also influence demand for the insurance. Thus, this study has examined the effect of these factors on demand for Rainfall-index insurance.

2. Theoretical Framework

Suppose a farmer can be described by vector of characteristics x. The Rainfall-index insurance contract can also described by a vector of coverage characteristics ψ and a price or premium p. A farmer's value for the insurance is assumed to be determined by events during the coverage period. Let S denote the set of possible outcome. For example, $s \in S$ might represent whether the index (rainfall) fall below the pre determined milliliter or not at the village station. Let, therefore, $\pi(s|x)$ is the probability of outcome s. The farmer's utility depends on what happens and on the coverage s/he gets; let $u(s, x, \psi, p)$ denoted the farmer's realized utility.

In addition to this notation, as a natural starting point as well as to describe the points clearly, let's adopt a standard expected utility framework. The farmer's valuation of the insurance contract (ψ, p) is, therefore:

$$V(\psi, p, x) = Max \sum_{s \in S} \pi(s|x)\, u(s, x, \psi, p) \qquad \textbf{(1)}$$

Where $V(\psi, p, x)$, represents expected utility.

Thus, a farmer with characteristics x is assumed to find the insurance contract optimal to purchase if and only if it gives him or her higher (or equal) utility than being uninsured by. That is:

$$V(\psi, p, x) \geq V(x) \qquad \textbf{(2)}$$

Therefore, the farmers' demand for the insurance is:

$$V(\psi, p, z_i, r_i) = \alpha_{\psi}\psi + \alpha_z z_i + \alpha_i r_i - \alpha_p p \qquad \textbf{(3)}$$

Where the α's are coefficients to be estimated, ψ is vector of the contract characteristics, z_i is a vector of farmers' demographic and socio-economic characteristics, r_i and p represent the farmers' risk-aversion and premium, respectively.

3. The Data

This study has used cross-sectional data from household survey conducted in August, 2010 by Mekelle University and Columbia University. The data was collected after the Rainfall-index insurance contract was introduced and offered for sale in the five villages. A total of 297 sample farm households were taken using systematic random sampling from the five villages. The sample households were consisted of purchasers and non-purchasers of the insurance contract.

4. Econometric Framework

Given that our data is consisted of purchasers and non-purchasers of the insurance contract the demand model (Eq. 3) can be reduced to a binary choice model. Assuming the error term is distributed randomly we have specified probit model (See Maddala, 1983; Green, 2000; and Train, 2003 for detail review of binary choice models) as follows:

$$p(d = 1/x) = F(x'\beta) \qquad 4$$

Where d is dependent variable which represents the farmers' demand for the Rainfall-index insurance and

$$d = \begin{cases} 1 & if a farmer purchased the \text{Rainfall} - \text{index insurance} \\ 0, & otherwise \end{cases}$$

And β is the vector of parameters to be estimated, x is the vector of explanatory variables including household demographic characteristics, risk-aversion and other socio-economic characteristics. Specifically, the independent variables included in the model are head's sex (1 if female), head's age and head's education (1 if literate), family size (number of working age adults), risk-aversion (approximated by the farmers fertilizer adoption behavior before the HARITA Rainfall-index insurance is introduced to the villages i.e., 1 if a farmer was not adopting chemical fertilizer before introduction of the rainfall-index insurance, 0 otherwise), number of ox, farm size(in *Tsemad*), access to irrigation, contact with agricultural extension workers, knowledge on Rainfall-index insurance, PSNP participation, and Village dummies. Due to lack of sufficient premium variations in our data, we didn't included premium in the model. Descriptive statistics of the variables are reported in Table 1 below.

Table 1: Descriptive Statistics of key variables

Definition of Variables	Mean	Std.Dev.
Dependent variable		
Purchasing Rainfall-index insurance (=1 if household purchased Rainfall-index insurance, 0 otherwise)	.619	.486
Independent variables		
Head's sex (=1 if female)	.383	.487
Head's age	42.760	13.361
Head's education (=1 if literate)	.377	.485
Family size (number of working age adult)	2.777	1.339
Risk-aversion (=1 if the head did not take the risk of fertilizer adoption)	.859	.368
Number of oxen	.969	.991
Owned farm size*	3.458	2.814
Access to irrigation (=1 if hh has access)	.363	.481
Contact with extension (=1 if has contact with extension workers)	.774	.418
PSNP participation (=1 if household participate in PSNP)	.692	.462
Knowledge on the rainfall-index insurance (=1 if the head understand the insurance contract well)	.610	.488
Village dummy-1 (=1 if Genete)	.185	.389
Village dummy-2 (=1 if Hade alga)	.191	.394
Village dummy-3 (=1 if Adi ha)	.218	.414
Village dummy-4 (=1 if Awet bekalsi)	.164	.371

**Owned farm size is measured in Tsemad.*

5. Results and Discussions

a. *Descriptive Summary* of the Sample Households

The various farm household characteristics in our data set provide some indications on the factors that affect purchasing Rainfall-index insurance. Table 2 below shows the demographic and socio-economic characteristics of the purchasers and non-purchasers of the Rainfall-index insurance. The proportion of male headed purchasers (57%) was found less than the proportion of female headed household purchasers (70%). Large portion of female headed households have purchased the Rainfall-index insurance. The difference was found statistically significant at 5%.

Table 2: Characteristics of sample households by purchase of Rainfall-index insurance

		Mean	
		Purchasers	**Non-purchasers**
Sex	Male	.57	.43
	Female	.70	.30
Age		41.15	45.38
Education	Literate	.72	.28
	Illiterate	.56	.44
Family size		2.75	2.82
Number of Ox		.88	1.12
Owned farm size (in *Tsemad*)		2.90	4.37
Access to irrigation	Yes	.70	.30
	No	.58	.42
PSNP Participation	Yes	.73	.27
	No	.37	.63
Contact with agricultural extension workers	Yes	.65	.35
	No	.51	.49
Knowledge on WII	Yes	.80	.20
	No	.41	.59

The average age of purchasers of Rainfall-index insurance (41.15) was less than the average age of non-purchasers (45.38). The difference was found statistically significant at 1%. Regarding education, 72% of the literate household heads was found purchased the Rainfall-index insurance. 56 % of the illiterate was also found purchased the Rainfall-index insurance. The difference between proportion of the literate and illiterate purchasers was found statistically significant at 1%. The average of adult members of family between purchasers and non-purchasers were 2.75 and 2.82, respectively. This difference was found statistically insignificant.

The average ownership of ox between the purchasers and non-purchasers was .88 and 1.12 respectively. The ox ownership difference between the purchasers and non-purchasers was found statistically significant at 5%. The average Owner ship of farm size between the purchasers and non-purchasers was also 2.90 and 4.37, respectively. The purchasers were found possess less ox and land than the non-purchasers. The difference was found statistically significant at 1%.

About 58% of the households who have not access to irrigation were found purchased the Rainfall-index insurance contract, while 70% of households with access to irrigation have also purchased it. This difference was found statistically significant at 5%. In relation to PSNP, about 73% of the PSNP participants have purchased the Rainfall-index insurance contract. Only 37% of non-participants in PSNP have purchased the Rainfall-index insurance. This difference was also found statistically significant at 1%.

About 65% of the households who had contact with agricultural extension workers have purchased the Rainfall-index insurance contract. And about 51% of the households who have not contact with agricultural extension workers have purchased the Rainfall-index insurance contract. This difference was found statistically significant at 5%. Finally, from the household heads who had understood the Rainfall-index insurance contract well, about 80% have purchased the contract. And only 41% of those who did not understand have purchased it. Large portion of the household heads with good knowledge on Rainfall-index insurance contract have purchased the Rainfall-index insurance contract. This difference was also found statistically significant at 1%.

b. Estimation Results and Discussions

Table-3 below presents the Probit estimated result of the factors explaining probability of purchasing Rainfall-index insurance. The head’s sex coefficient was found statistically significant and positive that shows female-headed households are more likely to purchase Rainfall-index insurance than male-headed households. Possible explanation for this is that women may have weak ex-post drought coping capacity than male-headed households. Head's age was found statistically significant but negatively affect probability of purchasing Rainfall-index insurance. Perhaps more of the old-aged household heads may be reluctant to purchase Rainfall-index insurance. Head's education was also found statistically significant and positively influence probability of purchasing Rainfall-index insurance. Literate household heads are more likely to purchase Rainfall-index insurance. However, family size was found statistically insignificant to affect purchasing Rainfall-index insurance.

Table 3: Factors determining the probability of Purchasing Rainfall- index insurance

	Coefficient	Robust SE
Intercept	-.286	.523
Head's sex	.438	.240*
Head's age	-.017	.008**
Head's education	.427	.234*
Family size	.072	.084
Risk-aversion	-.566	.264**
Number of ox	-.013	.132
Farm size	-.082	.041**
Access to irrigation	.333	.262
Knowledge on Rainfall- index insurance	1.078	.212***
Contact with extension workers	.643	.237***
PSNP participation	.406	.217*
Village dummy-1 (=1 if Genete)	-1.208	.311***
Village dummy-2 (=1 if Hadealga)	-.801	.297***
Village dummy-3 (=1 if Adi Ha)	-.196	.350
Village dummy-4 (=1 if Awet bekalsi)	.383	.365
Number of observations	*258*	
Wald chi2(15)	*82.35*	
Prob>chi2	*0.000*	
Pseudo R2	*0.382*	
Log pseudo likelihood	*-103.151*	

*Note:*significant at 10%; ** significant at 5%; and *** significance at 1%.*

The proxy variable of risk-aversion (fertilizer adoption) was found significant but negatively related with purchase of Rainfall-index insurance contract. Risk-averse farmers were found to purchase the Rainfall-index insurance contract less likely. Perhaps this may be because the risk-averse farmers may not trust the insurance contract. To capture possible effects of wealth of the households, the number of ox and farm size owned was included in the model. Number of ox was found insignificant while farm size was found significant but negatively affect purchasing the insurance. This may be due to the reason that households with large farm size prefers to insure rainfall risk via crop diversification and other strategies than purchasing Rainfall-index insurance which is at its early introduction in the villages. Access to irrigation was also found insignificant.

Knowledge of Rainfall-index insurance was found significant and positively affect Rainfall-index insurance demand implying that farmers with better understanding about the Rainfall-index insurance contract purchase the contract more likely, *ceteris paribus*. Farmers contact with agricultural extension workers was also found to positively affect the Rainfall-index insurance demand. Farmers who have contact with extension workers are more likely to purchase the contract than those who have not contact. This may probably because extension workers had role in informing farmers to purchase the insurance. PSNP participation was also found significantly and positively related to purchase of the Rainfall-index insurance. This may be because PSNP participants are considered as cash constrained households and are allowed to pay premium in kind through their labor in PSNP.

Lastly, from four village dummies only two Village dummies (i.e., Village dummy-1 and Village dummy-2 which represent Genete and Hade alga, respectively) were found significant but negatively related with purchasing Rainfall-index insurance. These two villages are located in Southern zone district of Raya-azebo. Therefore, farmers from the district of Raya-azebo were found to purchase the contract less likely relative to the farmers from other district.

6. Concluding Remarks

This study was focused on investigation of determinants of demand for Rainfall-index insurance. The study has used cross-sectional data collected from Rainfall-index insurance Supplied five Villages in Tigray, Ethiopia. Using a probit regression analysis, factors such as head’s sex (1=female), head’s age, head’s education, risk-aversion, farm size, knowledge on Rainfall-index insurance, farmers’ contact with agricultural extension workers, PSNP participation, and Two village dummies out of four Village dummies (*i.e.,* the dummies for village Genete and village Hade alga which are located in Southern zone district of Raya-azebo) were found to have statistically significant effect on demand for Rainfall-index insurance.

Female-headed households were found to purchase Rainfall-index insurance more likely than male-headed households. Heads' age was found to negatively affect demand for Rainfall-index insurance. Risk-aversion was found negatively related with purchase of the Rainfall-index insurance contract. Risk-averse farmers were found to purchases the Rainfall-index insurance contract less likely, *ceteris paribus*. Farm size was found significant but negatively affect purchasing Rainfall-index insurance. The knowledge on Rainfall-index insurance was found to positively affect the Rainfall-index insurance demand. That is, farmers with better understanding about the Rainfall-index insurance contract purchase the contract more likely, *ceteris paribus*. The farmers' contact with agricultural extension workers was also found to positively affect the Rainfall-index insurance demand. Farmers having contact with agricultural extension workers are more likely to purchase the contract. PSNP participation also found positively affects purchasing Rainfall-index insurance. PSNP participants are more likely to purchase Rainfall-index insurance than non-participants. However, the two village dummies were found negatively related with the demand of Rainfall-index insurance. The farmers from the district Raya-azebo purchase the policy less likely relative to other farmers.

The main findings of our study have two potentially important policy implications. One, farmers' Rainfall-index insurance purchase mainly depends on good knowledge about the insurance contract. Thus, take-up rate of the insurance can be increased by giving detailed training to the farmers. Two, it is important to note from the effect of the village dummies that Rainfall-index insurance is not equally demanded by farmers in every location.

Our study leaves the following interesting points open for future research. First, risk-averse farmers were found to purchase Rainfall-index insurance less likely while they were theoretically expected to purchase more likely. The reason why this happened is open for future research works. Second, we have conducted our study during early introduction period of the Rainfall-index insurance to the farmers. Therefore, future research works can be directed towards evaluation of the trend of take-up rate by farmers and its impact on agricultural technology adoption and livelihood.

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