Willingness to pay for index based crop microinsurance in India

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Abstract

Microinsurance is potentially a useful tool that facilitates low-income households' transition out of poverty. However, the uptake of microinsurance products is low and this is a phenomenon that is not specific to any country or continent. Studies on the demand for microinsurance, especially in the Asian markets, are scarce. This paper focuses on the demand for index based crop microinsurance in India. Indian agriculture accounts for 23 percent of the nation's GDP. In view of the significance of agriculture in the Indian economy and its vulnerability, the need for evolving an adequate, sustainable risk management system has been duly recognized.

India is one of the pioneers of microinsurance in the world. It is one of the first countries to have introduced regulation for their microinsurance industry. However, insurance companies in India face a variety of challenges in outreach and delivery.

I employ a contingent valuation model to study the demand for rainfall index based microinsurance programmes among 400 small and marginal turmeric farmers in Tamil Nadu, India. Using an open-ended interactive bidding process, I identify both the farmers' willingness to join (WTJ) and the amount of willingness to pay (WTP) for a hypothetical microinsurance policy.

78 percent of the samples express a willingness to join the microinsurance scheme. Further analysis reveals that while the willingness to participate is influenced by household wealth, risk attitudes, product literacy and basis risk, the amount a household is willing to pay is driven by a careful assessment of other risk coping avenues available to a household.

The paper also examines the usefulness of contingent valuation techniques in microinsurance demand analysis. The bidding procedure has been corrected for both starting point and hypothetical bias in order to obtain precise estimates of willingness to pay.

KEY WORDS: crop index microinsurance, contingent valuation, interval regression, ordered probit, Heckman selection model, Willingness to pay

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Section 1 Introduction

"The presence of uninsured risk results in welfare losses. For the poor, it is a reason for substantial hardship. At present, many poor people are not offered opportunities to insure themselves against this hardship, while the support offered when shocks occur is often limited" (Dercon 2005, pg. 20).

Poor and vulnerable communities in developing countries face substantial risks in everyday life. There is a need for *formal*[2] market based risk management solutions to facilitate poor households administer both idiosyncratic and systemic shocks efficiently.

Formal risk management strategies represent interventions at a larger scale. In general, Governments and private markets operate on larger geographies and tap into the diversities in these regions to create profitable risk portfolios. This is difficult when the risk is spread across smaller homogenous regions only (as in the case of self or mutual insurance). Such formal risk management strategies include *ex-post* formal credit (microfinance) and *ex-ante* microinsurance. The microfinance movement has gained substantial scale in the last few decades attracting academicians, governments, multi-lateral agencies and philanthropists across the globe.

Microinsurance can be defined as "a system of protecting poor people against specific shocks using risk pooling for regular affordable premiums proportionate to the likelihood and costs of the risk involved" (McCord, 2003). Microinsurance products are generally marketed through local institutions such as self-help groups, non-governmental organisations or microfinance institutions. The microinsurance sector has expanded exponentially in the last few years, from 78 million individuals insured in 2006 to 135 million insured in 2009 across the globe (Churchill et al., 2012).

Insurance companies in developing countries are keen to exploit this market base, but are *still* struggling to understand the risk portfolios of these communities and design products accordingly. Often traditional insurance products are downscaled in terms of premium and sum insured and offered to these markets. Poor households, on the other hand, are wary of these market-based solutions as they are required to pay a fee (premium) upfront for insuring a 'risk' that may or may not occur.

India is a pioneer in microinsurance and is one of the first countries that formally regulated its microinsurance sector. In India, it is mandatory for all insurance companies to ensure that atleast 5% of their gross annual premium comes from microinsurance products and businesses. It has been estimated that 50% of the total population covered by microinsurance live in India (Churchill et al., 2012)

The Indian agriculture sector accounts for 23 percent of the nation's GDP. With over 60 percent of the labour force employed in agriculture, 80 percent of agricultural land

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[2] The World Development Report (2000-2001) defines informal strategies as "arrangements that involve individuals or households or such groups as communities or villages," while formal arrangements are "market-based activities and publicly provided mechanisms."

highly rainfall dependent and the Indian farmer constantly battling against the twin problems of mounting debts and crop failures (sometimes leading to suicides), the need for effective risk management solutions has never been more pressing.

Crop index microinsurance was introduced in India through a pilot financed by the World Bank in 2003. Since then, the country has seen huge innovation in this space – both in terms of products as well as outreach models.

It is imperative to study the challenges faced by microinsurance, both in terms of product design and uptake. This paper analyses the factors that influence a household's willingness to participate in and pay for hedging their agriculture production risks. I employ a contingent valuation model to study the demand for rainfall index based microinsurance programmes among 400 small and marginal turmeric farmers[3] in Tamil Nadu, India.

Churchill et al. (2012) present an elaborate list of all literature in the space of *willingness to pay* (WTP) for microinsurance. Most of these studies are focussed on health microinsurance. It must also be noted that very few of these studies separate the *willingness to join* (WTJ) from the WTP for these schemes. It is important to distinguish between them as a farm household may be willing to join microinsurance programmes as they see value in the product but may not be willing to pay as they do not trust the insurance provider or lack the ability to pay.

This paper is one of the first attempts to not only study the WTP for index microinsurance but also separate the WTJ from the WTP for such policies. I employ a Heckman selection model where I model WTJ using ordered probit and WTP using interval regresion. The Inverse mills rato calculated from the ordered probit are incorporated in the interval regression to observe selection effects, if any.

Results indicate that while the willingness to join crop index microinsurance is influenced by household wealth, risk attitudes and product literacy, the amount a household is willing to pay is driven by a careful assessment of the other risk coping avenues available to a household and only the 'residual' risk is passed on to insurance.

The rest of this paper has been organised as follows: Section 2 reviews the existing literature, Section 3 describes the data collection process and bidding methodology, Section 4 provides the analysis and Section 5 presents the conclusion.

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[3] The Indian Government defines marginal farmers as those cultivating agricultural land up to 1 hectare (or 2.5 acres). A small farmer is defined as cultivating between 1 hectare and 2 hectares (as defined in the Financial Budget of 2008). In most Indian states, the small and marginal farmers account for between 70 to 94 per cent of total farmers.

Section 2 Literature review

Willingness to pay or WTP for a product may be defined, as the amount of money an individual or household is willing to pay for purchasing a product given her/his income, risk preferences and other background characteristics.

WTP is generally analysed using the contingent valuation method (CVM). CVM helps estimate the value an individual places on a good, usually an intangible good. The CVM was pioneered by Davis in 1963. This method is mainly used to evaluate environment and health care programmes (Blumenschein et al., 2008). However, CVM are now being increasingly used to evaluate private market goods and services.

Broadly, there are two approaches to studying WTP under CVM. The first is a close ended format also called referendum or the 'take-it-or-leave-it' approach. Here, the product is offered to the individual at a pre-determined price. The individual provides his/her preference to accept or not accept the product at that price. Hanemann and Kanninen (1999) suggest that the close ended format as a good way to elicit individuals' preferences for the reasons that it closely mimics a real market situations and reduces strategic bias (as cited in Donfouet and Makaudze, 2010). However, it is considered a rather ad-hoc approach to understanding an individual's preferences.

The other method, which is more widely used, follows an open-ended format and is called the "interactive bidding" (IB) method. Under the IB method, an individual is offered the product at a starting price. If s/he accepts the price, a higher price is offered and the process goes on until s/he rejects the bid. Alternatively, if s/he rejects the price, a lower bid is offered and the process goes on until s/he accepts the bid. There is a huge literature dedicated to bidding methodologies, which is elaborated on in a later section.

While the IB method helps identify a more precise estimate of WTP, it also suffers from certain limitations including starting point bias and hypothetical bias. Starting bias arises when respondents interpret the starting value in the bidding game as being indicative of market information, or as representing a typical bid. For instance, Kartman and colleagues (1996) found that individuals in the highest starting-bid group were willing to pay double that of those in the lowest (as cited in Dong et al., 2004, pg 124).

Starting point bias can be reduced by using a range of starting point bids (i.e. different starting values for different respondents) and comparing the effect of each of those starting points on the final WTP value elicited. For example, to study WTP for community based health microinsurance in Burkina Faso, Dong et al (2004) use as many as thirteen starting bids.

Hypothetical bias arises when an individual responding to a survey fails to take into account the additional information s/he possesses in terms of her/his budgetary constraints, preferences, available substitutes etc (Slovic, 1972 as cited in Bateman, 1993). Thus, in order to make results more accurate, it is important to explicitly introduce "mental accounting" into CVMs by asking some initial questions about the respondent's total yearly budget etc (Bateman, 1993). Hypothetical bias can be dealt

with using a cheap talk script[4] or respondent certainty method[5] (Blumenschein et al., 2008).

Having reviewed the methodology to elicit WTP, the next step is to identify relevant literature on factors that affect WTP of microinsurance. Drawing from Gustafsson-Wright et al.'s (2009) model of WTP for health microinsurance, one may generalise the WTP for microinsurance as follows:

$$WTP = \phi \ (q^1, q^0, y, X, \Pi, \gamma, \varepsilon)$$

where, q^1 and q^0 are the levels of utility associated with and without insurance, y is wealth, X represents a vector of socio economic characteristics (age, sex, education etc), Π is probability of facing the risk, γ is measure of risk aversion and ε represents other unobserved factors. ϕ (.) is the maximum value individuals are willing to forgo to avoid or lessen their exposure to a particular risk. Therefore, individuals will buy the insurance policy only if:

$$V \ (q^1, y–WTP, X, \Pi, \gamma) \geq V \ (q^0, y, X, \Pi, \gamma); \varepsilon$$

where, $V \ (q^1, y–WTP, X, \Pi, \gamma, \varepsilon_1)$ and $V \ (q^0, y, X, \Pi, \gamma, \varepsilon_0)$ are indirect utility functions with and without insurance respectively for an individual and ε_1 and ε_0 are assumed to be i.i.d with zero mean.

However, it is important to distinguish the WTP from the willingess to participate or join (WTJ) the programme in the first place. A household may be willing to join microinsurance programmes as they see value in the product but may not be willing to pay as they do not trust the insurance provider or lack the ability to pay. Mathiyazhagan (1998) studied both WTJ and WTP for health microinsurance in India and reported that the probability of willingness to join was greater than the probability of willingness to pay. However, there is no literature to my knowledge that separates WTJ and WTP for index based crop microinsurance policies.

Demand for rainfall insurance is shown to be highly dependent on price (with a price elasticity ranging from -0.66 to -0.88) and sensitive to cash on hand in Cole et al. (2008). Microinsurance demand is lower in the poorest and richest households and is highest in households with intermediate wealth. Clarke and Kalani (2011) provide evidence for such a hump-shaped relationship between weather index microinsurance demand and wealth based on a study in rural Ethiopia.[6]

Demand for microinsurance and nominal income levels are known to be positively correlated, while household income and WTP as a percentage of household income is negatively correlated (Dror et al., 2006).

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[4] Under the cheap talk scripts method, the respondents are asked to read a note prior to the survey describing the issue of hypothetical bias and advising them to do some mental accounting while participating in the bidding process. This method was first used by Cummings and Taylor in experimental referenda about donations to public goods and has since received mixed responses in terms of its precision.

[5] This method uses a follow up question at the end of survey requesting the respondent to validate his choice of a bid. This could be done in two ways: (i) a scale is used to assess degree of certainty where the respondents ranks their chosen WTP on a one to ten scale (ten being the most certain) and (ii) where only two degrees of certainty were provided in the follow up question- probably sure and definitely sure. The former was first used by Champ et al. in 1997 in experimental referenda about donations to public goods and the latter by Johannesson et al. in 1998 (as cited in Blumenschein et al., 2008)

[6] In this case the total livestock units in a household is used as a proxy for wealth

Another factor that affects the willingness to participate in index based microinsurance programmes is basis risk. Basis risk is the difference between the rainfall on a farmer's field and rainfall recorded in a weather station situated *x* kms away from the field. It represents the potential mismatch between insurance payout and actual losses. Micro-climates and uneven topography may affect the yields greatly and these aspects are sometimes not accurately factored into the product design. The fact that very few farmers have access to weather information (through radio, television or friends) reduces their demand considerably (McCarthy, 2003). Hill, Hoddinott and Kumar (2011) identify that willingness to continue purchasing microinsurance in the subsequent years is also affected by basis risk as 30 percent of their respondents refused to continue with the product if there was no pay-out when rains failed their farm based on a study in Ethiopia.

Households that belong to social networks and/or have access to savings and borrowings are likely to have more knowledge of insurance products and are thus likely to demand insurance (Clarke and Kalani, 2011). Note that these factors represent existing risk coping mechanisms.[7] Other factors that affect the demand for crop insurance include risk aversion (Cole et al., 2008), household level marketing (Gaurav et al., 2011) and trust in the insurance company and/or the insurance agent.

Section 3: Survey design

3.1 Data collection

Data was collected from 400 households across two blocks- Andhiyur and TN Palayam- in Erode district, Tamil Nadu. Agriculture is the major occupation in these areas. The major crops grown are turmeric, sugarcane, banana, cotton and maize.

Turmeric is a spice (cash crop) that is used as medicine or condiment. India is a major producer of turmeric and most of the production centres are in South India – Erode being one of the primary centres. The normal area under the turmeric crop in the district is around 6,000 hectares. Almost all farmers in the Erode belt produce atleast one acre of turmeric.[8]

Both Andhiyur and TN Palayam provide a favourable atmosphere for high tonnes of turmeric production. Both these blocks are also well irrigated due to the existence of a dam at the sub-district level. Major risks in turmeric cultivation in these regions include crop diseases, high rainfall for consecutive days and low average rainfall (refer Table 3.1).

I also organised discussions with local NGOs as well as farmers to understand major cropping risks, coping mechanisms and their reliance on institutions and individuals in Andhiyur and TN Palayam. The focussed group discussions revealed that the only *ex-*

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[7] This paper explores the existing risk coping strategies in greater detail and measures the extent to which these factors affect the amount of WTP for index based insurance.

[8] A sub-tropical crop, turmeric requires warm and humid climate. It is typically a ten-month crop consisting of four growth phases – sowing, rhizome vegetation, rhizome maturation and harvesting. Average rainfall requirement is 1,500mm and temperature range preferred is 20°–30°C. Turmeric grows up to 1,200 meters above mean sea level. It is a root crop and grows well in loamy soils that have natural drainage systems. The crop is averse to water stagnation and alkalinity.

ante strategies adopted to deal with turmeric weather shocks were savings and multiple cropping.[9] Most households preferred to borrow from friends, relatives or moneylenders to manage shocks *ex-post*. Formal bank borrowing is considered tedious, as it requires heavy documentation. Few people in the area have past experiences with agriculture insurance (as per the survey only 12 households in Andhiyur). Individuals were not aware of area yield insurance or weather index based insurance.

Table 3.1 Major risks in turmeric production in Erode

Type of risk	Nature of the risk	Relevance in survey areas
Crop diseases	Affects the stems and leaves of the crop leading to infections in the root nodules	One of the major risks in the area. Diseases are treatable through pesticides recommended by local universities
Heavy rainfall	While the overall rainfall requirement of turmeric remains high, consecutive daily heavy rainfall and water stagnation completely corrode the root crop.	It is an issue when heavy rainfall is combined with water released from the dam- the losses are high especially in lower lands.
Low average rainfall	Leads to low maturation of the root nodule, so the final product is of low quality	Since these areas are well irrigated, this risk is generally manageable to an extent

Small and marginal farmers in TN Palayam and Andhiyur realise the importance of formal risk management mechanisms to deal with production and price shocks. They have a clear sense of the risks in their production process – the extent to which they can handle losses themselves and their need for external solutions. Their main motivation to participate in the household survey was to educate themselves on market-based risk management strategies. This meant that the respondents provided their WTJ and WTP in an unbiased environment by matching their requirements against the product features.

The data was collected through a household survey. Myrada, an NGO in Erode, implemented the survey. Myrada works primarily for agricultural development – it provides crop level consulting and educates farmers on state of the art practises.[10] The enumerators were senior officials of the self-help groups monitored by Myrada.[11] This ensured that samples were easily identified and that they reported accurate information. Around 400 farmers were randomly selected to participate in the survey. Most of them were small or marginal farmers.

The household survey had to incorporate the key nuances of both contingent valuations methods as well as insurance related aspects. The questionnaire scheme is described in the annexure. Detailed descriptive statistics are also provided in the annexure

The product is an excess rainfall cover and was developed with the help of an actuary in India. The product is straightforward and provides a full cover for rainfall beyond a certain level. It does not have a linear pay out structure. The features of the product are highlighted in Box 3.1.

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[9] Farmers also employ some interesting strategies to deal with some risks of banana and sugarcane production. For instance, they install electric fences around sugarcane to prevent elephant attacks to sugarcane near hilly areas. Also, they use twines to ensure the banana trees are not fully uprooted by heavy winds. There are no such strategies for turmeric

[10] For further details, see http://myrada.org/myrada/

[11] The enumerators underwent a two-day training. The entire data collection was completed in two weeks. Further, I accompanied an enumerator to the field every day to supervise the effort.

Since the households were not aware of area yield or weather index based insurance policies, the product had to be designed in a manner that it was simple and easy to understand. The idea is to only sell the concept of index based insurance rather than an actual product.

Box 3.1 Hypothetical product

- Cover: It is an excess rainfall cover – if the rainfall for any two consecutive days is cumulatively 85mm or above during the crop vegetative phase (months 2-5 after sowing), a payout would be made to the farmer.
- Pay out: INR 25000 per acre insured[12]
- Actuarial premium: INR 2000 per acre approximately[13]
- Basis risk: The respondent was informed that the rainfall would be recorded in a weather station that was approximately 7-10 kilometers from his/her farm.
- Starting bids: INR 1000, 1500, 2000, 2500 and 3000. The starting bids varied per 80 questionnaires and it was distributed equally among the enumerators to ensure that each enumerator has questionnaire with each of the starting bid values.
- The subsequent bids in the bidding game vary by INR 500. E.g. For the questionnaires in which premium is INR 2000 – the second higher bid is INR 2500 and the second lower bid is INR 1500.

3.2 Contingent valuation process

Traditionally, the bidding methodology used in WTP studies was either "single-bounded" with the respondent answering yes or no to a particular price or was "multiple-bounded" where the bidding process would go on until a yes response changed to a no and vice versa.

Hanemann (1991) suggested the use of "double bounded dictomous choice" response models (DBDC models) for WTP elicitation. He showed that the "double-bounded" approach is asymptotically more efficient than the conventional, "single- bounded" approach. This method is also preferable to triple or higher biddings as literature validates based on Monte Carlo simulations that that the additional statistical efficiency gains in estimating mean WTP from adding third or fourth follow up bids is relatively small and it can increase the chance of inducing response effects (Cooper & Hanemann, 1995; Yoo & Yang, 2001)

Under this method, a starting bid is provided to each individual who has expressed willingness to join the crop microinsurance programme. If s/he accepts the first bid, a second higher bid is offered. If s/he accepts the higher bid, that value is considered as the WTP. If s/he rejects the higher bid, the original bid offered is considered as the WTP. If the respondent rejects the initial bid, then s/he is offered a second lower bid. If s/he accepts the lower bid, that value is considered as the WTP. If the respondent rejects the second lower bid, then s/he is asked to provide an estimate of the maximum amount

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[12] This is the average cost of cultivation in the vegetative phase

[13] The product rests on heavy assumptions on rainfall in Andhiyur and TN Palayam. Since, the aim was to provide a premium and sum assured similar to market standards for a crop that is their major source of income and not to sell this product to the farmers, our analysis remains unaffected. The premium rate for this product is 8%. The average premium for commercial and horticulture index insurance products in India ranges from 6-12%.

s/he is willing to pay for the product.[14] Note that in this process, each individual provides one of the four resonses: yes-yes, yes-no, no-yes, no-no.[15]

Figure 3.1 Bidding methodology
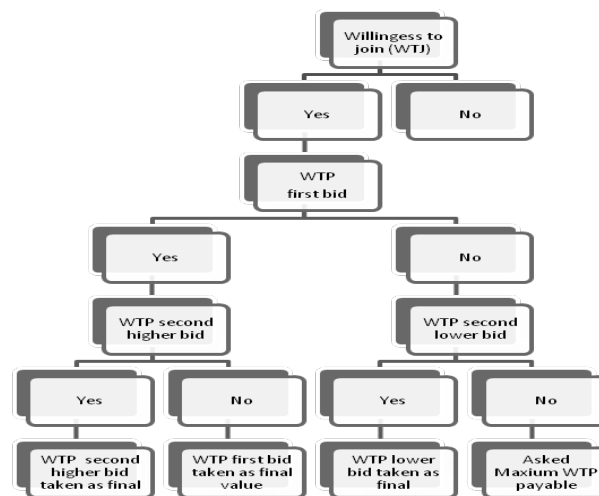
The additional iteration in my analysis is that only the respondents, who expressed a willingess to participate (WTJ) in such a scheme will be subject to the bidding process. For this, the respondent was asked to choose between four responses: *Definitely not willing to join, Rather not willing to join, Rather willing to join and Definitely willing to join*. The first two categories represent the "no" response and the latter two represents the "yes" response in Figure 3.1 and 3.2.

Figure 3.2 Contingent valuation results
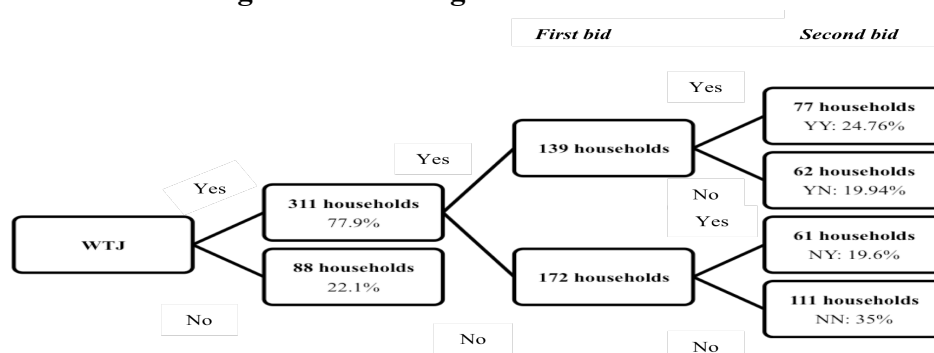
The responses to the WTJ and WTP bidding are illustrated in figure 3.2. Of the 311 households that were willing to join the scheme, 56% were definitely willing and 43% were rather willing to join. Out of the 88 households that were either rather not willing or definitely not willing to join the policy, 80% suggested that they would register for the policy if it were provided for free by the government.

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[14] Some of the studies that employ DBDC models include Hanemann (1984), Alberini et al. (1997), Hagos et al. (2006), Cawley (2008), Kristom (1990), Hanemann (1991), Carson et al. (1994), Watanabe (2008), Huang (.), and Carson et al. (2003), Gustafsson-Wright et al. (2009) and Donfouet and Makaudze (2010) among others

[15] Here, the second bid is contingent on the first bid (Hanemann, 1991). Gustafsson-Wright et al. (2009) provide further evidence on this in their study on health microinsurance.

Section 4 Analysis and results

4.1 Econometric methodology

WTP values elicited using DBDC framework are generally analysed using maximum likelihood methods. While Alberini et al. (1997), Hagos et al. (2006) Cawley (2008) and others model WTP in an interval regression framework; Kristom (1990) Hanemann (1991) Carson et al. (1994) Watanabe (2008) Huang (.), Carson et al. (2003) and others use survival functions[16] to estimate WTP under a DBDC framework. I intend to use an interval regression model to study WTP.

Assuming a linear functional form for WTP equation, the WTP can be defined as

$$WTP_i^* = x_i^{'}\beta + v_i \qquad\qquad \text{where } v_i \sim N(0,\sigma^2)$$

where β is a vector of parameters and v_i is the random error term with mean zero and variance σ^2. If t^0 is the first bid, t^H is the second higher bid and t^L is the second lower bid, WTP_i^* can be defined as follows:

$$WTP \geq t^H \qquad \text{for the yes-yes responses}$$
$$t^0 \leq WTP < t^H \qquad \text{for the yes-no responses}$$
$$t^L > WTP \geq t^0 \qquad \text{for the no-yes responses}$$
$$WTP < t^L \qquad \text{for the no-no responses}$$

Note that for the 'yes-yes' responses, the lower limit is the second higher bid and the upper limit is positive infinity; for the 'yes-no' responses, the lower limit is the first bid and the upper limit is the second higher bid; for the 'no-yes' responses, the lower limit is the second lower bid and the upper limit is the first bid; for the 'no-no' responses, the upper limit is the second lower bid and the lower limit is zero or negative infinity (depending on whether insurance is a normal good).

The log likelihood function for this model can be written as (developed in Alberini et al., 1997; Hagos et al., 2006; Cawley, 2008; Haab, 1997):

$$L = \sum_{i=1}^{N}\left\{ I_i^{YY}\ln\left[1 - \Phi\left(\frac{t_i^H - x_i^{'}\beta}{\sigma}\right)\right] + I_i^{YN}\ln\left[\Phi\left(\frac{t_i^H - x_i^{'}\beta}{\sigma}\right) - \Phi\left(\frac{t_i^0 - x_i^{'}\beta}{\sigma}\right)\right] + I_i^{NY}\ln\left[\Phi\left(\frac{t_i^0 - x_i^{'}\beta}{\sigma}\right) - \Phi\left(\frac{t_i^L - x_i^{'}\beta}{\sigma}\right)\right] + I_i^{NN}\ln\Phi\left(\frac{t_i^L - x_i^{'}\beta}{\sigma}\right)\right\}$$

where I(.) is an indicator function that takes the value 1 if the indivdual i belongs to the particular bidding argument and zero otherwise.

However, in our case WTP can only be observed if an individual is WTJ the microinsurance programme. WTJ can be defined as follows:

$$WTJ_i^* = x_i^{'}\alpha + \varepsilon_i \qquad\qquad \text{where } \varepsilon_i \sim N(0,1)$$

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[16] Here, instead of "time", survival is defined with respect to the cost variable. A respondent willing to pay a specific amount "survives" that amount and a respondent who is not willing to pay a specified amount "fails" that amount (Carson et al., 2003). For example, a yes-no response indicates that the respondent's maximum WTP amount lies between the first bid and second higher bid. In survival analysis terms, the failure occurred between the first bid and second higher bid cost amounts

where   WTJ$_i$ = 0 [definitely not willing]   if WTJ$_i^*$ < ϑ_0
         WTJ$_i$ = 1 [rather not willing]   if $\vartheta_0 \leq$ WTJ$_i^*$ < ϑ_1
         WTJ$_i$ = 2 [rather willing]   if $\vartheta_1 \leq$ WTJ$_i^*$ < ϑ_2
         WTJ$_i$ = 3 [definitely willing]   if $\vartheta_2 \leq$ WTJ$_i^*$

The log likelihood (LL) function for such an ordered probit model can be expressed as (Greene, 2002):

$$LL = \sum_{i=1}^{n}\sum_{j=0}^{3}\delta_{ij}\log_e[\Phi(\theta_j - X_i'\alpha) - \Phi(\theta_{j-1} - X_i'\alpha)]$$

where δ_{ij}=1 if the ith individual falls in the jth category and 0 otherwise, log$_e$ (.) is the natural logarithmic operator and Φ(.) is the cumulative distribution function operator for the standard normal distribution. Note that we assume that ε_I is normally distributed with mean zero and standard deviation $\sigma^2 = 1$ (conventional normalisation as applied in the case of probit models).

Clearly, WTP is only observed when WTJ$_i \geq 2$, i.e if the individual is either *rather willing* or *definitely willing* to join the programme. This selection bias can be modelled using a Heckman selection approach.

The use of Heckman's selection model with a first stage ordered probit and second stage interval regression is not common in literature. While several models use a first stage ordered probit framework, the second stage tends to be a linear OLS regression (Yoo and Yang, 2001; Joyce, 1994; Hurley et al., 2004; Chantarat et al., 2009; Moon et al., 2002; Bacon and Moffatt, 2011; Richards, 2000).

Iwai et al. (2005) present a framework where the first stage is an ordered probit and the second stage uses survival analysis. Also, Chantarat et al. (2009) explores a first stage ordered probit and a second stage bounded model to study WTP for livestock microinsurance. Both these papers have been used as the basis to develop the likelihood function, inverse mills ratio term(s) and corrected covariance matrix for this analysis.

If A_i^L and A_i^U are the lower and upper bounds of WTP, the final likelihood function (L) is defined as per as follows (using the framework in Yoo and Yang, 2001):

$$L = \prod_{WTJi=0}^{1}\Pr(WTJ_i \leq 1)\prod_{WTJi=2}^{3}\Pr(WTJ_i \geq 2, A_i^L < WTP_i^* < A_i^U)$$

Assuming that ε_i and ν_{ij} follow bivariate normal distribution with correlation coefficient ρ, the mean WTP conditional on WTJ for the ith individual in the jth category now takes the form:[17]

$$E\left[WTP_{ij}^* / WTJ_i \geq 2\right] = \chi_i'\beta + \rho\sigma_\nu\lambda_{ij} \qquad \text{where } \varepsilon_i,\nu_{ij} \sim \text{BVN}(0,0,1,\sigma_\nu^2,\rho_{\varepsilon\nu})$$

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[17] The corrected covariance matrix has also been worked on using Chantarat et al. (2009).

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for each case where WTP is observed i.e. if WTJ=2,3. The selection correction term for each category is given by (Iwai et al., 2005):

$$\lambda_{ij} = \frac{\phi\left(\theta_j - x_i' \alpha\right) - \phi\left(\theta_{j-1} - x_i' \alpha\right)}{\Phi\left(\theta_j - x_i' \alpha\right) - \Phi\left(\theta_{j-1} - x_i' \alpha\right)}$$

The independent variables chosen are based on past literature, descriptive statistics and observations made from group discussions at both Andhiyur and TN Palayam. A description of the explanatory variables used in both the models is presented in table 4.1. The exogeneous variables used in the ordered probit model are described in table 4.2.

Table 4.1 Set of independent variables used in the two stage estimation

Variable name	Description	Sample average	Average for WTJ=2	Average for WTJ=3
Household size	1= more than 3 members; 0= 3 members or less	0.699	0.776	0.621
Age	continuous variable	44.416	45.112	44.073
Start bid	Starting bid values of the CVM	1998.747	1992.537	1926.554
Andhiyur	1=if respondent belongs to Andhiyur block; 0= if not	0.499	0.709	0.215
Land quintiles: (base category land1- lowest land area in acres)				
Land 2	1= belongs to that quintile; 0= otherwise	0.221	0.269	0.136
Land 3	1= belongs to that quintile; 0= otherwise	0.258	0.224	0.333
Land 4	1= belongs to that quintile; 0= otherwise	0.070	0.045	0.124
Land 5 (highest)	1= belongs to that quintile; 0= otherwise	0.113	0.104	0.175
Acres of planted land	continuous variable	4.133	3.858	5.117
Savings as a general means of risk coping	1= yes; 0= no	0.538	0.679	0.449
Borrowings as a risk coping strategy	1= yes; 0= no	0.396	0.485	0.333
Other sources of income	1 = if the household has other income sources; 0= if not	0.65	0.76	0.63
Risk aversion[18]	Calculated using the lottery game	0.758	0.771	0.724
Mathematical literacy[19]	1= higher literacy (score >3); 0= lower literacy	0.737	0.545	0.949
Log income	1= yes; 0= no	11.763	11.579	12.040
Grows more than one crop	1= yes; 0= no	0.895	0.933	0.910
Member of SHG/MFI/NGO	1= yes; 0= no	0.441	0.672	0.232

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[18] Calculation of risk aversion: The expectation and standard deviation of each bet was calculated and a risk aversion index defined as the rate at which the household is ready to take up additional risk is calculated (i.e. ΔE/ΔSD). Higher values indicate higher risk aversion. Refer annexure for further details

[19] This is based on simple mathematical questions answered by the respondent

Table 4.2 Exogeneous determinants of WTJ

Variable	Description	Explanation	Sample average
Think poor	1= if they think they are poorer than others in their village and district; 0= otherwise	If a household thinks it is poor and has a limited source of income, it will think twice before investing in a scheme that promises to pay only if a certain event occurs. Such households are likely to express lower/zero WTJ level irrespective of the bid levels[20]	0.607
Product literacy	1= yes to all questions on the product; 0= wrong answer for at least one question	If a household just doesn't understand or appreciate the product, it is not likely to participate in the scheme irrespective of bid levels and vice versa	0.845
Basis risk	1= understand basis risk; 0 = otherwise	If a household understands basis risk, one of the following scenarios could occur – (1) a risk averse respondent is not likely to be WTJ the scheme as s/he may think of this as a mere wager (2) a risk preferring respondent will choose to join the scheme as s/he is likely to value the opportunity of receiving pay outs even in the event of no losses. In both cases, the bidding values are not likely to influence their WTJ choices.	0.972

4.2 Willingness to join

The results of the ordered probit model are presented in table 4.3 and the marginal effects of the significant variables are shown in table 4.4. The estimated robust model has a log pseudolikelihood value of -388.098 which is significant at 0.0000 level. Variables that significantly affect the WTJ microinsurance programmes include socio-economic factors such as age and block, wealth indicators such as land size, risk attitudes and product specifics features among others.

The area of planted land is used as a proxy for wealth in this analysis. Land is divided into five quintiles and results indicate that belonging to the third (3.5 to 5 acres) and fouth (5.5 to 7.5 acres) qunitiles of land holdings has a significant impact on the WTJ. This is consitent with the results found in Kumar etal. (2011) and Clarke (2011) to a certain extent and indicates that farmers with very low or very high levels of land do not value insurance as much as farmers with medium land sizes. In terms of marginal effects, both these categories show a positive probability of belonging to the *definitely willing* category on average and *ceterius paribus*. Similarly, if a farmer grows more than one crop, it increases his probability to belong to the *definitely willing* category by 18.6 percentage points on average and *ceterius paribus*.

The more risk averse an individual is, the less likely s/he is to belong to the *definitely willing* category (consistent with Cole et al., 2008). This indicates that insurance could be considered as a 'risk' by some sections of the community. This probably stems from a lack of understanding about insurance and the fear of not getting anything in return for paying a sum of money upfront or a lack of trust in the insurance provider.

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[20] Bendig et al. (2009) study uptake of financial services such as savings, credit and insurance to find that households, which assume that they are more vulnerable to risk, opt not to use any financial services at all. In the survey, this variable was assessed by asking the respondent to evaluate his/her economic position vis-à-vis the other households in the village.

Among the the exogeneous variables, think poor also has a negative impact on the WTJ. Perceiving oneself as poor decreases the likelihood of belonging to the *definitely willing* category by 15.3 percentage points on average and *ceterius paribus*.

Table 4.3 Ordered probit model

Independent variables	Coefficients	Robust SE
Household size	-0.125	0.161
Age	-0.016**	0.008
Start bid	-0.0003**	0.000
Andhiyur	-0.730**	0.178
Land quintiles: (base category land1)		
Land 2	-0.155	0.166
Land 3	0.388**	0.181
Land 4	0.673**	0.314
Land 5	0.326	0.345
Savings	-0.0182	0.129
Borrowings	-0.078	0.123
Risk aversion	-0.469*	0.242
Mathematical literacy	0.293*	0.156
Log income	0.035	0.154
More than one crop	0.504**	0.237
SHG/MFI member	-0.244*	0.145
Exogenous variables		
Think poor	-0.389**	0.162
Product literacy	0.328**	0.163
Basis risk	0.984**	0.289
/cut1	-1.534	1.712
/cut2	-1.087	1.709
/cut3	0.172	1.722
Log pseudo likelihood	-388.098	
Pseudo R2	0.1867	
Wald chi2 (18)	202.33	
Prob > chi2	0	
Number of observations	395	

**Significant at $P<0.05$. *Significant at $P<0.10$

Both product literacy and basis risk have a positive impact of WTJ. Product literacy increases the probability of the respondent belonging to the definitely willing category by 12.5 percentage points on average and *ceterius paribus*. An understanding of what basis risk entails increases the probability of belonging to the *rather willing* and *definitely willing* categories by 0.3 and 31.3 percentage points respectively on average and *ceterius paribus*.

It is interesting to note that holding an SHG or an MFI membership decreases the willingness to join (which is not consistent with the literature in section 2). Perhaps, individuals may choose to borrow from these institutions rather than invest in market based solutions to manage risks indicating the existence and preference for ex-post risk

coping strategies. It may also be the case that they are unsatisfied with the services of these institutions and are thus vary of non-governmental entities

Table 4.4 Marginal effects of significant variables

Variable	Definitely not wiling (WTJ=0)	Rather not willing (WTJ=1)	Rather willing (WTJ=2)	Definitely willing (WTJ=3)
Age	0.002	0.002	0.003	-0.006
Start bid	0.00004	0.00003	0.00005	-0.00011
Andhiyur	0.092	0.069	0.119	-0.281
Land 3	-0.042	-0.036	-0.076	0.153
Land 4	-0.053	-0.053	-0.156	0.262
Risk aversion	0.058	0.046	0.081	-0.184
Mathematical literacy	-0.040	-0.030	-0.044	0.113
Grow more than one crop	-0.083	-0.052	-0.051	0.186
SHG/MFI member	0.031	0.024	0.041	-0.096
Think poor	0.045	0.037	0.071	-0.153
Product literacy	-0.048	-0.034	-0.044	0.125
Basis risk	-0.223	-0.093	0.003	0.313

Starting bid has a negative effect of belonging to the *definitely willing* category indicating starting point bias and justifies the use of multiple starting bids in the contingent valuation process.

Other factors that affect WTJ include age and mathematical literacy. An increase in age decreases the probability of belonging to the *definitely willing* category by 0.6 percentage points on average and *ceterius paribus*. Similarly, mathetically literacy increases her/his probability of belonging to the *definitely willing* category by 11.3 percentage points on average and *ceterius paribus*. The block level dummy for Andhiyur is significant and increases the probability of belonging to the *rather willing* category by 11.9 percentage points on average and *ceterius paribus.*

4.3 Willingness to pay

The results of the interval regression model[21] to study factors that affect the amount of WTP for individuals who are *rather willing* or *definitely willing* to participate in the programme are presented in table 4.5. The log likehood function in significant in both cases. The McFadden R^2 has been calculated using the log likelihood function.[22]

Let us consider the *rather willing* category. This represents a section of respondents who appreciate the product but are not totally convinced to invest. The start bid has a positive impact on the amount a household is WTP for the scheme, indicating that once they have agreed to participate, they believe that it is worth paying a slightly higher amount, if required, to enjoy the benefits of the product. The respondents from Andhiyur are *rather* WTP 47% lower than TN Palayam on average and *ceterius paribus*. This is consistent for two reasons- the respondents of Andhiyur have had bad past experiences with agriculture insurance and the annual income of Andhiyur is lower than that of TN

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[21] Note that the dependant variable represents intervals of WTP amounts expressed in logrithms.
[22] McFadden R^2 = 1 - $\underline{\text{L (maximum)}}$
L (β=0)

Palayam on average. For a one unit increase in the acres of land planted, there is a 5.2% increase in the amount of WTP on average and *ceterius paribus.*

Table 4.5 Interval regression

Particulars	Rather willing to join (WTJ=2)		Definitely willing to join (WTJ=3)	
	Coefficients	Robust SE	Coefficients	Robust SE
Household size	-0.169	0.117	-0.01003	0.040
Age	0.003	0.003	-0.0002	0.002
Start bid	0.0004**	0.000	0.0002**	0.000
Andhiyur	-0.637**	0.112	-0.679**	0.078
Acres of planted land	.0508**	0.017	0.0204**	0.007
Savings	-0.226**	0.071	-0.0534	0.037
Borrowings	-0.168*	0.094	-0.0861**	0.041
Other income	-0.237**	0.110	0.0435	0.042
Risk aversion	0.234*	0.137	-0.151**	0.070
Grow more than one crop	-0.027	0.237	0.202**	0.075
SHG/MFI member	.0039	0.098	-0.0083	0.043
Mills_3	-0.0028	0.099	-	-
Mills_4	-	-	0.163*	0.089
Constant term	6.697**	0.254	7.051**	0.161
Ln Sigma	-1.21**	0.135	-1.743**	0.107
Log pseudo likelihood	-79.560		-137.934	
McFadden R^2	0.4511		0.4343	
Wald chi2 (12)	298.54		613.12	
Prob > chi2	0.0000		0.0000	
Number of observations	134		175	

**Significant at P<0.05. *Significant at P<0.10

Interestingly, all the three variables representing risk coping mechansisms – savings, borrowings and other sources of income (diversification)- are significant and negative. Households who use savings as a means of risk management are *rather* WTP an amount that is 20.2% lower than the base category on average and *ceterius paribus.* Similarly, household that generally borrow from formal or informal sources to meet shocks are *rather* WTP an amount that is 15.5% lower than households who do not borrow to meet losses on average and *ceterius paribus.* Respondents who earn income from multiple sources (including allied agriculture actvities, other businesses and remittances) are also *rather* WTP 21.1% lower than those with only one source of income on average and *ceterius paribus.*

This indicates that people who are rather willing to join have already established risk coping networks and they see microinsurance as an additional strategy for risk management. Thus, they are *rather* WTP only a small amount to secure their 'residual' risk. This clearly shows that individuals are well aware of their risk management needs and that they do value microinsurance as a *ex-ante* strategy.

Another prominent aspect is risk aversion. For a unit increase in risk aversion, there is an increase of 26.4% in the amount of WTP on average and *ceterius paribus.* This is

consistent with the earlier point. Since these households are risk averse in nature, they do have other *effective* risk management mechanisms in place and even so, are willing to secure their residual risk through market based indemnity. The inverse mills ratio is not significant in this case and thus there are no selection effects of belonging to this category.

The *definitely willing* category also shows similar results in terms of variables such as the start bid, block level effects and acres of planted area. A unit increase in the acres of planted land increases the amount of *definite* WTP by 2.1% on average and *ceterius paribus*. Similarly, farms that grows more than one crop are *definitely* WTP 22.4% higher than single crop farms on average and *ceterius paribus*.

In terms of other risk mangement solutions, only borrowings are significant in this case. A respondent's access to borrowings reduces the amount of money s/he is *definitely* WTP for the microinsurance programme by 8.25% on average and *ceterius paribus*. A quick look at the mean values for the three risk management variables for both the *rather willing* and *definitely willing* cases (table 4.1) shows that the number of households that have access to or use risk coping mechanisms are higher on average in the *rather willing* category. This builds a clear case for the preference of households to belong to the *rather willing* or *definitely willing* categories. The households in the *definitely willing* category are more keen on microinsurance as they do not have many other 'significant' means of risk coping.

Also note that risk aversion is significant, but negative, in this case. This is probably a case of low trust and bad past experiences with other institutions – perhaps, also the reason why they do not have other effective means of risk coping.

The inverse mills ratio is significant at 10% indicating the presence of selection effects. These unobservable factors could relate to nature of the alternative crops grown by the farmer[23], past insurance experiences (and other risk coping methods) of their peers/relatives living in other areas, the amount of loan outstanding, cash in hand, famer's perception on the certainty of future income flows from both agriculture and his/her other sources of income or fluctuations in the market prices of turmeric as well as other crops grown by the farmer among others.

Validation checks were also conducted on the exogenous variables by including them in the second stage regressions. All the exogenous variables were not significant in the interval regressions. In order to check for hypothetical bias, interval regressions are also estimated using only those respondents who were "*definitely certain*"[24] of purchasing the product at the agreed price. The second part of the model (interval regression) was also estimated using survival analysis (lognornal distribution). These results are similar to the above results and are not presented in this paper.

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[23] For instance, consider a farmer grows banana and turmeric. The risks to both crops are different- banana is primarily affected by wind and turmeric is affected by rain. While the farmer may be willing to buy turmeric insurance, he will be willing to pay lesser for turmeric as the cost of production for banana is higher.

[24] This is based on a question asked at the end of the survey: Now please think about your agreed premium. If provided with the product, will you be actually willing to pay that price? – the responses were definitely sure, probably sure and not sure. 67% of the respondents who participated in the bidding game agreed to definitely buy the product and 32% were probably sure that they would buy the product.

Cooper, Hanemann and Signorello (2002) compare the confidence interval for double bounded model, and show that mean WTP is more biased than median WTP associated with the follow-up responses.

In this case, both Mean and median WTP for the *rather willing* and *definitely willing* respondents are estimated using the fitted values from the interval regressions. The standard errors and confidence intervals for the mean and median are arrived at using bootstrapping (as per Crawley, 2008). The estimates are provided in table 4.6.[25] Note that the dependant variables are expressed in natural logarithm in the interval regressions.

Table 4.6 Mean and Median WTP

Particulars	Value	WTP (in INR)	Bootstrap SE	z	P>z	[95% Conf. Interval]	
			WTJ=2 (Rather willing)				
Mean	6.98	**1072.93**	0.05	139.24	0.00	6.88	7.08
Median	6.86	**956.77**	0.09	83.51	0.00	6.70	7.03
			WTJ=3 (Definitely willing)				
Mean	7.59	**1978.31**	.032	240.26	0.00	7.53	7.66
Median	7.65	**2100.64**	0.04	213.63	0.00	7.58	7.72

Figure 4.1 Demand for index based crop microinsurance
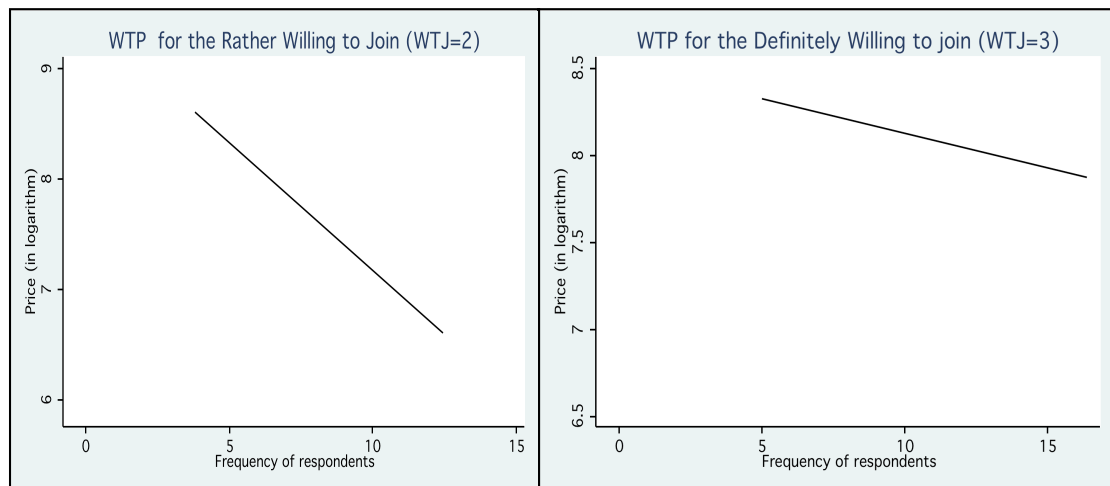
Note that the mean and median WTP is higher for the *definitely willing* category. Clearly, they are a group that are fully aware that they ought to invest in risk coping strategies and are open to paying slightly higher amounts of money for the same.

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[25] The unconditional estimates of mean and median based on the actual bidding values are as follows:

Particulars	WTJ=2	WTJ=3
Mean	977.98	1803.39
Median	500.00	2000.00

Demand curves are also estimated using the fitted values of the interval regressions (figure 4.1).[26] The demand for index based crop microinsurance is downward sloping and hence is a normal good (Hanemann, 1991; Kumar et al., 2011). The curve for the *definitely willing* category is more elastic which is consistent with our findings. The *rather willing* category is more inelastic towards the price of the microinsurance policy.

Section 5 Conclusion

From the above, it is evident that there is a difference between the WTJ and WTP for index based crop microinsurance scheme. Also, among households that express WTJ the policy, there are key factors that separate the *rather willing* and the *definitely willing* households. Households seem well aware of the range of risk coping mechanisms available to them and evaluate microinsurance as an additonal strategy within the context of all existing strategies. Risk aversion also plays a significant role in determining uptake.

Studies on the demand for index based microinurance have usually been implemented either via lab experimentation or through randomised interventions. These studies have directly looked at the impact of different factors on the willingess to pay for a hypothetical or real microinsurance product. Often, in these studies, a sizeable portion of the sample agrees to purchase the 'hypothetical' product but the numbers fall short when the actual sale happens. In other cases, while the response is good in the pilot phase, the product does not achieve scale subsequently.

By separating the willingness to participate from the amount of willingness to pay, this work aims to bridge the gap between the 'hypothetical' and the 'actual' *responses* to index based microinsurance schemes. While households are *prima facie* more inclined to participate in insurance programmes, this does not translate into actual purchases. Since households have already identified some means of risk coping over the years, they prefer to continue to tap into those sources and invest lower amounts of money in insurance only to cover the *left-over* risks.

This has an important policy perspective. Literature has shown that while informal networks and savings help cope up with risks, these measures fail in the event of systemic shocks (Azam and Imai, 2009; Heltberg and Lund, 2009; Dercon, 2001). Microinsurance marketing and education should, thus, focus on enlightening households on the long term impacts of their existing mechanisms and how these may fail in certain cirumstances. This knowledge should enable them re-think their own approach towards managing risks and look at microinsurance as a more formidable market-based *ex-ante* source of coping with small-scale and large-scale shocks in the long term.

We are seeing the tip of an iceberg in so far as crop microinsurance market in India is concerned. Conscious effort towards planning, designing and implementation of relevant crop insurance products at the grass root level are an immediate requirement. The very fact that this will affect and transform the life of the common man in India is reason enough for sustained work in this area.

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[26] Demand curves can also be plotted by non parametic methods using Kaplan Meier survival functions (pioneered by Kristom, 1990)

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1. Questionnaire scheme

- Building "mental accounting" to reduce hypothetical bias and elicit precise estimates of WTJ and WTP as suggested in Bateman, 1993 and Diamond and Hausman, 1994
  - Socio- economics data of the household including key sources and amounts of income
  - Agricultural data on land sizes, ownership, major crops grown, production levels and cost of cultivation
  - How "well-off" do their consider themselves when compared to others in their village/district

- Risks: experiences, perceptions and insurance
  - The major agricultural risks faced by the household in the last few years and their risk coping methods
  - Understanding their risk preferences through a simpler version of a Binswanger (1980) lottery that provided three lottery scenarios and the respondent was asked to choose a particular lottery
  - Understanding their time preferences where the respondent is asked to choose between INR 100 today and a higher value at a later point in time.
  - Past insurance purchases and experiences

- Willingness to pay and willingness to join
  - A hypothetical product note is presented followed by certain questions on the product note to check if the respondent has understood the product
  - Re-iterating the meaning and understanding of basis risk in index insurance contracts
  - Eliciting the willingness to join the microinsurance programme through the responses- (0) Definitely not willing to join (1) Rather not willing to join (2) Rather willing to join (3) Definitely willing to join. *Only respondents who answered (2) or (3) proceeded to the bidding game.*
  - A "cheap talk script" is then presented to the respondent and through a two stage interactive bidding game his/her amount of willingness to pay for the scheme is elicited. Note that starting bids varies between questionnaires to avoid starting point bias.
  - Finally, a certainty question of the type "probably/definitely sure" to avoid hypothetical bias (Blumenschein et al., 2008; Blomquist et al., 2009)
  - The respondents were also questioned on policy renewal in the event the product does not pay in the current year due to basis risk (Kumar et al., 2011)

2. An illustration of a basic weather (rainfall) index insurance contract

Consider a contract that is being written to protect against deficient cumulative rainfall during a cropping season. The writer of the contract may choose to make a fixed payment for every 1 mm of rainfall below the strike. If an individual purchases a contract where the strike is 100 mm of rain and the limit is 50 mm, the amount of payment for each tick would be a function of how much liability is purchased.

There are 50 ticks between the 100 mm strike and 50 mm limit. Thus, if $50,000 of liability were purchased, the payment for each 1 mm below 100 mm would be equal to $50,000/ (100-50), or $1,000. Once the tick and the payment for each tick are known, the indemnity payments are easy to calculate.

For example, if the realized rainfall is 90 mm, there are 10 ticks of payment at $1,000 each; the indemnity payment will equal $10,000. Figure 8.1 maps the payout structure for a hypothetical $50,000 rainfall contract with a strike of 100 mm and a limit of 50 mm

Figure A2.1 Payout structure for a hypothetical rainfall contract
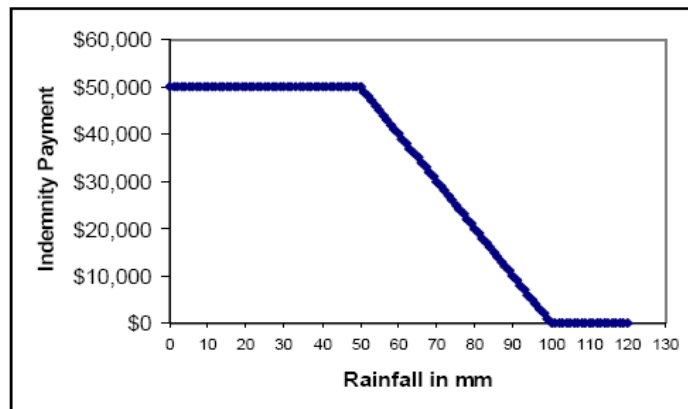
Source: Skees (2003)

A2.2 A typical term sheet for weather index insurance policy

TERMSHEET FOR WEATHER INDEX INSURANCE			
Product Reference	NA06		
Crops	Any crop in the district		
Reference Weather Station	Nalgonda		
Index	Aggregate rainfall during the cover phases in mm. If rainfall on a day is < 2 mm it is not counted in the aggregate rainfall. If rainfall on a day is > 60 mm it is not counted in the aggregate rainfall. Above condition applicable only for deficit rainfall cover and not for excess rainfall cover		
Definition of Day 1	month of June at reference station is observed >= 50 mm. If above condition is not met in June, Policy invariably starts on July 1		
Policy Duration	110 days		

Cover Phase	I	II	III
Duration	35 days	35 days	40 days
PUT			
Strike (mm) <	60	80	-
Exit (mm) <	10	10	-
Notional (Rs / mm)	10.00	10.00	-
Policy Limit (Rs)	1,000	1,000	-
Phase premium (Rs)	90	90	
CALL			
Strike (mm) >	-	-	240
Exit (mm) >	-	-	340
Notional (Rs / mm)	-	-	10.00
Policy Limit (Rs)	-	-	1,000
Phase premium (Rs)	-	-	110

Combined Premium (Rs)	280
Combined policy limit (Rs)	3,000
Data Source	Indian Meteorological Department
Settlement Date	Thirty days after the data release by IMD and verified by Insurer.

Source: BASIX of India; a similar contract appears in Manuamorn, 2007

Source: Skees (2007)

3. Descriptive statistics

3.1 Socio-economic variables

The following are based on the survey of 200 households each in Andhiyur and TN Palayam. The basic variables are described in table A3.1

Table A3.1 Socio economic variables

Variable	Description	Total sample mean	Andhiyur mean	TN Palayam mean
Age	in years	44.42	42.43	39.27
Household size	Number of members in the household	4.16	4.66	3.66
Gender	Male=1, female=0	0.88	0.90	0.85
Marital status	Married=1, single=0	0.95	0.95	0.95
Primary occupation	Agriculture=1, others=0	0.99	1	0.98
Education	High school or higher=1, Primary education or lower =0	0.63	0.59	0.68
Caste	Backward caste=1, others=0	0.82	0.65	0.99
Annual income	in INR	179196.50	103161.60	254849.20

Andhiyur's sample has more exposure to and participation in beneficiary programmes. Atleast 90 households participate in the NREGA and 112 households are members of the cooperative society. 95 are members of SHGs. In comparison, only 23 households in TN Palayam are members of SHGs. Only 3 are aware of the NREGA and 41 are members of cooperatives. Both blocks have less exposure to MFIs.

3.2 Production and past shocks

Around 75% of the respondents in Andhiyur operate on their own lands and the average land holdings are around 3 acres. 95% of farmers in TN Palayam have own lands and the average land size per farmer is around 5 acres.

Every household grows turmeric on atleast one acre of their total planted area, other crops being sugarcane, banana, cotton, maize, paddy or others.[27] On average farmers grow turmeric on atleast 1.5 acres of their land in Andhiyur and 2.1 acres of their land in TN Palayam. Though TN Palayam has more acres of turmeric under cultivation on average, the production of turmeric *per acre* is statistically higher in Andhiyur.[28] The cost of cultivation per acre of turmeric is significantly lower in TN Palayam (INR 40000 approx) compared to Andhiyur (INR 44000 approx).

Around 15% of the respondents cite heavy rains as a major source of losses for their crops. Most households drew from their savings or borrowed from informal sources to manage past shocks. As reflected in the initial discussions, farmers do not have any ex-ante risk management strategies (apart from savings) to deal with risks in turmeric production. On average, it takes the households around a year to recover from shocks irrespective of land size or income level. Income losses are highest for farmers who grow banana in addition to turmeric (around INR 100000 approx.) caused mainly due to heavy winds in the district.

3.3 Risk attitudes and past insurance experience

In general, households grow multiple crops on their land and earn profits on average. Other strategies to deal with shocks include savings and formal or informal borrowings (loans from friends, relatives or moneylenders). The details are provided in table A3.2.

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[27] In Andhiyur, farmers operating on smaller land sizes prefer to grow more cotton rather than sugarcane or banana. This may be due to the cost of production as the average input cost per acre of cotton (INR 10000-15000) is lesser than banana or sugarcane (INR 50000-70000). Average for turmeric is around INR 40000-50000.
[28] Andhiyur produces 1900 kg of turmeric per acre and TN Palayam produces 1700 kg of turmeric per acre.

Table A3.2 Risk coping strategies

Technique	Primary strategy (in %)	Secondary strategy (in %)
Do nothing	21.11	
Multiple cropping per season	41.71	21.71
Savings	20.35	49.22
Formal borrowing	4.52	11.63
Informal borrowing	12.06	12.79
Have other sources of income	0.25	2.33

A separate question on loan preferences shows that 32% of the respondents prefer to borrow from relatives, friends or neighbours during emergencies. The next preferred sources are moneylenders (28%) and local cooperative banks (15%). These results are in line with the inferences from the FGDs conducted prior to the data collection process as indicated in an earlier section. This suggests that there are some forms of informal insurance arrangements in the community. While these arrangements do help manage sudden cash crunches, the situation is different when systemic shocks affect the communities – especially in case of heavy winds and rainfall vagaries- where most of the farmers suffer losses.

A Binswanger (1980) game was used to capture the risk aversion levels. The respondent was provided with the following scenario. A coin is tossed and there are three types of pay-offs associated with it: (a) INR 50 for heads and INR 50 for tails representing *extreme risk aversion* (b) INR 40 for heads and INR 120 for tails representing *intermediate risk aversion* and (c) INR 0 for heads and INR 200 for tails indicating *risk preference*. Around 49% of the respondents are extremely risk averse and 27% were risk preferring. Interestingly, households at low levels of income in TN Palayam exhibit higher risk preference.[29] The Risk aversion index was calculated based on Cole et al. (2008) as shown in table A3.3

Table A3.3 Risk aversion index

Lottery	Expected Value (E)	Standard deviaton (SD)	Risk aversion measure ($\Delta E/\Delta SD$)
(50, 50)	50	50	1
(40, 120)	80	40	30/40 = 0.75
(0, 200)	100	100	20/60 = 0.33

Around 92% of the total sample has purchased life insurance policies. However, most of these life insurance policies are yet to be claimed. On average, 7% of households have experiences with health insurance- respondents indicate that they have had issues with the claim process in reimbursement policies. Of the total sample, only 12 households in Andhiyur have experiences with agriculture (sugarcane area yield) insurance. Households that have not invested insurance in the past indicate that insurance is not necessary (39%) and that the policies are expensive (24%).

3.4 Bidding game

On the bidding game, 59% of the respondents who were not willing to join cited basis risk as the primary reason for the same. 12% did not join as they had no faith in the insurance provider. Other reasons cited for non-participation include bad past experinces (7.4%), inadequate claim amounts (7%) and non-necessity of insurance to manage risks (6.2%).

36% of the respondents chose a certain final bid level based on their affordability, 24% claim to have provided their preferences based on guesswork. However, 35% felt that they believed that the price they finally chose to pay was the appropriate price for such a product.

Also note that, 81% of the households prefer to pay the premium in a one time lumpsum at the beginning of the crop season. 25% of the households prefer to not renew the policy if pay-outs are not made in the current season due to basis risk issues (similar to Kumar et al., 2011).

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[29] 43% of the households in the lower income quintiles chose the 0-200 lottery