

An analysis of the demand of weather index-based insurance with flexible attributes in a risk management framework

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Abstract:

We propose a rural household's risk management framework to investigate whether the low take-up of index-based insurance may depend, first, on the heterogeneity of the product's attributes and, second, on a substitution effect between the insurance and on-farm and off-farm risk management strategies. We conducted a discrete choice experiment in Ethiopia with a sample of farmers using a weather security with fixed compensation in case of drought. We offered securities with different combinations of attributes: premium, compensation, preferred season, frequency of drought, sale location, and time of premium payment, allowing for interest payment and administration and distribution costs. We used a Mixed Logit Model. We find that while available risk management strategies are not important in the decision to buy insurance, heterogeneity in the demand is remarkable and relies on the indemnity and home delivery attributes, the type of drought insurance (for moderate or severe drought), and the capacity to appreciate the value of insurance.

Key Words: weather insurance, microfinance, risk management, Ethiopia

1. Introduction

Consequences on rural households and individuals in developing countries of man-made or natural risks or shocks may be classified into disasters or adverse, non catastrophic conditions. The latter, although less harsh, may

challenge farmers and limit their potential to develop and innovate. Traditional risk management strategies followed by households, such as reducing exposure, cumulating money buffers, looking for credit, diversifying the economic activities, or participating in informal insurance mechanisms may indeed help to comply with this vulnerability. However, as some studies stress, they have some limits (Fafchamps, 1999), related to their rigidity or their inability to succeed when the risk is covariant (Dercon, 2003). This is the case of rainfall risk, a major problem in agriculture, especially in remote rural areas. Innovative risk management strategies, on the other side, include the access to formal crop insurance which is still under study and in a pilot phase in most low-income countries. Factors such as the suitability of the contract to rural households' preferences and the need to reduce information asymmetries, as well as the difficulties related to the distribution, are a challenge as Brown (2001) explains. Furthermore, the limited size of the market may still limit diversification strategies. Asymmetric information problems, in particular, are often found in crop insurance: moral hazard, for example, loosens farmers' commitment in production (Hess, Richter and Stoppa, 2002); this is especially evident in public insurance projects (Viganò, 2002). The relatively recent development of index-based insurance, whose compensation is related to the value taken by a specific climatic index correlated with crop yields (Bryla, Dana, Hess and Varangis, 2003) is meant to overcome the shortcomings of traditional insurance and to minimize ex-post verification costs (Hill and Robles, 2011); the compensation is due if the index exceeds or falls short of (depending on the type of risk to be covered) a certain threshold. The literature on the topic is vast. Several types of indexes have been adopted or at least tested: area yield, livestock, weather indexes or weather derivatives are among the most common ones. (Hess, Richter, and Stoppa, 2002; Skees 2003; FAO, 1992 and 2001; Skees, Varangis, Larson and Siegel, 2002). In weather index insurance, computing the correlation between the natural phenomena and the agricultural yields and, so, the due indemnity, is a complex process based on the adequate choice of the period of observation, the quality of data at the weather stations and on farmers' production (Hess, 2003; Skees, 2003). The same outcome of weather-index insurance can be achieved by applying a pure weather derivative where the indemnity is based on a tick size multiplied by the gap between the traded index and the actual measurement of a weather variable correlated with crop production (Hess, Richter, and Stoppa, 2002; Skees 2003). These contracts are found to be more suitable to adapt to customers' preferences by Hills and Robles (2011), even if they are becoming increasingly interchangeable with index-based insurance (Berg, Schmitz, Starp, Trenkel, 2004). Effectiveness of these contracts in helping farmers manage their revenue variability is proved by Hill and Robles (2011)

and Hess and Hazell (2009) in different countries of the world. In fact, pilot projects and actual implementations are increasing over time but a general consensus on the appreciation by farmers is still lacking for several reasons and potential purchasers have not yet shown an overall appreciation (Sarris, 2013; Clark and Kalani, 2011). The lack of enthusiasm depends on different factors: basis risk exposure, high price, transaction costs and the difficulty in delivering the products (Skees, 2003, Hess, 2003, Larson et al., 2002). All these obstacles affect farmers' willingness to purchase the contract, to pay the premium and, more generally, to bear total transaction costs related to their purchase with respect to the potential advantages of such contracts. The farmers' overall risk exposure, and the existence of alternatives, both formal and informal, are also important elements affecting the decision to purchase.

One important point in this analytical framework is the ability of farmers to implement their own combination of risk management strategies. In fact, while the purchase of insurance cannot cover the complete range of risks to which farmers are exposed, their willingness to purchase external insurance depends on how effective and suitable is the product in addressing their expectations for protection and on how able they are to combine traditional and more modern strategies in order to achieve what they believe is the optimal combination, given the budget constraint, in order to stabilize their revenue. In the following sections, we study whether flexibility of the contract and risk management strategies implemented by farmers are important factors affecting the willingness to pay for drought risk protection. The remaining part of the paper is organised as follows. Section 2 reviews the literature on the determinants of the willingness to pay for index-based insurance referred to various countries in the world and with specific focus on Ethiopia. After a brief overview of main factors studied in the literature, the accent is on two specific aspects: the importance of the flexibility of contractual conditions to adapt to potential customers' preferences and the role of alternative risk management strategies customers can implement. Section 3 presents the experimental design and the product's attributes. Section 4 provides the results of the univariate analysis. Section 5 and 6 offer the presentation of the multivariate methodology and a discussion of the main findings. Section 7 concludes.

2. Findings of international studies and the case of Ethiopia

Studies on the reasons behind the preference of rural households concerning index-based insurance, and on their willingness-to-pay (WTP) for it are abundant in the literature. They mostly aim to explore the main factors behind the households' choices, related to their socio-economic

characteristics, to the products offered or to the supplier and supplying system. Different delivery channels may have different impact on the potential customers' preferences; the type of product (for example, an index-based policy or a weather derivative) and its features also affect the WTP, depending on how well they meet the expectations of the clientele. Some of the studies are mostly theoretical but the majority rely on field data or experiments. The efficacy of experiments and the reliability of their outcomes are still under discussion as, while supporters show their benefits (Norton et al., 2011 and 2012), they are artificial by definition although they want to replicate reality, and, in some cases, limited correlation is found between outcomes from experiments and choices of real insurance (McIntosh et al., 2013). When they are based on hypothetical products, answers obtained do not necessarily represent actual behaviors (Breidert, Hahsler, and Reutterer 2006, as quoted by Hill et al., 2013). In some studies such as Hill and Robles (2011) or McIntosh et al. (2013), outcomes of experiments and of real insurance schemes show little correlation. Norton et al. (2011, 2012) find the opposite. However, Hill and Vecsisza (2010) state that small-scale field experiments have the advantage of being conducted in an environment in which disturbing effects, such as credit constraints or trust issues, are absent. More importantly, Patt et al. (2009) highlight the learning process triggered by experimental games, which may increase financial literacy and trust. On the other side, given the inexistence of a market for insurance products, this is often the only possible choice.

Factors affecting WTP found in the literature cover different aspects of the clientele: their status, financial and economic situation, preferences and attitudes, the environmental conditions. Soil quality, agro-climatic zones, types of disaster risks are portrayed as objective factors by Hill and Robles (2011) or Sakurai and Reardon (1997). The characteristics of the households are also relevant, from those related to the size and economic conditions to more personal ones. For example, studies show that wealth matters but has an ambiguous effect on the WTP (Patrick, 1988); assets, in fact, while allowing for shock absorption may also imply some moral hazard and push farmers to take higher risks. Land extension may show the same contradictory trends even if some studies prove a positive relation of this attribute with the WTP (Aker et al., 2009). Clarke and Kalani (2011) find an interesting irregular pattern where the highest take-up ratio of insurance is expressed by the intermediate wealth levels; in fact, too poor farmers may have nothing to lose and do not need to insure, while very rich farmers may have other options than weather index insurance (Castellani et al., 2013). Other factors positively affecting the WTP for insurance relate to cash holdings (Cole et al., 2009) but also opposite relations can be found,

especially in the case cash comes from aid. In fact, in different studies, subsidies or initial endowments in experiments are the main element inducing farmers to subscribe insurance (Sarris, 2013) but this fact may distort farmers' decisions and the interpretation of the results of the studies on the WTP. As Sakurai and Reardon (1997) point out, public food aid too may have moral hazard effects on farmers' decisions.

Patt et al. (2009) focus on behavioral factors: emotions and trust in the suppliers, in the product or in oneself. In fact, for example, people are sensitive to the channel or strategy used to offer insurance as these elements may affect their knowledge and trust. Trust is found very relevant by Cole et al. (2009) and Hill and Robles (2011). Another important fact outlined is the role of social links in subscribing insurance, as potential customers are more likely to participate if they subscribe the contract as a group (Hill et al., 2013) especially if the potential subscriber is not educated. Akter et al. (2009) or Giné et al. (2008) stress the importance of customer awareness in increasing the WTP.

Customers' knowledge and awareness have to do with the complexity of the contract which, in turn, is defined by its attributes: price, maturity, delivery methodology, chosen index, triggers or thresholds, compensations, etc. Conditions directly affect the WTP, and quite often, their effect is combined; the products offered may be characterized by different degrees of complexity and of flexibility in adapting to the ability of the farmers to understand the product and to his/her specific situation. Cole et al. (2009), in fact, find that demand for insurance may not be so reactive to price per se but to the combination of price and suitability of the index chosen, or other contract conditions. In this evaluation, transaction costs are important. They can be borne by the supplier (and then charged as loading on premium) or by the customer, who has, for example, to travel to the supplier seat to buy the product. In this respect, Hill et al. (2013), find that cutting transaction cost increases the WTP: they find that distribution through local risk-sharing groups is preferred by customers.

The product terms and conditions affect the important issue of basis risk amplitude (Hill et al., 2013; Fuchs and Wolff, 2011): the more the product is built such that farmers compensations are aligned with actual losses, the higher is the preference for insurance. In a pilot study in Ethiopia by Volpi (2005), farmers explicitly express the fear of low correlation between rainfall patterns at the weather station and those of the area where they had their plots.

More generally, farmers appear to be sensitive to the ability of the product to fine-tune as compared to their situation. In the study of Hill and Robles (2011) conducted in Ethiopia, the basic idea is that farmers are diversified in their production and preference structures and need to be offered diversified insurance contracts. They in fact maintain that offering each farmer a combination of weather derivatives is better than offering an index insurance, somehow standardized. Lack of customization and of flexibility may hamper the adaptability of products to farmers. Farmers are different for various reasons; an intriguing one proposed in the paper is that, in order to diversify among members of the same risk-sharing group, they may make different production decisions as compared to neighbors. Also the study by McIntosh et al. (2013) which focuses on the use of fertilizers and their relationship with weather index insurance in Ethiopia highlights the role of product design and the challenge represented by fine tuning the products. The study of Volpi (2005) also stresses that farmers are aware of multiple risk exposure and of the fact that insurance only compensates for one risk. In fact, single-risk protection may not appeal if the price is not low enough. Therefore, the more the contract is flexible in its terms and conditions, the more likely is that the potential customers would buy insurance for a given price. This supports the proposal of a compound index product (Elabed et al., 2013) or a combination of different weather derivatives including more than one risk (Hill et al., 2013) can contribute to overcome the asserted rigidity of such contracts.

Together with the flexibility of the contract, farmers' attitude toward risk and strategies to face it are other key factors. Perceived risk exposure is found to be positively associated with higher WTP for insurance (Hill et al., 2013). The attitude towards this risk exposure may end up in contradictory outcomes, sometimes counter-intuitively, as other factor complicates the decision. A negative correlation between risk aversion and WTP is found, under specific conditions, by Hill et al. (2013) for Ethiopia. Giné et al. (2008), in their study on India, find that risk averse households are less likely to purchase if unfamiliar with the insurance contract or with the dealer. Hill and Viceiza (2010), on the contrary, in their field experiment in Southern Ethiopia related to the purchase of fertilizers and their links with index insurance, show, among other things, a positive link between the purchase of insurance and risk aversion.

Risk exposure and attitude towards risk affect the WTP in different ways considering that households have different strategies to face the various situations, ex-ante and ex-post. Sakurai and Reardon (1997), for example, find that wealthier, more self-insured farmers demand less formal drought

insurance. Off-farm income and livestock holdings induce lower demand for formal insurance, as both allow to implement self-insurance mechanisms and to diversify. Nevertheless, this depends on the stratum of the sample they analyze; for example, in the upper stratum, neither off-farm income nor livestock holdings have a significant effect. Akter et al. (2009) too stress the role of different risk management strategies: extension of the areas, household head occupation, land ownership and farm size, are all elements related to the degree of ability to self manage risk. Gautam et al. (1994), do not test only for risk attitude but, in their study in India, empirically test for the joint hypothesis of risk avoidance and welfare smoothing, with the aim of studying the latent demand due to inadequate risk management strategies. Their results prove that this demand is high. The study of Hill et al. (2013) focuses on the demand for weather insurance based on products and farmers' characteristics. They also confirm that people with higher risk exposure or, with some controversy, who are more risk averse, buy more insurance and that potential customers tend to optimize risk management by combining informal risk sharing and insurance depending on levels and types of risk. To investigate these effects, estimates on risk aversion, time preference and the possibility to count on neighbors or the community for help in case of shocks as well as source of finance for emergency (credit, sale of assets, participation in emergency-insurance groups such as the *iddir* or remittances) are considered.

Norton (et al., 2012) in their study based on experimental games in Ethiopia compare different choices among options about how allocate an initial cash endowment: taking the drought index insurance, investing in simulated savings accounts, participating into risk-sharing groups, or holding cash. Decisions on allocations are observed. Choice of higher frequencies of payouts is recorded as a preference for liquidity but also as a consequence of insufficient self-insuring mechanisms which would probably be more cost-effective. More frequent choice of insurance over savings and over participation in risk sharing groups is another outcome. These results confute the common belief that poor farmers would minimize their expenses and the related insurance coverage. Clark and Kalani (2011) in their experiment in Ethiopia aim to analyze the determinants of WTP for index insurance and for indemnity insurance. They find that historical risk exposure has an important role in positively influencing take-up rates of indemnity insurance. In general, participation into risk-sharing groups has the same effects on both types of insurance. They interestingly stress the rationality of farmers in choosing their products, interpreting eventual low take up rates with the unsuitability of the contract for the potential clientele.

This goes back to the issue of the product design and the need to make it suitable to the target clientele with flexible conditions. The preceding discussion showed that clientele expectations and preferences may also depend on the clientele's ability to adopt alternative or complementary risk management strategies. Therefore, insurance can be perceived differently depending on the characteristics of the customer which explains different signs in the correlation between WTP and some causing factors. Some of the cases of controversial effects mentioned above can indeed be explained in such a conceptualization. New insight also comes out of the field research presented in this study.

3. Experiment framework and insurance attributes

In order to study how flexibility influences the willingness to pay for drought insurance products, we provide, first, a definition of flexibility. We assume that an insurance product is flexible when the product's attributes can be tailored according to the consumer's characteristics and preferences. Among household's characteristics, existing risk management strategies against drought are the main substitutes or complements of insurance and so, important determinants of the insurance take-up. This risk management perspective is discussed further in the multivariate analysis.

In a simple way, we suppose that the utility that each household obtains from the insurance product is a linear combination of the attributes, X_i 's, and a random component, ϵ :

$$U = \sum_{i=1}^J \beta_i X_i + \epsilon \quad (1)$$

Equation (1) points to a straightforward approach in both the data collection and the empirical analysis. Data was indeed collected through a discrete choice experiment with fractional factorial design in which the surveyed households were asked to make a choice out of different choice sets (Hensher et al., 2005). In discrete choice experiments, each choice set is made up of two or more alternatives where one alternative might be the *status-quo*. In our case, the non *status-quo* alternatives are characterized by insurance product's attributes while the *status-quo* alternative is the no-insurance situation, that is the current household's status. The experiment complies with orthogonality in the product's attributes (Hensher et al., 2005). Apart from traditional advantages of choice modeling (CEI, 2001), providing different combinations of premium and other attributes allows to test for

heterogeneity in the household's preferences. The latter is the research question that we want to address in this study. In fact, we can argue that the greater the heterogeneity, the greater the necessity to provide flexible products. The expected results of this small-scale field experiment can however be controversial, also due to the questionability of the experiments themselves, as previously explained, but, bearing in mind these limits, can provide interesting insights. The theoretical model and the empirical methodology are discussed in detail in the next sections.

The experiment was conducted on a sample of 205 rural Ethiopian households in the Wolayta zone (SNNP region) over a period of 3 weeks, in November 2013. The households were randomly selected from a larger sample of 360 households already involved in a three-year data collection project (2010–2013). The surveyed farmers were from three *Kebele*, i.e. the smallest administrative unit, improperly referred to as villages in this study. The villages are representative of three different agro-ecological zones of the Wolayta area which differ in terms of altitude, rainfall pattern, and households' livelihood strategies. The zones are named by the Ethiopian Ministry of Agriculture after their characteristic crops: the ginger and coffee zone, barley and wheat zone, and maize and root crop zone.

We decided to keep the field experiment as simple as possible. We opted for an insurance product with a limited number of attributes and attribute levels. The reasons for that are twofold: first, the percentage of illiterate people was high (37%), and second, neither traditional crop insurance nor other kinds of formal insurance were available at the time when the survey was conducted. These two problems can hinder the ability of interviewees to fully understand the insurance product and the utility that they can derive from using it. A preliminary training in groups of 10-20 people was also provided to all households. The training focused especially on drought probability, insurance and the problem of basis risk, the latter explained by the fact that the rainfall is hypothetically measured at the main district town.

The hypothetical product offered to the households was not designed according to the real rainfall data but according to the revealed perceived drought frequencies. Data on perceived frequencies were retrieved from a previous experiment that was conducted in the same villages in March 2013 (Castellani et al., 2014). We picked two different frequencies each that are representative of the observed distributions: 2 and 3 years for moderate drought, and 10 and 18 years for severe drought. The product pays a fixed indemnity when either a moderate or a severe drought occurs. We provided households with simple and straightforward definitions of both moderate and severe drought that were agreed upon during preliminary focus group

activities. A moderate drought was defined as “insufficient rainfall that leads to a reduction of production yield and lack of grazing land”, and a severe drought was defined as “no rainfall at all that results into no agricultural production, no consumption, high poverty and death of human beings, animals and plants.” Even though the definitions seems to be on a very vague level, the fact that they were established together with farmers make them relevant for the experiment. This is supported by the stated drought frequencies. Indeed, the average perceived frequency of a moderate drought is one every almost 3 years (Std Dev. 1.14), while the average perceived frequency of a severe drought is one every almost 10 years (Std Dev. 4.83).

The fair premium for every insurance product was established beforehand. The objective was to build reasonable hypothetical products that households can actually afford. The range of the fair premium was settled employing as a benchmark the premium of a drought insurance product that was already available in another area of the same region and had proved to be somewhat successful (Hill and Robles, 2011). The fair premium levels were ETB 50 and ETB 100. The indemnity was then determined as the ratio between the fair premium and the selected probability of drought, that is the inverse of the frequency.

Each household was faced with eight different choice situations, four for moderate drought and four for severe drought. In each choice situation, the respondent could opt for one of two different insurance products or the *status quo* alternative. As one insurance alternative was selected, the interviewee was asked to choose how many insurance contracts of that type of insurance he/she would be willing to buy, considering the total premium to be paid and the total expected indemnity.

Apart from frequency, premium and indemnity, the other product's attributes are: loading, home delivery, and deferred payment. The former is a non explicit attribute since it is only implied in the premium. The loading consists of a 15% increase in the fair premium that we deem as devoted by the insurer to cover the operating cost. This percentage is also hypothetical and does not necessarily correspond to the real cost. The loading attribute levels are therefore “loading” and “not loading”. Home delivery implies that the insurance product is delivered and paid at household's door step as well as when the indemnity would be redeemed. In the opposite case, the household should go to the main district town to perform all the transactions. This attribute allows for possible transaction costs that arise from the opportunity cost of time and the potential transportation costs. All main district towns are between 15 and 20 km from the villages' administration units that are usually located at the village's midpoint. Whereas some

households might live very close to the district town and have easy access on foot, for other households the distance might be relevant implying high transaction costs. The last attribute is the deferred payment. Households can pay the premium either before (at the beginning of the *Belg* season) or after the rainy season (at the end of the *Meher* season). A deferred payment implies an extra premium of 10% as interest rate. Whether the deferred payment is preferable depends on two factors. First, the period after the rainy season corresponds to the main harvest and most of crop cash income is generated in this period. Despite the experiment should avoid the liquidity problem, liquidity could however still be perceived as a constraint and households might prefer to pay the premium when most of the liquidity is available. Second, households can be impatient and discount future payments more than the implied interest rate. This also can contribute to prefer the deferred payment.

Figure 1 provides an example of the choice set.

Figure 1

Example of the choice set

Choice set 1		A	B	SQ
Frequency (years)		3	2	
Premium (ETB)		100	110 (including interest)	
Indemnity (ETB)		300	200	
Deferred Payment		No	Yes	
Home delivery		Yes	No	
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of contracts		Premium (Indemnity)	Premium (Indemnity)	
1		100 (300)	110 (200)	
2		200 (600)	220 (400)	
		

The next sections provide an univariate and multivariate analyses respectively.

4. Univariate analysis of attribute heterogeneity

On a theoretical basis, the hypothesis that there exists a demand for a flexible insurance product can be tested against the null hypothesis that there exists a demand for a standardized product. This can be carried out by testing how different are the choices made by the surveyed households. In particular, we want to examine the variation in the preferred insurance attributes. Preliminary insights can be gained by analyzing the responses of households that stated to be willing to buy at least one of the offered insurance products. The total households that decided to buy at least one product are 192 or 94% of the sample. This figure includes 117 (57%) households that opted for the product alternative in all the eight choice occasions, 32 (16%) in seven choice occasions, 18 (0.9%) in six choice occasions, and 25 (12%) in less than six choice occasions. The average total premiums are ETB 146 and ETB 151 for moderate and severe drought insurance respectively.

In order to compare different households, the first step is to identify a virtual product for each household that consists of the average attribute levels of the preferred products. Since each household stated to buy a certain number of contracts of the preferred products, the average can therefore be determined as a weighted mean of the attribute levels where the weights are the associated total premiums that the household is willing to pay. Table 1 reports the weighted averages and the standard deviations. However, these figures do not provide any information on the level of heterogeneity in the attributes. The standard deviations in absolute values are not comparable and there are no statistical values associated. We develop a simple heterogeneity proxy given by the ratio of the mean and standard deviation and we construct confidence intervals through bootstrapping. The results (Figure 1 and Figure 2) suggest that for the demand of both moderate and severe drought products most of heterogeneity is generated by the loading, home delivery, and deferred payment attributes. The loading increases the premium and for some households this increase in the cost of the product can reduce their willingness to pay. The home delivery entails a reduction in transaction costs and so, contrary to the loading, can increase the willingness to pay. The deferred payment, on the one hand, heightens the premium but, on the other hand, allows to make up for the premium when most of agricultural income is generated. By comparing attributes of moderate and severe drought

insurance, preference heterogeneity seems to be more relevant for severe drought products.

The heterogeneity in the attributes is, in turn, explained by the heterogeneity in the socio-economic characteristics of the households. This can however be tested only through a multivariate analysis. Besides, given the high percentage (94%) of households that accepted to buy at least one product, these results can be partially led by the design of the experiment. Only a multivariate analysis that includes all households can control for the product design. We carry out this analysis in the next section.

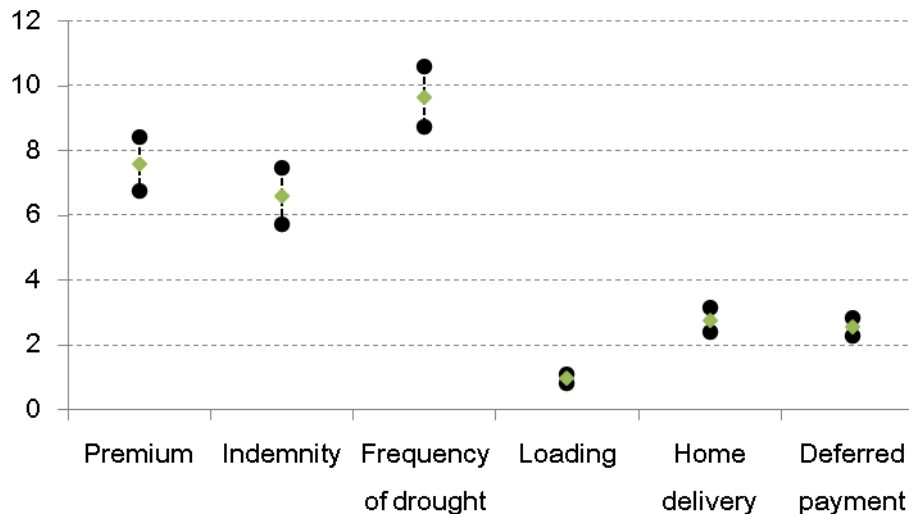
Table 1

Weighted average and standard deviation of attribute levels.

Attribute/Drought impact	Moderate		Severe	
	Mean	Std Dev.	Mean	Std Dev.
Premium (ETB)	97.15	12.79	90.23	14.48
Indemnity (ETB)	223.35	33.83	1113.81	244.74
Frequency of drought (years)	2.56	0.26	13.89	2.15
Loading (1-0)	0.48	0.50	0.48	0.50
Home delivery (1-0)	0.73	0.26	0.64	0.26
Deferred payment (1-0)	0.50	0.19	0.47	0.23

Figure 2

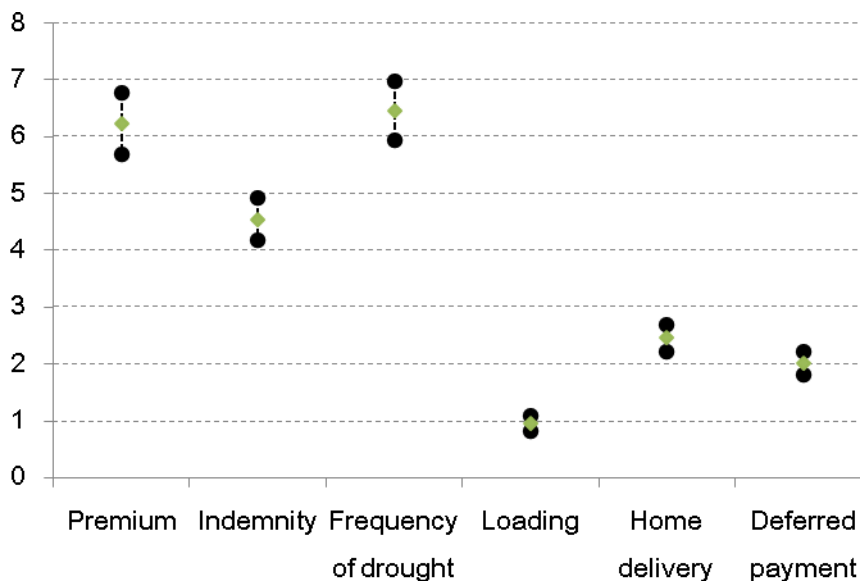
Mean and confidence interval (95%) of the Mean-Std. Dev. ratio of product attributes for moderate drought.



Notes: bootstrapped confidence intervals with 1,000 repetitions.

Figure 3

Mean and confidence interval (95%) of the Mean-Std. Dev. ratio of product attributes for severe drought.



Notes: bootstrapped confidence intervals with 1,000 repetitions.

5. Multivariate methodology

Heterogeneity in the demand of a product implies that the utility that each individual obtains if the product were standardized is remarkable dissimilar. In equation (1), heterogeneity can be expressed with individual specific parameters of the attributes that allow for taste variation. Assume that a household n faces a choice among J alternatives in each of T choice situations. Equation (1) can be reformulated as follows:

$$U_{njt} = \beta'_n x_{njt} + \varepsilon_{njt} \quad (2)$$

where x_{njt} are the attributes and ε_{njt} is a random term. The coefficient vector β_n is unobserved by the researcher and varies across households with density $f(\beta_n|\Omega)$, where Ω are the parameters of the distribution that are to be estimated. The stochastic element, ε_{njt} , is also unobserved and different assumptions on its distribution result in different choice models. As is usually common in choice analysis, we impose the condition that ε_{njt} is independent and identically distributed (IID) extreme value type 1 (or Gumbel) across all n, j , and t (Hensher et al., 2005). Conditional on β_n , the logit probability of household n choosing alternative j in the choice situation t is:

$$\pi_{njt}^{std} = \frac{e^{\beta'_n x_{njt}}}{\sum_i e^{\beta'_n x_{nit}}}, i = 1, \dots, J \quad (3)$$

The standard logit model, as expressed by (3), does not allow for unobserved characteristics that can induce correlation among the alternatives in a choice situation and among the choices over time. The mixed multinomial logit model, i.e. the unconditional logit probability, overcomes these restrictions by allowing for the variance in the unobserved household-specific parameters and, therefore, does not exhibit the property of independence from irrelevant alternatives (IIA) (Revelt and Train, 1998). The mixed logit probability is:

$$\pi_{njt}^{mix} = \int \left(\frac{e^{\beta'_n x_{njt}}}{\sum_i e^{\beta'_n x_{nit}}} \right) f(\beta_n|\Omega), i = 1, \dots, J \quad (4)$$

Equation (4) is a weighted average of the logit formula evaluated for different values of β_n . It follows that the mixed logit probability for the sequence of choices is:

$$\Pi_{njt}^{mix} = \int \prod_t \left(\frac{e^{\beta_n^i x_{njt}}}{\sum_i e^{\beta_n^i x_{nit}}} \right) f(\beta_n | \Omega) , i = 1, \dots, J \quad (5)$$

In (5), we want to estimate Ω , that is, the population parameters that describe the distribution of individual parameters (Revelt and Train, 1998). Moreover, normally distributed zero mean error components based on household's characteristics are added to the mixed logit model in order to allow for different variances of the insurance alternatives and the *status-quo* option, that is, to accommodate heteroskedasticity (Scarpa et al., 2007).

6. The risk management framework and results

In the surveyed area as well as in most of rural Ethiopia, both traditional and index-based crop insurance are not available. The implication for our analysis is that there is no insurance alternative to the hypothetical products offered in the experiment. The *status-quo* is therefore a no-choice option. Potential substitutes or complements of insurance can be the set of different risk management and coping strategies that the households implement to deal with drought risk. Some traditional strategies can indeed be ineffective when the risk is systemic. For instance, local risk sharing networks provide a limited support in case of drought if most of members of the networks are affected. According to Morduch (1995), poor households in low-income countries cope with risk in a two-step procedure, that is, through, first, income smoothing and, second, consumption smoothing. In the presence of drought risk, the income smoothing can be pursued by, for example, carrying out low-risk and low-return livelihood strategies, acquiring drought-resistant production technology, such as improved seeds, or diversifying the income sources. We focus on the role of diversification because the data does not allow to know whether the seeds used by farmers are drought-resistant and to single out which activities can be considered as with low-risk and low-return. In particular, we employ a measure of crop diversification and the ratio of off-farm income over total income. The former measure is a Herfindhal

index of the land diversification. The higher the index, the greater the diversification of land over different crops. On the other hand, consumption smoothing strategies consists of "...borrowing and saving, depleting and accumulating nonfinancial assets, adjusting labor supply, and employing formal and informal insurance arrangements." (Morduch, 1995, p. 104). Whether the household can have access to borrowing and new job opportunities when a drought occurs cannot be predicted in advance. Moreover, local credit and job markets might also be hindered by the effects of a drought. In this regards, Sen (1981) suggests that droughts lead to a collapse of the demand for local services and crafts. In the absence of formal insurance and the presence of ineffective informal insurance, as discussed above, the accumulation of saving and nonfinancial assets seems to be the best available strategy against drought. In rural Ethiopia, livestock holdings are the main assets. Livestock raising is also an important source of income for many households. However, the sale of assets such as livestock can be ineffective if local markets are thin and fairly inactive (Fafchamps et al., 1998). If this is the case, distress sales lead to a lower price than the real market value and livestock purchases turn to be partially irreversible investments (e.g., Dixit and Pindyck, 1994; Fafchamps and Pender, 1997). According to the authors' experience, in the surveyed area the livestock markets are located in the main district cities and they are both thick and very active. Beside a measure of total net assets, we consider also a proxy of livestock diversification that is a Herfindhal index as in the case of crops. The total net assets consist of livestock holdings, savings, agricultural assets and nonagricultural assets, net of total borrowings. Finally, the *status-quo* and village constants are also included in the equation. The former controls for the constant either gain or loss in the utility if the household remains in the *status-quo* and does not choose any insurance. The village constants allows for unknown effects of differences between villages such as rainfall patterns or

The equations of insurance alternatives are a linear combination of the attributes excluding the frequency of drought since it is assumed to be collinear with the indemnity. We include also two zero-mean error components. The first is a dummy variable that takes the value of 1 if the interviewee is illiterate and 0 otherwise. As stated above, illiterate people can be less able to appraise the value of insurance. The second is a dummy variable that allows for the gender. The female are usually not primarily involved in the agricultural activity, although they have some tasks, and so they might be less aware of the impact of drought on the agricultural production.

The distribution of the random parameters are tested in a step-wise procedure and the final selection is discussed in the results. In particular, we do not impose any particular restriction on the distribution of the premium to allow for inconsistent behaviors that are observed in Castellani et al. (2014).

Table 2 presents the results of the estimates. First, the specifications are reasonably good. In both models the zero-mean error components are very statistically significant and this implies the both illiteracy and gender are important determinants of the capacity to appreciate the utility of index-based insurance. On the contrary, apart from the constant and the proxy for livestock diversification in the “moderate” model, most of risk management variables in the status-quo equation are not statistically significant. These results are contradictory with, for instance, Sakurai and Reardon (1997) and Akter et al. (2009) where they find that the risk management strategies are significant determinants. This suggests two possible explanations. The first is that these strategies are deemed ineffective by the households to deal with drought. This hypothesis is somewhat supported by the change in sign or magnitude of coefficients from the “moderate” model to the “severe” model. The other possible explanation is that as the lack of disturbing effects, such as credit constraints or trust issues, in small-scale field experiments (Hill and Veceisza, 2010), the effect of risk management strategies is also irrelevant in the decision process. This hypothesis can be tested only against a real scheme.

The analysis of heterogeneity of attributes put forward that an important even though partial taste variation is present and it is generated by the indemnity and the home payment variables. We considered a normal distribution of coefficients. Premium, loading and deferred payment are instead considered as fixed parameters because the standard deviations turned out to be statistically insignificant in all the different model specifications that were estimated. As expected, the coefficients of the premium and the indemnity have the opposite signs in both models. However, while in the “moderate” model the signs are consistent with the theory, that is negative for premium and positive for indemnity, in the “severe” model the signs are inverted. This inconsistency is similar to Castellani et al. (2013). An explanation rests on the hypothesis that the insurance for severe drought have no close substitutes and is alike to a Giffen good. A necessary and sufficient condition for insurance to be a Giffen good is that absolute risk aversion either increase or decrease sufficiently rapidly (Briys, Dionne and Eeckhoudt, 1989). The price increase can be translated to a wealth decrease, i.e. wealth effect. If this negative wealth effect heightens the absolute risk aversion rapidly, then the individual may purchase more

insurance, even though the price increases. Another explanation comes from Norton et al. (2012) where they find that households prefer higher frequency of payout. In our case, severe drought is a very low frequency event and the frequency effect may prevail the price and indemnity effects. The estimates of the mean and standard deviation of the indemnity's coefficient imply that the sign is relevant for almost 73% of households in both models. For the home delivery attribute, the coefficient is positive and the percentage of households is 80% and 74% for the "moderate" model and "severe" model respectively. The magnitude of the mean of coefficients though indicates that the home delivery attribute is more important for the severe drought insurance products. This result hints that transportation costs as well as the opportunity cost of time can be detrimental in the decision to buy insurance. This result is consistent with Hill et al. (2013) where insurance delivery through local risk-sharing networks turned out to be important.

The loading and deferred payment attributes appeared to have fixed parameters. While for the deferred payment attribute the coefficient is not significant in both models. for the loading attribute it is statistically significant only the "severe" model and the sign is negative as expected.

Table 2

Estimates of mixed logit of both moderate and severe drought insurance models

<i>Model</i>	<i>Moderate</i>		<i>Severe</i>	
<i>Variable</i>	<i>Estimate</i>	<i>Std Err.</i>	<i>Estimate</i>	<i>Std Err.</i>
<i>Insurance equations</i>				
Premium	-0.011**	0.006	0.019***	0.005
Indemnity	0.006***	0.002	0.001***	0.000
Sts Dev. Indemnity	0.010***	0.002	0.002***	0.000

Loading	-0.101	0.753	-1.500**	0.837
Home delivery	1.878***	0.278	2.229***	0.370
Std Dev. Home delivery	2.213***	0.361	3.319***	0.474
Deferred Payment	-0.118	0.139	-0.295	0.214
Err. Comp. Illiterate	3.862***	1.114	4.675***	1.055
Err. Comp. Gender	3.392***	0.726	3.948***	0.731

Status-quo equation

Constant	-9.760**	4.069	-6.187	4.237
Crop diversification	4.358	2.961	-3.005	2.013
Share of off-fam income	-0.964	1.468	-1.820	1.599
Net assets (log)	0.337	0.360	0.433	0.408
Livestock diversification	-3.781**	1.679	-2.538	1.769

N. of Obs	2423	2424
LR – χ^2 (12)	82.45***	72.86***
Pseudo-R2	0.25	0.23

*** Significance level at

1%

**Significance level at

5%

* Significance level at

10%

7. Conclusions

This study aims to contribute to the literature on index-based insurance in low-income countries and, in particular, the demand of drought insurance. The main objectives are, first, to assess how product's heterogeneity is important in the decision to buy insurance and, second, to test whether the available risk management strategies are possible complements or substitutes of insurance. We believe as in the case of Hill and Robbles (2011), that insurance products with flexible attributes can increase the take-up likelihood since farmers are heterogeneous on the base of socio-economic

characteristics and have a different perception of the value of the insurance. The heterogeneity is analyzed from the perspective of product's attributes, i.e. contractual conditions such as: premium and loading, indemnity, period of payment of the premium, and place where the product is delivered. In particular, we consider the variation in the preferred attributes and their effects on the willingness to pay. The data collected through a discrete choice experiment allows to test for heterogeneity. We conducted the experiment in three rural villages in Southern Ethiopia.

Preliminary insights provided by a univariate analysis suggest that most of heterogeneity is generated by three attributes: loading to cover for administration and distribution costs, home delivery, and deferred payment. This means that the surveyed households, while differing on different aspects, are differentiating their strategies mainly basing the decision on the costs of the product (with and without loadings), the implicit transaction costs related to delivery, the cost linked to the possibility to delay payments. This outcomes may derive from the fact that most of the interviewed farmers present very similar socio-economic structures and similar risk management strategies, only differentiating on the size which may allow different attitude towards the overall cost of the new insurance product

On the other hand, the multivariate analysis conducted through the estimation of a mixed logit put forward that the heterogeneity is explained by the indemnity and home delivery attributes. These results hint that the size of the compensation in case of drought and the transactions costs are perceived in a different way from household to household. The added error components suggest further that if the consumer is illiterate and/or female (on average less educated), she can be less able to appreciate the real value of insurance. Another source of heterogeneity is also provided by the type of drought impact. The different estimates of the models for moderate and severe drought insurance indeed suggests that the households follow two dissimilar decision processes that can be somewhat explained by the difference in terms of drought frequency. Besides, in the case of the "severe" model, the results are not consistent with law of demand. This apparent contradictory outcomes may derive, indeed, from the heterogeneity of farmers and, as portrayed in Castellani et al. (2014), from their rationality, confirming Clark and Kalani (2011) which induces farmers to appreciate the contract in the case they can better handle and assess (moderate case). We can in fact assume that in the extreme case (severe drought), the farmer realizes her inability to duly evaluate the conditions and cost/benefits.

To sum up, the analysis demonstrates that the difference in households' characteristics and perceptions implies that a generalized offer of

standardized insurance products may not be the optimal solution. Individual preferences, also based on the ability of the farmers to understand the products and different objective situations, imply that rational farmers express a quite diversified demand which should be satisfied with a flexible offer of insurance products.

Diversifying the offer of insurance products in rural areas, then, becomes a suggestion and at the same time a challenge for insurance companies and other entities involved in pilot projects or actual marketing. This suggestion would appear an obvious statement for the offer of insurance but it has been often forgotten in low-income countries where the potential customers' preferences are often ignored (in microfinance and microinsurance) for the sake of keeping the products simple. Potential customers show, on the contrary, their sensitivity to the suitability of the products to their actual needs.

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