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Temperature and Rainfall Index Insurance in India §

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Ayako Matsuda*
Research Fellow, Japan Society for the Promotion of Science
Osaka School of International Public Policy (OSIPP)

Takashi Kurosaki**
Professor, Institute of Economic Research, Hitotsubashi University

【キーワード】Weather Insurance, Temperature Insurance, Demand for Insurance.
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【要約】Weather index insurance has been attracting much attention from academics and policy makers. This paper investigates the demand for temperature and rainfall index insurance in India using the data from randomized subsidy experiments. We find that price, income and asset levels influence the demand for both temperature and rainfall insurance. We also show that richer farmers are less price-sensitive and farmers' response to the discount becomes less price-sensitive as the amount of discount increases. Non-price factors such as age and education level of a respondent are important correlates. Purchase decisions are also influenced by individual prior experience and society experience of insurance.

*1-31 Machikaneyamacho Toyonaka, Osaka, 560-0043, Japan. Email: a-matsuda@osipp.osaka-u.ac.jp
** 2-1 Naka, Kunitachi, Tokyo, 186-8601, Japan. E-mail: kurosaki@ier.hit-u.ac.jp.

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1. Introduction

Farmers around the world face a variety of risks during agricultural production. In particular, uninsured weather risk has been a significant barrier for farmers engaging in *ex ante* risk management and in *ex post* risk coping. Irrigation is often not available in developing countries, thus agricultural profits largely depend on seasonal and temporal weather variations, leaving the risk of inclement weather as a significant cause of production inefficiency and income variability.[1] We examine data collected in India, where dependence on monsoons is known to be very high. Nearly 70% of India's cultivable land is rain-fed. Thus hedging weather risk is an essential way to improve household welfare by enabling greater production stability.[2]

Historical experience suggests that traditional crop insurance has not been financially viable, both in developed and developing countries. The claim payouts of crop insurance are determined on the basis of realized harvests, and hence, an insurance agent has to assess the farmers' yields (either at the individual or regional level). However, the costs of obtaining accurate information on the yield loss and of monitoring farmer behavior are prohibitively high, raising the problems of moral hazard and adverse selection (Besley, 1995). In addition, systemic weather effects induce high correlations among farm-level yield, defeating insurer efforts to pool risk across farms (Miranda and Glauber, 1997). Consequently, indemnity payouts and administrative costs are far more than collected premiums, leading the insurance system to become insolvent.[3]

As an alternative formal insurance mechanism, weather index insurance has been attracting much attention from academics, policy makers, and NGOs (Patrick, 1988; Hazell, 2003; Skees et al., 2005; Morduch, 2006; Barnett and Mahul, 2007; Barnett et al., 2007; Chantarat et al., 2007; Alderman and Haque, 2007; Mobarak and Rosenzweig, 2013, Karlan et al. 2014).[4]

[1] Rosenzweig and Binswanger (1993) find that a one-standard-deviation decrease in weather risk would raise the average profits by 35% among the poorest quartile in India.

[2] Since the 1990s, there has been remarkable progress in theoretical and empirical studies on risk and insurance in developing countries. Self-insurance mechanisms as a means of precautionary savings, such as storing crops and holding livestock, are often suboptimal; there are other more productive resources that farmers could invest in. Kurosaki and Fafchamps (2002) find that farmers under-invest in more productive but risky crops when they face severe weather shocks. Informal insurance, such as mutual help and rotating savings and credit associations (ROSCAs), plays an important role when access to credit markets is limited (Morduch, 1994, 1995; Dercon et al. 2008). Townsend (1994), Udry (1994), Ligon et al. (2002) and Ligon (2008) show how informal insurance mechanisms have been working against various kinds of idiosyncratic shocks. However, informal insurance might not be able to play a large role against weather risk, such as drought, floods, and typhoons, which are highly covariate in a village.

[3] See, for examples, Hazell,(1992), Goodwin (1993), Wright and Hewitt (1994), Besley (1995), Miranda and Glauber (1997) and Mahul and Wright (2003).

[4] Weather index insurance products are available in many developing countries, including Bangladesh, Benin, Burkina Faso, Cameroon, the Caribbean Islands, China, Ethiopia, Ghana, Guatemala, India, Kenya, Malawi, Mali, Mexico, Mongolia, Morocco, Nicaragua, Peru, Senegal, South Africa, Tanzania, Thailand, Vietnam, Ukraine, and Zambia. They are provided either as pilot projects or on a larger scale. Barnett, et al. (2007)

In weather index insurance, payouts are usually based on weather parameters (e.g. rainfall, temperature, air moisture, and satellite-measured vegetation level) observed at a particular weather station. For example, typical rainfall insurance starts with a contract by which an insurer indemnifies a farmer for his income loss if the amount of precipitation in a given time period is below the pre-determined cutoff.

The primary advantage of this insurance is that claim payments are made only on the basis of observable and verifiable indices, not on individual losses, so farmers cannot manipulate the indices conditional on that weather stations are securely locked. Second, the contract significantly mitigates adverse selection problems because the claim payments are independent of the characteristics of insured farmers. Finally, in practice, there is no need to estimate the actual loss experienced by the policyholder (Barnett and Mahul, 2007). Thus, the implementation cost is less than that of indemnity-based insurance in that the claim rate is invariant across farmers in a village, ensuring prompt payments with minimum costs. Providing payouts as quickly as possible is especially important when farm households face credit constraints. The argument in favor of index insurance mentioned above is mostly theoretical and our understanding of weather index insurance and farmers' demand for it is still limited.

In this study, we conduct an empirical analysis of the demand for weather index insurance products in low-income developing country. In collaboration with an insurance company, we collected primary data of farmers through questionnaires and field experiments in which the farmers randomly receive different levels of price subsidies. Using the dataset, we describe the demand patterns for rainfall and temperature insurance. Main characteristics of our study are as follows. First, our sample farmers do not face liquidity constraints as a confounding factor because all of them have bank accounts to receive agricultural credits and the insurance premium was deducted from their bank accounts. Second, we offer randomized insurance premium rates to farmers. Third, farmers' basis risk.is considered by randomly choosing the ones who are located differently to their nearest weather station. Our study highlights how the demand for weather index insurance is correlated with the above characteristics. The main contribution of this study to the literature is that we cleanly identify price elasticities using the exogenous variation in offered prices. Furthermore, the price response of insurance demand is not contaminated by credit constraints. These aspects distinguish the estimation results of our study from those in the literature on the price response of insurance demand.

This paper presents details of surveys implemented under the project conducted by the authors and describes the key variables collected. In our regression analysis, we compare how price, income and asset levels influence the demand both for temperature and rainfall insurance policies. The results show that farmers respond less to the price of rainfall insurance than to the temperature insurance. We also find that richer farmers are less price-sensitive and farmers' response to the discount becomes less price-sensitive as the amount of discount increases. In

provide a summary of ongoing programs in middle- and low-income countries.

addition, we show that non-price factors such as age and education level of a respondent and education are important correlates. Previous experience with an insurer, which is a proxy for trust to an insurer, also matters. Finally, purchase decisions are also influenced both by individual prior experience and by society experience of insurance. The latter suggests spillover effects among farmers in the same society.

The rest of the paper is organized as follows. Section 2 discusses the related literature on weather index insurance. Section 3 describes the details of the insurance contracts analyzed in this paper. Section 4 discusses the study sites and the sampling strategy. Section 5 provides the characteristics of the sample, and Section 6 and 7 investigate the correlates of the demand by regression analysis. Section 8 provides discussion and Section 9 contains concluding remarks.

2. Literature on weather index insurance

In the last decade, important progress has been made in the empirical literature on weather index insurance. The existing studies assume that there is a substantial demand and attempt to identify the factors that affect take-up. First, price is certainly a major determinant. Many existing studies include (either hypothetical or actual) subsidies for the premium to increase take-up (Giné and Yang, 2009; Miura and Sakurai, 2012; Cole et al., 2013; Mobarak and Rosenzweig, 2012, 2013; Cai et al., 2015; Karlan et al., 2014; Takahashi et al. 2016). Cole et al. (2013) estimate the slope of the demand curve by randomly varying the price of insurance, and find significant price sensitivity: a 10% price decrease leads to a 10.4% − 11.6% take-up increase.[5]

Second, liquidity constraint is another important factor. Households purchase insurance at the beginning of the planting season when there are many other expenses to manage, such as payments toward labor for land preparation, seeds, and/or fertilizer. Thus, households with less land and less wealth are less likely to buy insurance (Giné et al., 2008; Chen et al. 2012; Cole et al. 2013; Matul et al., 2013).[6]

Third, Giné et al. (2008), Miura and Sakurai (2012) and Cole et al. (2013) find that measured household risk aversion is *negatively* correlated with insurance demand. This result is inconsistent with what standard microeconomic theory predicts. Giné et al. (2008) conjecture that uninformed risk-averse households are unwilling to experiment with the new financial

[5] Cole et al. (2013) estimate that the price elasticity of their insurance product is −0.66 to −0.88. Mobarak and Rosenzweig (2012) discusses that the price elasticity for their product is −0.44. Hill et al (2016) find the price elasticity of their product is −0.58.

[6] Cole et al. (2013) randomly give households high cash rewards as compensation for taking part in their study and found that having enough cash increases insurance take-up. Chen et al. (2012) allow a deferral in the premium payments by providing credit vouchers to farmers and find an increase in take-up by 11 percentage points.

product, given their limited experience with it. These existing papers use risk aversion measures elicited by a framed field experiment as defined by Harrison and List (2004).[7] Their lab-experimental games follow the approach developed by Binswanger (1980) by asking respondents to choose among cash lotteries varying in risks and expected returns. While the implementation of the lab games is relatively convenient, it is very difficult to realistically frame the games in the context of a particular insurance contract. Also, the stakes delineated in the lab-experimental games are generally much lower than the real stakes farmers face. In addition, Rabin (2000) proves that risk preferences elicited by small-stake games cannot accurately reveal large-stake real-world risk preferences.

Fourth, existing literature has suggested that basis risk is one of the most important reasons for weather index insurance not being attractive to potential clients. A theoretical study by Clarke (2016) showed that a farmer might be worse off with the insurance than without it. The existence of basis risk means it is possible that a farmer pays the premiums, experiences a loss, but then, does not receive an insurance payout. Clarke (2016) also showed that the demand for index insurance of risk-averse agents would be low when the basis risk is high. Existing empirical studies have also addressed the significance of basis risk. In order to measure the basis risk, Gine et al. (2008) used: i) a dummy variable, which takes a value one if a farmer uses accumulated rainfall to decide when to sow and ii) the percentage of land used for Kharif crops. Mobarak and Rosenzweig (2012a, 2012b) used perceived distance reported by the study participants, which was converted to zero if the weather stations were situated in the village.

There are other important factors which appear to curb demand. One factor is subjective uncertainty.[8] Households' pessimism about the weather is positively correlated with take-up (Giné et al., 2008). Gallagher (2014) find that flood insurance take-up increases by 9% soon after experiencing a flood. This recency bias is also discussed in Section 7.4. of the current paper. Galarza and Carter (2010) find the opposite, with farmers tending to believe that a flood is less likely to happen during the subsequent season. A lack of understanding and limited attention are also possible factors that discourage purchasing, given that people have only limited financial literacy and are not always able to evaluate the insurance (Cole et al., 2013; Cai et al., 2015).

Some studies contend that trust is another key factor impacting demand. Giné et al. (2008), Cole et al. (2013) and Karlan et al. (2014) find that take-up decisions are strongly correlated

[7] Harrison and List (2004) propose the following taxonomy of field experiments: i) an *artefactual field experiment* is the same as a conventional lab experiment but with a nonstandard subject pool; ii) a *framed field experiment* is the same as an artefactual field experiment but with a field context in either the commodity, task, or information set that the subjects can use; iii) a *natural field experiment* is the same as a framed field experiment but where the environment is one where the subjects naturally undertake these tasks and where the subjects do not know that they are in an experiment.

[8] Delavande et al. (2011a, 2011b) discuss different methods for eliciting subjective expectations in developing countries.

with measures of familiarity with, and the reputation of the insurer. Salience and framing are also important. Giné et al. (2008) find that the use of negative framing language on a flyer and conducting household visits have a positive effect on take-up. Networks appear to be another influential factor. Galarza and Carter (2010) show that having peers who suffered from a disaster increases the likelihood of take-up. Cai et al. (2015) also finds that having a friend who has received financial education raises take-up by almost half as much as directly obtaining financial education. Existing risk-sharing mechanisms are also related to low take-up. Sakurai and Reardon (1997) find that demand varies according to individuals' self-insurance strategies. Dercon et al. (2014) find that index insurance is a complement to informal risk sharing and that demand is higher among groups of individuals that can share risk. In contrast, Mobarak and Rosenzweig (2013, 2014) show that the availability of caste-based informal risk sharing arrangements lower the take-up of their product, as the caste network could cover both idiosyncratic and aggregate risk. Takahashi et al. (2016) find that consumer education through the provision of learning kits improves knowledge of the index insurance, but that improved knowledge per se does not cause greater uptake.

Certain studies focus on supply-side issues. Carter et al. (2011) prove that take-up is higher when index insurance is interlinked with credit contracts, while Giné and Yang (2009) show that take-up among farmers that were offered a bundled loan was actually 13% *lower* than for the control group offered a standard loan.[9] De Janvry et al. (2013) show that demand for insurance can increase if the policy is sold to groups with common interests rather than to individuals when free-riding and coordination failure are serious problems.

Other studies analyze household behavior. Simulations by Ragoubi et al. (2013) and de Nicola (2014) show that the provision of weather insurance induces investment in riskier but more productive crop varieties. Karlan et al. (2014) find an increase in agricultural investment among households which are randomly given index insurance. Fuchs and Wolff (2011) find an increase in yield among the insured maize farmers. Janzen and Carter (2013) show that insured households are reported to be less likely to anticipate drawing down assets and reducing meals.

Among these factors affecting the insurance demand, we focus on the effect of price (premium) of the insurance product. Our study explores variation in prices that is orthogonal to other factors. In particular, we offered potential customers four different price levels, and one of them is randomly selected. We also consider heterogeneity in demand due to basis risk in interpreting the demand patterns. A more detailed discussion of our survey and experimental design is provided in Section 4. For the insurance contract studied in this paper, cash was not required for the payment and the income levels of the sample households were far above the subsistence level. Therefore, liquidity constraints does not have a key role. Also, our target population had been able to borrow sufficient credit from the bank. Therefore, our demand

[9] The authors interpret the result as indicating that since farmers were already implicitly insured via limited liability in the standard loan, they did not value the insurance.

estimates are not contaminated by credit constraints. Trust issues are addressed in this paper using the variation in farmers' previous exposure to similar products or companies offering the insurance product. A more detailed discussion of the insurance contract and its history is provided in Section 3.

3. Contract details

The weather index insurance market in India is the world's largest, covering more than 9 million farmers.[10] In this paper, we study two insurance products, rainfall index insurance and temperature index insurance, sold by IFFCO-Tokio General Insurance Co. Ltd. (ITGI), which is one of the major insurance companies in India.[11] The rainfall insurance product is called Barish Bima Yojna (BBY), "rainfall insurance scheme" and temperature index insurance product is called Mausam Bima Yojna (MBY) "temperature insurance scheme".[12] There are two main crop seasons in India, Kharif and Rabi: a Kharif crop is a monsoon or autumn crop, with sowing usually occurring in June–July and harvests in September–November. Rabi crops are usually sowed in November-December and harvested in March-April. For this reason, an agricultural year in India is defined by combining the Kharif and Rabi crops in this order, and we denote it as, for example, 2011/12 (that is, Kharif 2011 plus Rabi 2011/12). BBY is indexed to the precipitation during the Kharif season, while MBY is indexed to temperatures during the Rabi season. ITGI started selling BBY insurance in 2004, and has since expanded its market to most of the country.

The current study focuses only on the state of Madhya Pradesh (Figure 1), which is one of the biggest markets with more than 110,000 farmers. Once ITGI approaches, the insurance product is offered to all farmers, regardless of the type of crops they cultivate, but they have to be eligible to borrow from the District Central Cooperative Bank (DCCB). The DCCB is an agricultural bank affiliated with a cooperative society, which is an agricultural unit in which each farmer holds a share[13].

[10] For an overview of weather insurance products sold in India, see Clarke et al. (2013).

[11] ITGI is a subsidiary of a former public fertilizer company, Indian Farmers Fertiliser Cooperative Limited (IFFCO).

[12] Mausam Bima Yojna literally means "weather insurance scheme." In this paper, we call MBY as "temperature index insurance" considering its contract terms.

[13] The DCCB's branches are usually located at (or next to) a cooperative society's buildings. Most of the landowner farmers borrow money from the DCCB once or twice a year. Prior to the beginning of Kharif or Rabi, a farmer visits his society manager to ask for a new loan. The society manager approves and sets the loan limit. The loan limit is usually determined by the landholdings, repayment status, and crop portfolio. Then the society accountant fills in the farmer's passbook with a certificate and the farmer brings his passbook to the bank branch of the society to receive the loan. The gross interest rate for a short-term (one-year) loan is 12% (9% is subsidized by the local government) when the current study was conducted. There are other financial

[Figure 1]

3.1 BBY 2007-11

BBY (rainfall index insurance) is sold in May-June, prior to the beginning of the Kharif season. The details of the contract vary across different districts with different seasons and years covered. In this subsection, we describe the contract details that were in force during the current study. We specify the year to denote the agricultural year that the BBY covered. For example, BBY 2011 corresponds to the rainfall index insurance for Kharif 2011. The insurance terms were changed between BBY 2011 and BBY 2012, which is explained in further detail in Section 3.3.

The premium rates are listed in Tables 1. In the past, the government offered a subsidy for the insurance premium, but this was not available for BBY 2011. The premium rate increased from 4.5% in 2007 to 8% in 2011 (Table 1).[14] This is both because the subsidy from the government suspended and the area became "riskier" from the insurer's viewpoint as more claim payouts were made in 2007 and 2008. The premium of each insurance product is higher than the actuarial fair level with a mark-up of around 25% in 2007, and increased to 75% in 2011.[15]

[Table 1]

Clients chose the amount of the sum insured (SI), which is the maximum amount a farmer can be paid in the event of loss. The actual premium payment is calculated as (the premium rate)$\times$(SI).

BBY $2007-11$ was indexed to the total rainfall from June to September. The monsoon rainfall in Madhya Pradesh is the heaviest during these months, and thus the cumulative precipitation over this period is a good measure of the monsoon conditions. The trigger level was 768.8 mm, which was calculated and specified by ITGI. The weather station whose records are used for BBY is situated in the center of the district, in the district hall.[16] The insurer pays claims if the amount of total precipitation over the four months is below the predetermined cutoff. The payment schedule is provided in Table 2. The claim rate is defined as a percentage of SI.

institutions, including informal moneylenders, from which farmers can borrow, but interest rates are generally higher than those offered by the DCCB.

[14] In our study site, BBY was not sold during 2009-2010 because of capacity constraints experienced by the supplier. In 2010, BBY was available in other districts of Madhya Pradesh.

[15] The markup was calculated by the authors. The data used to calculate the actuarially fair premium was taken from the National Climate Data Center, Climate Data Online from the National Oceanic and Atmospheric Administration: `http://www7.ncdc.noaa.gov/CDO/cdo`.

[16] Appendix shows pictures of the weather station and the rain gauge.

[Table 2]

Suppose a farmer is eligible to borrow Rs $20,000$ from the DCCB, and the loan is distributed prior to the beginning of Kharif. In May, an insurance agent approaches the farmer about possibly taking up insurance. If the farmer agrees, he decides the amount of SI. Suppose the farmer's SI is Rs $10,000$. If the premium rate of the area is 8.0%, his premium will be Rs 800. This will be deducted from his bank account. Cash is not required for the premium payment, and hence liquidity constraints are not a factor discouraging take-up of the insurance. After the coverage period, the insurer declares the amount of the claim on the basis of the weather data reported by the Indian Meteorological Department. If there are positive claim payouts, an insurance agent visits the village to distribute checks to the individual clients before the beginning of the next season. A claim payout is calculated according to the deficiency rate. The deficiency rate (%) is defined as $1-[(\text{total observed rainfall})/(\text{trigger level})]$. As shown in Table **??**, if the deficiency rate is 30%, the insurer will make an insurance payment of 10% of the SI.

During the current study, the per-acre price of the insurance was presented to elicit the farmers' individual demand, i.e. the number of acres they want to insure at that price. As discussed earlier, for 2007-2011, farmers were asked to choose the amount of the Sum Insured. In contrast, during the subsidy experiments of the current study, farmers were asked to choose the number of acres, not SI.[17] Then the interviewers offered four different levels of subsidy (0%, 25%, 50%, and 75%) if a farmer chose to participate in the study and buy insurance. The details of this subsidy experiment are provided in Section 4.2.

As is clear from the insurance contract details, there is little potential for adverse selection because the claim payments are independent of the characteristics of insured farmers. Also, there is little reason to believe that moral hazard is an impediment since the policyholder cannot influence the realization of the underlying weather index (Barnett and Mahul, 2007).

3.2. MBY 2012

ITGI's temperature index insurance is called Mausam Bima Yojna (MBY: temperature insurance scheme). MBY is a unique index insurance product that covers damage to crops attributable to extreme heat during the growing and flowering periods for Rabi crops.[18] For instance, wheat, which is the main Rabi crop, is highly vulnerable to high temperatures during January–February. If a high temperature hits the wheat crop during these months, the harvest is substantially reduced.

[17] This change was made because the insurance company found asking about acreage coverage was easier for farmers to answer.

[18] Appendix shows a picture of a thermometer used in the current district.

The details of the contract vary across different districts during different dates and years covered. Although MBY has been available in other places, it was introduced for the first time to our studied region for Rabi 2011/12. Since the insurance is indexed to the temperatures in early 2012, we refer to it as MBY 2012, and describe it in this section.

MBY is sold in October–November, prior to the beginning of the Rabi season. The contract details of MBY 2012 are summarized in Table 3. The contract divides the season into two phases and six periods. Each period is two weeks long. Trigger levels and strikes are different for each phase. The indices are two-week averages of the daily *maximum* temperature and two-week averages of the daily *average* temperature. The per acre premium of MBY 2012 is Rs 576. For simplicity, the insurer specified the SI of MBY 2012 to be Rs $7,000$.

To calculate the claim payout of Phase I, suppose that the actual temperatures observed during Period 1 and Period 2 were $X_1(\,^\circ\mathrm{C})$ and $X_2(\,^\circ\mathrm{C})$. Let the triggers, which are the average of the daily average temperature and the average of the daily maximum temperature for each two-week period, be $T_1(\,^\circ\mathrm{C})$ and $T_2(\,^\circ\mathrm{C})$, respectively. The strike is defined as $S(\,^\circ\mathrm{C})$. Then, the claim payout (Rs) is calculated as follows:

$$\text{Per Acre Claim Payout} = 350 \times [\max\{(X_1 - T_1) + (X_2 - T_2) - S,\ 0\}]$$

The notional is Rs 350 and the maximum payout is Rs $3,500$. Suppose there is a farmer who purchased this product for one acre. He paid Rs 576 for the premium. Suppose then that the average observed maximum temperature of Period 1 (X_1) was 28 °C. As shown in Table 4, this is greater than the trigger level ($T_1 = 27$) of Period 1 in Phase I by one degree. Similarly, suppose that the average maximum temperature of Period 2 (X_2) was 36 °C. This is greater than the trigger level ($T_2 = 30$) of Period 2 in Phase I by six degrees. Therefore, the total number of degrees exceeded throughout Phase I was seven degrees. This is greater than the strike ($S = 4$) by three degrees. Therefore, the farmer will be paid $350 \times 3 =$ Rs $1,050$. In MBY 2012, the actual claim payout was Rs 157. This was paid to clients in May–June 2012. The claim payout for Phase II is calculated in a similar way.

[Table 3]

3.3. BBY 2012

Prior to Kharif 2012, the insurer changed the terms of the BBY, in effect extending the coverage to include excess rain and consecutive dryness, in addition to the drought conditions already covered under BBY $2007-11$. The premium, defined in terms of insured land, was Rs 750 per acre. Again, farmers were asked to state the number of acre(s) they want to insure. The insurer specified the SI of BBY 2012 to be Rs $5,000$ for the cumulative rainfall deficit, Rs $2,500$ for the excess rainfall, and Rs $1,500$ for the consecutive dry days. The details of this modified BBY are summarized below.

First, we explain the cumulative rainfall deficit insurance. There are four phases, and strikes and notionals are different for each phase (Table 3). In order to calculate the claim payout on rainfall deficiency of Phase I, suppose that the actual precipitation is denoted by R (mm). There are two ranges of strikes. Denote the upper and the lower bounds of the two strike ranges as U_1, L_1, U_2, L_2 ($U_1 > L_1 = U_2 > L_2$). Notionals for each range of the strike are N_1 and N_2, respectively. Then, the claim payout (Rs) is calculated as follows:

$$\text{Per Acre Claim Payout} = \begin{cases} 0 & \text{if } U_1 < R \\ N_1 \times (U_1 - R_1) & \text{if } L_1 < R \leq U_1 \\ N_1 \times (U_1 - L_1) + N_2 \times (U_2 - R) & \text{if } L_2 < R \leq U_2 \\ 1250 & \text{if } R \leq L_2 \end{cases}$$

As Table 1 shows, for Phase 1, $\{U_1, L_1, U_2, L_2, N_1, N_2\} = \{60, 30, 30, 10, 10, 47.5\}$. The maximum total payout is Rs $5,000$. If the rainfall of Phase 1 is 40 mm, the claim amount will be $10 \times (60 - 40) =$ Rs 200. If the cumulative rainfall of the phase is 11 mm, the claim amount will be $10 \times (60 - 30) + 47.5 \times (30 - 11) =$ Rs 1202.5.

[Table 4]

The second component of BBY 2012 is the excess rainfall insurance. A claim for excess rainfall is paid when the cumulative rainfall of any two consecutive days in a phase is greater than the strike (mm). The strikes, notionals, and maximum payouts for each phase are listed in Table 4. The claim is calculated as:

$$\text{Per Acre Claim Payout} = \max \left\{ \begin{array}{l} \text{(Cumulative rainfall of any two consecutive days - Strike)} \\ \times \text{ Notional, } 0 \end{array} \right\}$$

[Table 5]

Third, BBY 2012 insures the event of consecutive dry days (CCD). The Consecutive Dry Days' (CCD) index is applied from July 5 to September 15 (Table 6). A claim is paid when the total number of consecutive days with a daily rainfall of less than 2.5 mm exceeds a strike. The maximum payout for CCD coverage Rs 1,500. The total claim payout of BBY 2012 is the sum of the payouts for all three covers.[19]

[Table 6]

[19] The possible maximum total payout is Rs $6,500$. This is the case when there was little rain throughout Kharif season and maximum claims for the cumulative rainfall deficit and consecutive dry days are paid.

4. Study sites and data

4.1. Study sites, sampling strategy, and primary surveys

In Madhya Pradesh, we chose the Burhanpur District in the East Nimar region for our study, located in the southern part of the state, bordering the state of Maharashtra (Figure 1). Before explaining the details of our surveys, we describe our studied region as the background information.

The Burhanpur District is known for its rain-fed agriculture. Tubewells are available only in a few areas. The major crops of the district are cotton, bananas, soybeans, sugarcane, wheat and vegetables. Table 7 shows the proportions of land in the district cultivated for these specific major crops, in comparison with the total land cultivated in the state. Cotton is the most important cash crop, occupying the largest share of the gross cultivated area (23.3%). It is a Kharif crop, although its harvest may extend into the early months of the Rabi season, as it usually takes 6 to 8 months to complete one crop cycle. The main cereals are jowar (sorghum) in Kharif and wheat in Rabi, both of which are suitable for rain-fed agriculture. These crops are mostly grown for subsistence purposes. As a whole, cereals account for only 14.8% of the gross cultivated area. Other important cash crops are soybeans and bananas.[20] Soybeans are mostly grown as a Kharif crop, although it is also harvested in Rabi. It is a fairly new crop in Indian agriculture, and its production spread throughout Madhya Pradesh during the 1990s as a cash crop from which vegetable oil is extracted. Banana cultivation takes on average two years to harvest. Therefore it is not classified as either a Kharif or Rabi crop. A timeline showing key events covered in the study is presented in Table 8.

In the Burhanpur District, formal insurance is not new at all; governmental crop insurance, motor, property, life, and health insurance have been available for years in some parts of the district. Government crop insurance, introduced in 1985 and originally called the Comprehensive Crop Insurance Scheme (CCIS), now called the National Agricultural Insurance Scheme (NAIS), is provided by the Agriculture Insurance Company of India Limited (AICI). Under NAIS, insurance for food crops, oilseeds and selected commercial crops is mandatory for all farmers that borrow from financial institutions such as DCCB.[21]

Our surveys and experiments were conducted as follows. As BBY is sold through cooperative societies, this is the first tier from which we drew the sample. Farmers often visit the cooperative society to purchase inputs such as seeds and fertilizer, and to gather for meetings. Its office building is usually located within 5-10 minutes from each house on foot or by motorcycle. Our strategy was to draw a random sample of farmers belonging to each cooperative

[20] Bananas are classified as "Fruits" in Table ??.

[21] In reality, almost no farmer in the current sample is aware of NAIS. No farmer actually has received any claim. Clarke et al. (2012) point out that delays in claim settlement of NAIS has been a serious concern.

society, with a substantial variation in the geographical distances between the weather station and the farmers' landholdings.[22] This is because the physical distance from the weather station provided us with the proxy for the basis risk (see Section 4.3. for the details). To obtain precise information on studied geographical locations and distances, we collected GPS information on all the farmers' houses. The number of samples collected at each society is proportionate to the size of the society.

[Table 7]

[Table 8]

Following the above methodology, the sample size of the current study consists of 433 farmers from 8 villages. The sampled farmers were active account holders of the DCCB, and were all landowners.[23] As discussed in Section 2, previous literature suggests one reason for low take-up of index insurance is a liquidity constraint. However, a unique characteristic of this paper's sampling strategy was to target the population that had been able to borrow sufficient credit from DCCB. The insurance premium is paid after the credit is disbursed, but before the starting of the next agricultural season. Therefore, the targeted population is not credit constrained at least at the time of the insurance purchase. There were six cooperative societies: Bambada, Chapora, Dedtalai, Loni, Phopnar and Shahpur. BBY was available in Shahpur, Bambada, Chapora, and Phopnar since 2007, but not in Loni and Dedtalai because of the insurer's supply constraints. MBY was introduced to all six societies for the first time in Rabi 2011/12. As summarized in Table 9, claims were paid in 2007, 2008, and 2012.

[Table 9]

The current dataset consists of the information collected in two rounds of surveys. The first survey (denoted as "Survey 2011") was conducted in October-November 2011, when MBY 2012 was being sold. The actual claim payout was Rs 157 per acre insured. This was paid to clients in May-June 2012. The second survey (denoted as "Survey 2012") was conducted in May-June 2012, when BBY 2012 was being sold. For both surveys, sample farmers were invited to the buildings of their cooperative societies to be interviewed on the basis of a structured questionnaire. Information on past take-up of BBYs was collected in a retrospective way from each farmer, and validated by crosschecking it with the administrative data maintained by the insurer.[24]

[22] In the survey sites, almost all farmers belong to cooperative societies. Section 5.3 discusses the heterogeneity in socio-economic characteristics of the sample across cooperative societies.

[23] The sample represents potential demanders. ITGI's potential clients are farmers who own the DCCB accounts for seasonal loans or have a positive balance in their saving accounts. Landless farmers are not eligible to borrow agricultural loans from the DCCB.

[24] Questionnaires used in Surveys 2011 and 2012 are available upon request.

4.2. Insurance price discount experiments

To elicit the price sensitivity of farmers' individual demand, we implemented experiments of random discounts in both Survey 2011 and Survey 2012. Once a farmer chose to participate in the study, the interviewers offered four different levels of subsidy (0%, 25%, 50%, and 75%).[25] A 0% subsidy is equivalent to offering the product at the original price, whereas a 50% subsidy is equivalent to offering the product at a half of the original price. The 75% discount is below the actuarially fair level. Next, the subject was asked to specify their demand in terms of acres at each subsidized price level (the insurance products were sold in 0.5-acre increments)[26]. Farmers agreed that they would purchase the quantity they specified but the actual prices would be determined randomly. By using this method, we elicited four price-quantity pairs per farmer. We used the same procedure in both surveys.

After all four price-quantity pairs were recorded, the subjects rolled an eight-sided dice. Each face value of the dice corresponded to the four options (1 and 2 to receive a 0% subsidy, 3 and 4 to receive a 25% subsidy, 5 and 6 for 50%, and 7 and 8 for 75%). Suppose a farmer answered 0.5 acres for 0%, 0.5 acres for 25%, 1 acre for 50%, and 2 acres for 75% in Survey 2011 for MBY 2012. The per acre premium was Rs 576. If the number on the dice he rolled was 7, then the actual amount payable by him would be Rs 576 $\times$ 2 $\times$ 25%= Rs 288. The difference between the subsidized price and the market price was the amount paid to the subject by the authors.

4.3. Measurement of the basis risk

Ideally, to estimate the basis risk, we need detailed precipitation data measured on both individual plots and weather stations. However, for this study, installing rain gauges on the plots of 433 farmers (who often also have multiple plots) was not practically possible, due to financial and logistical constraints.[27] Giné et al. (2008) used two variables: i) a dummy variable, which takes the value one if a farmer uses accumulated rainfall to decide when to sow, and ii) the percentage of land used for Kharif crops. These variables are indirect measures of basis risk, as Giné et al. (2008) state that an "alternative variable for measuring basis risk would be the distance to the rain gauge or some other direct measure of the difference in weather between the farm and the weather station." Mobarak and Rosenzweig (2013, 2014) used a perceived distance which was reported by the study participants. This distance was converted to zero if the weather stations were situated in the village.[28]

[25] All farmers agreed to participate in the experiment. This was likely to be because the experiment was followed by the socio-economic survey.

[26] Every participant was asked to answer the demand at the same order (from 0% subsidy to 75% subsidy).

[27] Miura and Sakurai (2012) collected rainfall data on individual plots for 48 households in Zambia.

[28] The mean of the reported distance was 4 kilometers, with a standard deviation of 5.9 kilometers.

Instead, we used the physical distance between farmers' houses and the weather station as a proxy variable for the basis risk. While the physical distance is not a perfect proxy, meteorologists and agronomists claim that the basis risk is large when the insured's plot is far away from the meteorological station (Fisher et al. 2013). This measure is also intuitive in that farmers are likely to estimate their basis risk subjectively on the basis of the difference between the weather near their house and that at the nearest weather station.[29] Therefore, we collected geocodes (latitude, longitude, and altitude) for the weather station and for each respondent's house. Given that farmers have multiple plots, they may not subjectively calculate the amount of the basis risk for each plot.[30] Therefore having the distance from their houses to the weather station is a reasonable proxy.

We show how these geocodes varied across societies and sampled farmers in Table 10. The mean distance to the weather station is 11.6km. The variance in the distance to the weather station is fairly large with the coefficient of variation at 111% (12.87 divided by 11.60). As shown in the table, most of this variation is between societies. However, it is important to point out that within-society variation is not negligible, especially in Chapora and Bambada. The mean altitude (above sea level) is 267.6m. The variance in altitude is very small, which implies that the area is flat.

[Table 10]

5. Characteristics of sample farmers

In both Surveys 2011 and 2012, we collected detailed information on the sample farmers' socio-economic characteristics, such as family roster, assets, income, agricultural activities, insurance take-up and claim receipts in previous seasons, consumption, and demand for the insurance that was sold during the surveys. In this section, we describe the summary statistics of those variables.

5.1. Basic characteristics

Table 11 summarizes the sample's socio-economic characteristics. The average age of the farmers is 51.4 years old, and the average household size is 5.48 persons. The farmers have received an average of 6.42 years of education, and have a literacy rate of 52.9%. This level of literacy is comparable to the state-wide level of 57.8% (rural areas only).[31] 12.6% of the

[29] Basis risk can also be caused by other topographical differences in ground contours, slope, etc. These factors are important, but beyond the scope of this paper.

[30] This was confirmed from casual conversation with respondents during interviews.

[31] Census 2011.

sample belong to the Scheduled Castes (SC) or Scheduled Tribes (ST),[32] and the majority of the sample (81.6%) belongs to the Other Backward Classes (OBC). Though 62.8% of them have access to wells, they still don't have enough water supply for agricultural uses: they pay an average of Rs $15,100$ (= USD 316) to rent motor pumps from their neighbors during Kharif.[33] Indeed, 88.4% of them answered that weather risk is the biggest risk that they face.[34]

Table 11 also lists summary statistics on assets and farming activities. As already described, all sample farmers own land. The average landholding size is 4.7 acres. This is slightly larger than the average landholding size of all farmers in Madhya Pradesh (3.68 acres in 2003),[35] indicating that our sample does not disproportionately represent wealthy farmers, but contains a number of small and medium farmers. Of the 4.7 acres of average landholdings, 4.03 acres are irrigated.[36] The average value of a house is Rs $335,000$ (that is, USD 7002).

Table 11 also reports the total agricultural income for each season. The total agricultural income during Kharif 2011 is Rs $135,700$ (= USD 2836). The average value of the loans the sample farmers for Kharif 2011 was Rs $85,600$ (= USD 1789). The total agricultural income during Rabi 2011/12 was Rs $111,200$ (= USD 2324), while the average loan provided at the beginning of this period was Rs $63,800$ (= USD 1329).

Areas under each crop are also listed in Table 11. Consistent with state-wide statistics, area under cotton is the largest in Kharif seasons. The area under bananas is much higher than the district average (Table10), suggesting that our sample comprises farmers with a stronger commercial orientation than the district average. After cotton and banana, jowar accounts for about 3.6% in Kharif, and wheat for 10.5%. These crops are highly susceptible to extreme weather. The numbers for Kharif 2012 were planned ones because Survey 2012 was conducted right before Kharif 2012. Disbursement of the Kharif crop loan was also in process.

In the sample, 97% of the farmers were clients of IFFCO, the fertilizer company. As we discuss later, this familiarity with the parent fertilizer company played an important role in enabling the insurer to sell the insurance products, by reducing potential farmer mistrust of the product and/or provider. The questionnaire also included eight arithmetic questions to determine the farmers' numeracy. The average number of correct answers was 3.1 (The standard deviation was 3.4).

[Table 11]

[32] 29.4% of the entire population of the state belong to the SC/ST (Census 2011).

[33] The average exchange rate of the financial year 2011/12 is Rs 100 = 2.09 USD (Government of India, 2012).

[34] Farmers were asked to rank different kinds of risks (weather risk, price risk, lack of money, lack of family labor, lack of land, and lack of infrastructure) from the most to least serious. This question is taken from Cole et al. (2013) where 89% of the sampled households cite the weather risk as the biggest risk.

[35] This figure excludes data on landless households and is taken from Statement 4 (state-wise average size of household ownership holdings), NSSO (2006), p.15.

[36] The change in landholding between the two surveys was very small. Although many farmers have access to some sort of irrigation, available water supply is usually not sufficient.

5.2. The take-up of weather insurance

The incidence and depth with respect to the take-up of MBY and BBY are summarized in Table 12. First, we describe the take-up in previous years. The table shows that 24% of the farmers had purchased BBY prior to the current project. This low level of penetration is consistent with existing studies.[37]

Second, we move to the results of our price discount experiments. In both Survey 2011 and 2012, we collected four price-quantity pairs per subject. To our surprise (we will discuss this below), those who demanded zero when discount was 0% continued to demand none even when positive discounts were provided. Therefore, although we collected the information about the uptake at the level of farmer-price pairs, we did not obtain any variation for those farmers regarding the take-up dummy. As a result, our measure of take-up becomes a dummy for those farmers. It takes 1 if the farmer demanded a positive amount of insurance and 0 if the farmer demanded no insurance.

As shown in the middle of panel of Table 12, in 2011, 72% of the respondents purchased MBY 2012. This take-up rate is extremely high when compared to existing studies. It might not be surprising, however, as our sample differs substantially from that of the existing studies in that the income level is higher, credit constraints are less likely to be binding, and index insurance is not at all new. In Survey 2012, BBY 2012 was purchased by 41% of the respondents (see the lower panel of Table 12). The decrease in the take-up rate of BBY 2012 might be because people were disappointed by the small (yet positive) claim amount (Rs 157) of MBY 2012. Also, there is a substantial heterogeneity in the take-up across cooperative societies. Detailed discussion on this is provided in Section 5.3.

[Table 12]

The results of the subsidy experiments are also summarized in Table 12. As expected, insurance demand is a decreasing function of insurance price for both MBY and BBY. This shows that subjects all well understood the rules of the experiments. It is striking that, conditional on the take-up, demand function of MBY is more price-sensitive. This may be because people are more likely to experiment the brand-new temperature insurance if the premium is discounted. Section 6 and 7 examine this point in details.

To our surprise, however, 64% (MBY) and 91% (BBY) of the 433 farmers demanded the same insurance coverage regardless of the price discounts. Figures 2 and 3 show the distribution of average demand for inelastic and elastic groups, across prices. The inelastic groups are those who did not change their demands at all when different levels of discounts were given, where as the elastic groups did change their demands.

[37] As mentioned before, the take-up rates of brand-new index insurance products implemented by Giné et al. (2008), Cai et al. (2014) and Cole et al. (2013) were 4.6%, 20% and 23%, respectively.

The inelastic groups are divided in two types: those who didn't demand anything regardless of the discount levels, and those whose demands were invariant across discount levels. From our field observations, the reason for the absence of price response for the first type of farmers would most likely to be general disinterest in or distrust against the insurance program. To them, price discounts were not effective to change their demand.

Among those whose demand for MBY was positive but inelastic, 13 farmers demanded 0.5 acres, 123 farmers demanded 1 acre, and 12 farmers demanded 2 acres, regardless of the price. For BBY, 52 farmers demanded 0.5 acres, 68 farmers demanded 1 acre, and 14 farmers demanded 2 acres, regardless of the price.[38] As shown in those figures, one farmer demanded 10 acres for all the four prices for both products.[39]

5.3. Differences across cooperative societies

Tables 13 and 14 show that there is a significant heterogeneity in the baseline characteristics, farming activities, and insurance-related characteristics across cooperative societies. Among the six societies, Phopnar and Loni are the richest. Though the average amount of land owned per household (8.4 acres) is the second largest in Dedtalai, the share of the irrigated land (79%) is the lowest, and this society has the second lowest average income. Also the literacy rate of farmers is the lowest (31%), and the ratio of SC/ST is very high (56%) in Dedtalai.

Almost all of the farmers in the six societies are clients of the fertilizer company. Cotton occupies the largest share in the cropping pattern of all the societies, except Shahpur. Bananas are also very important in all of the societies except Dedtalai, where its cultivation is almost impossible, due to the area's lack of water. The area of land used for banana cultivation was slightly reduced in Kharif 2012, probably because the banana production cycle ended in the previous season. However, given that these numbers are only planned figures, the actual cropping pattern might not be that different to that of Kharif 2011.

Demand for BBY 2012 was lower in Loni and Dedtalai than the overall average. This might be attributable to the non-exposure to weather index insurance until Kharif 2011, with BBY introduced for the first time to those societies in that year. In the case of Dedtalai, the size of the basis risk may have been responsible, since this society is the farthest from the weather station (Table 10). Among the four societies with previous exposure, the demand for BBY 2012 was the highest in Chapora and lowest in Phopnar.

[38] This observation is consistent with Cole et al. (2013). In their sample, households almost universally purchase only one policy unit when they ever do purchase insurance.

[39] The landholding of this farmer was 60 acres. Therefore, the demand in terms of the share of landholding is 0.6, which is an average amount in the current sample.

6. Regression analysis

6.1. Model

Using the data described above, we estimate multiple regression models for the insurance demand. The motivation of this analysis is descriptive. We are interested in expected values of an insurance demand conditional on specific combinations of prices and farmers' characteristics. Therefore, we estimate reduced form models by OLS with insurance demand as the dependent variable and a list of explanatory variables. See Matsuda (2014) for an analysis with structural estimation using the same dataset.

Specifically, for individual i and price level j, the demand function is regressed on a vector of variables (X_{ij}). The dependent variable is the demanded acre ($Demand_{ij}$). Thus the estimated equation is

$$Demand_{ij} = X_{ij}\gamma + \varepsilon_{ij} \tag{1}$$

where X_{ij} may include the discount for the insurance premium (the measure of price), socio-economic characteristics of farmer i, and the interaction terms between the two. ε_{ij} is a zero-mean error term, capturing unobservable factors such as risk preference, soil quality, availability of informal risk-sharing arrangements, and formal risk-coping mechanisms.

By design, the price p_{ij} is exogenous and varies over both i and j. Farmers' socio-economic characteristics may not be exogenous and vary over i only. We will estimate the equation (1) for both temperature insurance and rainfall insurance, assuming that error terms over the two periods are independent. Standard errors are clustered at individual level.[40] As main specifications, we report results using all 433 farmers, including those demanded zero acre regardless of the discount levels.[41] Empirical strategy is explained in the following subsection.

6.2. Empirical strategy

As an empirical strategy, we first regress the insurance demand on price, p_{ij}, which is the exogenous variable. Next, we add individual variables which might not be completely exogenous but highly likely to be predetermined variables, such as income, landholding, age, education level, distance (km), literacy and math. Then, we add individual variables for which simultaneity would be problematic, such as previous purchase and IFFCO client. Finally we check the correlation of the demand and society dummies. It is important to note that individual variables might be highly correlated with society dummies.

[40] We also considered household fixed-effect model. All the results are qualitatively identical to the following, as all the dependent variables except for insurance prices p_{ij} are in invariant for each farmer.

[41] The results using a restricted sample of those who demanded positive acres will be discussed as robustness checks.

[Figure 2]

[Table 13]

[Table 14]

7. Results

7.1. Results for the temperature insurance

Now we report the results of the regression of an insurance demand. Table 15 presents estimates of the regression (1) for the sales of MBY (temperature insurance). In Column 1, we find that the demand significantly decreases with premium (price effect). 100-rupee increase in premium significantly decreases the demand by 0.0696 acre. Although the magnitude is very small, the result is robust, suggesting that price is an important predictor of demand. Then, we add individual variables which would probably be predetermined variables, such as income, landholding, age, education level, distance to the weather station, literacy and math. In Columns 2-5, we show that measures of wealth are positively correlated with insurance demand. Columns 2 and 3 show that 1% increase in income and one acre increase in landholding raise the insurance demand by 0.195 acre and 0.0602 acre, respectively. Both estimates are statistically significant. The results on Column 4 confirms the robustness, but the income effect is no longer significant in Column 10.

Columns 5 shows that age of the respondents decreases the insurance demand, but the estimate is not significant. More educated or literate farmers, or farmers with math skills demand more insurance (Columns 6-8). Cole et al. (2013) and Cai et al. (2015) find that a lack of understanding and limited attention are important factors that discourage purchasing, given that people have only limited financial literacy and are not always able to evaluate the value of an insurance product. Column 9 shows that distance is negatively correlated with the insurance demand and the estimated coefficient is significant. Farmers living one kilometer away from the weather station demand less insurance by 0.006 acre. While this may suggest the basis risk, this might be driven by Dedtalai Society where is located very far from the weather station (Table 10). Finally, in Columns 10, we report that the price and asset effects, and distance are strongly correlated with the insurance demand. We will analyze the society effects in the next tables.

We analyze the correlation of the demand and society dummies in Table 16. Being a farmer of the new society (Loni and Dedtalai) is negatively correlated with the insurance demand (Columns 1-3). The magnitude of the estimated coefficient is large and significant at 1%.

Farmers in Bambada society also demand less (Columns 1 and 3). This may reflect that the income level of Bambada society is lower than other societies where the insurance had been introduced (Tables 13 and 14). We also find that indicators for farmers who had previous experience purchasing the ITGI's insurance or IFFCO's fertilizer is positively correlated with the demand (Columns 4 and 5). In Column 6, the share of irrigated land is positively correlated with the insurance demand, but the estimate is not significant.

Table 17 shows other results. In Column 1, we confirm that price and asset effects, new society dummy and IFFCO client dummy are significant. The magnitude of the estimates are similar to the results in Tables 15 and 16. Columns 2-4 include interaction terms. The interaction term, new society*price is positive in Column 3, implying that the demand of those who belong to the new societies are less price-responsive although the magnitude is quite small compared to the new society effect (-0.777 in Column 3). This might be because that those farmers demand (or experiment) at least some, conditional on the farmers in the new society being interested in the product. The term distance*price is positive and significant. Landholding*price is negative and significant, which suggests that farmers with larger land is less price-sensitive. Column 4 also shows that the interactions between IFFCO client dummy and price is -0.000456, implying that those who have experience with IFFCO are less price-sensitive. Another interesting finding is that the interaction between irrigation and price is positive and significant. Demand of the farmers who have access to irrigation is more price-sensitive.[42]

[Table 15]

[Table 16]

[Table 17]

7.2. Results for the rainfall insurance

Now we focus on the rainfall insurance. As before, we regress the demand (acre) of rainfall insurance (BBY) on farmer characteristics, assuming that error terms for the temperature insurance regression and rainfall insurance regression are independent. In Table 18, Columns 1-4 present the price, income and wealth effects. Price per acre is exogenous. 100-rupee increase in the price decreases the demand for the rainfall insurance by $0.0116 - 0.0113$ acre. This is comparable to Columns 1-4 of Table 15, which finds that 100-rupee increase in the price for the temperature insurance raises the demand by 0.0696 acre, suggesting that farmers respond less to the price of rainfall insurance than to the temperature insurance.

[42] The results discussed so far were found robust when we restricted the sample to those who demanded positive acre(s). Results for MBY using the restricted sample are available upon request.

In Columns 2-4, we find that the income effect and asset effect are positive and significant. The magnitude of the income effect is smaller and that of the asset effect is larger than those effects for the temperature insurance. By the nature of weather insurance, receiving the claim payout implies the weather (in this case, temperature) of the previous season was not good, which probably resulted in income loss. Hence, it is natural to think of the income effect; the income of MBY buyers might have been higher than that of non-buyers because buyers did receive the claim payout. However, recall that the claim payout was only Rs 157 per acre. The estimated coefficient on log income in previous tables suggests that receiving the claim of only Rs 157 was not enough to boost demand for the rainfall insurance the next season. In Column 5, we show that age is negatively but not significantly correlated with the demand. One year increase in schooling significantly increases the demand by 0.025 acre (Column 6).

We analyze the correlation between the demand and several dummies in Table 19. The corresponding table for the temperature insurance is Table 16. Consistent with the results for the temperature insurance, farmers in the new societies still demanded less (Columns 1-3). Column 4 includes a dummy variable, which takes the value one if a farmer purchased the temperature insurance in the previous period. The estimate for this dummy is positive and significant, suggesting that those who have recent experience with the insurance (and have received payout for it) demand 0.323 acres more. It is striking that the magnitude of the coefficient for MBY purchase dummy is large compared to, for example, price and income effects. Consistent with Stein (2014), Cole et al. (2014) and Karlan et al. (2014), this result suggests that experience of buying insurance and receiving the claim in the preceding season induce them to buy again.[43] Takahashi et al. (2016) discuss that farmers who received a discount for the insurance product in the previous season may have anchoring effect as the discounted price may work as a reference point. In this paper, we also estimate the coefficients for the discount of MBY (Rs) in Column 5. We find that the coefficient is positive but insignificant, suggesting that learning effect might be bigger than the price anchoring effect. We also find that indicators for farmers who had previous experience purchasing the ITGI's insurance or IFFCO's fertilizer is positively correlated with the demand (Columns 6 and 7).

Table 20 shows further results. Column 1 confirms price, income and asset effects. It also shows the robustness of the coefficient of education, distance, new society dummy and purchased MBY. We also regress the insurance demand on a set of interaction terms of price and farmer characteristics. Columns 3-4 find that the interaction between log income and price is negative and significant. This can be interpreted as richer farmers are less price-sensitive. This is consistent with the results that landholding*price is negative and significant. Similar

[43] By design, farmers who purchased the temperature insurance in the previous season all received the claim. Therefore, we cannot identify whether buying per se or buying and receiving the claim altogether increase the demand in the subsequent period.

to the Column 3 of Table 17, we show that the interaction term, new society*price is positive, but the magnitude is quite small. This suggests that those farmers are less price-responsive. The interaction between distance and price is negative and significant, implying that farmers living far from the weather station are less price-sensitive (Columns 3 and 4). Contrast with the result shown in Column 8 of Table 19, the coefficient for irrigation is not significant.

[Table 18]

[Table 19]

[Table 20]

7.3. The differential effect of the discounts

As a more flexible estimation of the price response of insurance demand, we introduce set of discount rate dummies. Table 21 investigates the differential effect of the discounts. Variables of Discount 25%, 50% and 75% are the indicators for each level of the discount. We find that a marginal effect of the discount decreases as the amount of the discount increases. This is consistent with the summary statistics shown in Table 12. The corresponding mid point arc elasticities are -0.60, -0.32 and -0.08 for the temperature insurance and -0.21, $-0.16, -0.04$ for the rainfall insurance. Our finding implies that even a small discount or subsidies to weather insurance can be effective to boost the demand. We also confirm that the demand for rainfall insurance is less price-elastic than the demand for temperature insurance. The results are robust when controlling other farmer characteristics in Columns 2 and 4. The estimated coefficient for an indicator of purchasing MBY is positive and significant in Column 4.

[Table 21]

7.4. The dynamics of the demand

Our results above imply that the experience of purchasing the insurance and receiving the claim payout in the previous season is an important correlate of the insurance demand for the following season. Table 22 examines this effect in details. The demand for MBY purchasers is larger than that of non-purchasers by 0.323 acre in Column 1. This is consistent with Stein (2014) and Cole et al. (2014), both of which find that individual experience of receiving an insurance payout increases the probability of re-purchasing. In addition to the individual experience, Karlan et al. (2014) finds that network-level experiences matter. Observing others in a society buying insurance and receiving the payout may influence one's purchase decision in the next season.[44] Columns 2 and 5 add the total number of households in a society who purchased MBY. In Column 2, the coefficient is positive and significant. If there are 10 more buyers in a society, there is an increase in individual demand by 0.0283 acre. The coefficient for the share of the households in a society who purchased MBY is not significant (Columns 3 and 5). While there are positive effects on society-level experience, we find that individual level experience is a stronger predictor of demand than society-level experience. Another hypothesis is that if more lands in a society are covered by the insurance, farmers (non-buyers) may be more attentive to the existence of insurance. The total number of acres in a society covered by MBY increases individual demand by 0.369 acre (Column 4) though the coefficient is no longer robust in Column 5.

Taken together, we find that individual purchase decision is influenced both by an individual prior experience and by society experience of insurance. The latter result is suggestive evidence of spillover effects. Karlan et al. (2014) and Cole et al. (2014) find that demand increases after either the farmer or others in his network or village receive an insurance payout, and demand is lower if a farmer was previously insured and the weather was good, thus no payout was made. The results shown in the Table 22 provides another suggestive evidence that the spillover/network effect is an important correlate of the demand. Controlling for the endogeneity is left for further research.

Alternative hypothesis is that the temperature shock changed farmers' belief over the weather in the following Kharif, or, experiencing bad weather may make the tail of weather distribution more salient. Karlan et al. (2014) and Stein (2014) discuss that insurance repurchase is driven by behavioral/psychological effects such as overweighting of recent events. Our current dataset does not allow a detailed analysis of the repurchasing decision and spillover effects. Such analysis is left for future research.

8. Discussion

Five characteristics of the current study distinguish our dataset from previous studies. First, a quarter of our sample had experience in purchasing the insurance products prior to our project. This is different from previous literature, which focuses on the take-up behavior of new clients. Second, almost all the households were familiar with the fertilizer company, which is the parent company of the current insurer. This would reduce mistrust of the insurer, which previous literature has shown to be one of the biggest barriers to insurance take-up. Third, there exists a wide variation among the sample households with respect to the distance to the

[44] While Karlan et al. (2014), Stein (2014) and Cole et al. (2014) investigate the dynamic purchasing behavior of the same products (rainfall index insurance) sold annually, this paper analyzes the purchasing behavior of the different products sold in much closer timing.

weather station, which gives us the variation in the proxy for basis risk. Fourth, we drew our sample from farmers who had bank accounts for crop loans and whose insurance premium was deducted from their bank accounts. This implies that our sample farmers did not face severe liquidity constraints. Due to the fourth characteristic, by construction, we can exclude liquidity constraints as a reason for the low take-up of weather insurance. It should be noted that our sample covers a wide range of landholding, including small farmers. Fifth, in collaboration with the insurance company, we analyzed the actual insurance products with real stakes, not hypothetical stakes in a lab, and experimentally changed the price for insurance to elicit the individual demand structure. The actual premium amount was determined randomly by rolling a dice.

The descriptive statistics of the data collected in two rounds of surveys in 2011 and 2012 show a substantial variation in demand for insurance across households. The take-up rate of the temperature insurance for the dry season was 72%, which is higher than that described in existing literature. After about a half year, the take-up rate of the rainfall insurance for the monsoon season declined to 39%, but the magnitude was still high. We find a wide variation in the demand for insurance across cooperative societies through which the insurance product was sold.

One of the limitations of the current paper is that we do not directly analyze the causal relationship between the insurance demand and farmer characteristics. Yet, consistent with existing studies, our findings suggest that purchasing an insurance product and obtaining a positive return will help boost the insurance participation even when the payouts are tiny. This might be because receiving a claim payment would increase salience and trust to the insurer and suggests that contracts should be designed to disburse claim payouts as quickly as possible, which is not always the case in the real world. In the current project, the payouts of the temperature insurance was actually made only at the time of the marketing of the rainfall insurance. Anecdotal evidence from the field suggests many farmers seemed to be disappointed with receiving only a small amount of payout with a time lag. Even in this case, the regression analysis of this paper finds that having purchased the insurance and receiving the claim are strong and significant correlates of the insurance demand. If the payouts had been made immediately, farmers would have been even more salient with the relationship between the weather condition and claim payouts, enhancing the trust to the insurer. In addition, payouts can be used to cover production loss or to fund inputs for the forthcoming season, or to repair any agricultural devices.

Future research will attempt to evaluate the insurance by quantifying the welfare impact with a particular focus on basis risk. Standard microeconomic theory predicts that insurance participation increases with risk aversion, but decreases with basis risk: a trade-off between having extra protection against disaster and bearing the basis risk. Especially in areas where the climate is highly localized, the basis risk is high. Existing studies have speculated that basis risk is one of the most important reasons for why weather index insurance is not attractive to potential clients. Matsuda (2014) develops a theoretical model of demand for index insurance in consideration of basis risk and structurally estimates the risk aversion parameters using insurance demand data.

[Table 22]

9. Conclusion

While formal micro-insurance products are penetrating into low income countries, their take-up levels have remained low. As an empirical research on weather index insurance in developing countries, we conducted surveys on rainfall and temperature index insurance products in Madhya Pradesh, India. While the temperature insurance covers against excess heat during the dry season, the rainfall insurance covers drought and excess rain during the monsoon season, This paper documented the details of surveys implemented under this project, described the key variables collected from them and investigated the correlates of the demand.

With regression analysis, we compare how price, income and asset levels influence the demand both for temperature and rainfall insurance products. The results show farmers respond less to the price of rainfall insurance than to the temperature insurance. We also find that farmers' response to the discount becomes less price-sensitive as the amount of discount increases. This implies that even a small discount or subsidies to weather insurance can be effective to boost the demand. Another finding is that non-price factors such as age of respondent and education are important correlates. It is striking that previous experience with the insurer, which is a proxy for the trust to the insurer, is a powerful predictor of demand. In addition to personal experience, purchase decision is also influenced by society experience of insurance, which is suggestive evidence of spillover effects. Distinguishing the impact of each of these factors on insurance demand and quantifying the net impact of take-up on household welfare are left for further research.

2007	4.5%
2008	4.5%
2009	NA
2010	NA
2011	8.0%

Table 1: Premium rate of BBY 2007-2011

Deficiency Rate (%)	Claim Rate (%)
0	0
10	0
20	0
30	10
40	15
50	25
60	35
70	45
80	75
90	90
100	100

Table 2: Claim schedule of BBY 2007-11

	Phase I		Phase II			
	Period 1 1/1-1/15	Period 2 1/16-1/31	Period 1 2/1-2/14	Period 2 2/15-2/28	Period 3 3/1-3/15	Period 4 3/16-3/31
Trigger (℃)	27	30	22	24	26	28
Strike (℃)	4		2			
Exit (℃)	14		23			
Notional (Rs)	350		166.7			
Max Payout (Rs)	3500		3500			

Note: The index of Phase I is the two-week average of the daily maximum temperature.
The index of Phase II is the two-week average of the daily average temperature.

Table 3: MBY 2012

	Phase 1 6/15-7/10	Phase 2 7/11-7/31	Phase 3 8/1-8/31	Phase 4 9/1-10/15
Strike 1 (mm) $[L_1, U_1]$	$[30, 60]$	$[35, 65]$	$[50, 125]$	$[10, 40]$
Strike 2 (mm) $[L_2, U_2]$	$[10, 30]$	$[10, 35]$	$[10, 50]$	$[0, 10]$
Exit (mm)	10	10	10	0
Notional of Strike 1 (N_1)	10	7.5	7.5	12.5
Notional of Strike 2 (N_2)	47.5	41	17.5	87.5
Maximum Payout (Rs)	1250	1250	1250	1250
Maximum Total Payout (Rs)	5000			

Table 4: Rainfall deficiency cover in BBY 2012

	Phase 1 6/15-7/10	Phase 2 7/11-7/31	Phase 3 8/1-8/31	Phase 4 9/1-10/15
Strike (mm)	47.5	60	60	62.5
Notional (Rs)	5	6	5	5
Maximum Payout (Rs)	700	600	600	600

Table 5: Excess rainfall cover in BBY 2012

Cover Period	July 5 to September 15					
Strikes (No. of CDD) $[L_3, U_3)$	$[17, 22)$	$[22, 28)$	$[28, 35)$	$[35, 50)$	$[50, 60)$	$[60, 72)$
Claim Payout (Rs)	175	250	375	500	1000	1500
Maximum Payout (Rs)	1500					

Table 6: Consecutive dry days (CCD) cover in BBY 2012

	Burhanpur		Madhya Pradesh	
	1000 ha	(%)	1000ha	(%)
Cereals				
Rice	2.3	(1.17)	1634.9	(4.18)
Wheat	10.4	(5.27)	4089.3	(10.45)
Maize	3.5	(1.77)	841.8	(2.15)
Sorghum (Jowar)	12.8	(6.49)	534.9	(1.37)
Total cereals	29.2	(14.79)	7671.6	(19.60)
Pulses				
Chickpea (Gram)	2.5	(1.27)	2655.7	(6.79)
Pigeonpea (Arhar, Tur)	3.7	(1.87)	300.5	(0.77)
Total pulses	8.5	(4.31)	4383.7	(11.20)
Oilseeds				
Soybeans	14.3	(7.25)	5187.9	(13.25)
Total oilseeds	15.0	(7.60)	6544.7	(16.72)
Sugarcane	2.6	(1.32)	77.2	(0.20)
Cotton	45.9	(23.26)	618.0	(1.58)
Fruits	14.4	(7.31)	48.9	(0.12)
Vegetables	0.7	(0.36)	204.2	(0.52)
Others	81.0	(41.06)	19592.5	(50.06)
Grand total	197.4	(100.00)	39140.7	(100.00)

Source: Compiled by the authors using the district-level database for *Area and Production of Principal Crops in India*, Ministry of Agriculture, Government of India.

Table 7: Area under major crops in Agricultural Year 2006/07

<table>
<tr><td>2011/12</td><td>October</td><td>November</td><td>December</td><td>January</td><td>February</td><td>March</td><td>April</td></tr>
<tr><td>Rabi Crops</td><td></td><td colspan="2">Planting</td><td colspan="3">Mid-season and harvest</td><td></td></tr>
<tr><td>Survey</td><td>Survey</td><td colspan="6"></td></tr>
<tr><td>MBY</td><td>Sales</td><td colspan="2"></td><td colspan="3">Temperature measurement</td><td>Claim payout</td></tr>
</table>

<table>
<tr><td>2012</td><td>May</td><td>June</td><td>July</td><td>August</td><td>September</td><td>October</td><td>November</td></tr>
<tr><td>Kharif Crops</td><td></td><td>Planting</td><td colspan="5">Mid-season and harvest</td></tr>
<tr><td>Survey</td><td>Survey</td><td colspan="6"></td></tr>
<tr><td>BBY</td><td>Sales</td><td colspan="4">Rainfall measurement</td><td colspan="2"></td></tr>
</table>

Table 8: Timeline

	Kharif 2007	Kharif 2008	Kharif 2011	Rabi 2011/12	Kharif 2012
	BBY 2007	BBY 2008	BBY 2011	MBY 2012	BBY 2012
Claim Paid?	Y	Y	N	Y	Y

Table 9: History of the index insurance

Society	Obs.		Mean	S.D.	Min	Max
Loni	54	Altitude (m)	245.18	10.61	211.23	276.45
		Distance (km)	1.99	0.29	1.20	3.58
Shahpur	82	Altitude (m)	242.08	14.02	188.67	273.71
		Distance (km)	4.74	0.12	4.42	5.00
Chapora	118	Altitude (m)	256.52	17.43	219.46	298.70
		Distance (km)	7.59	1.11	6.21	9.47
Bambada	126	Altitude (m)	262.89	10.49	226.16	294.13
		Distance (km)	7.85	1.12	7.71	8.14
Phopnar	17	Altitude (m)	286.42	14.48	261.21	306.63
		Distance (km)	10.17	0.84	9.14	11.04
Dedtalai	36	Altitude (m)	311.66	4.79	299.92	323.09
		Distance (km)	37.42	0.74	36.01	38.68
Total	433	Altitude (m)	267.58	26.67	188.67	323.09
		Distance (km)	11.60	12.87	1.20	38.68

Note: Altitude (m) is a vertical distance from the sea level. Distance (km) is a physical length from to the reference station. Summary statistics under "Total" are for the pooled sample. They therefore denote the sum of within– and between-society variations.

Table 10: Geographical attributes of the sample by society

	Mean	S.D.	Min	Max
Characteristics of Respondent in Survey 2011				
Age	51.4	12.9	20	88
Household Size	5.48	2.26	1	15
Education (years)	6.42	5.03	0	18
Literacy (%)	52.9			
Score in arithmetic questions	3.1	3.4	0	8
SC/ST(%)	12.6			
Share of OBC (%)	81.6			
Access to Well (%)	62.8			
Payment for irrigation usage (Rs)	15069	22789	0	200000
Answered weather risk as the biggest risk (%)	88.4			
Major assets at the time of Survey 2011				
Landholdings (acre)	4.70	5.05	0.25	60
Irrigated land (acre)	4.03	5.02	0	60
House value (Rs)	334728	538397	0	7000000
Agricultural production during Kharif 2011				
Area under cotton (%)	52.1			
Area under banana (%)	29.3			
Area under maize (%)	7.9			
Area under jowar (%)	3.6			
Area under soybeans (%)	4.4			
Total income (Rs)	135687	167960	0	1500000
Crop loan from DCCB (Rs)	85584	104234	0	1280000
Agricultural production during Rabi 2011/12				
Area under cotton (%)*	22.2			
Area under banana (%)	45.2			
Area under wheat (%)	10.5			
Area under maize (%)	13.9			
Area under jowar (%)	3.3			
Total income (Rs)	111217	125821	0	100000000
Crop loan from DCCB (Rs)**	63787	64339	0	440000
Agricultural production during Kharif 2012				
Area under cotton (%)	58.2			
Area under banana (%)	19.2			
Area under maize (%)	10.8			
Area under sorghum (%)	4.7			
Area under soybean (%)	5.0			
Crop loan from DCCB (Rs)	43474	63372	0	600000

Note: * The area under cotton in Rabi 2011/12 shows the percentage of land occupied by cotton belonging to the Kharif 2011 crops. ** The disbursement was in process.

Table 11: Characteristics of the sample farmers

	Mean	S.D.	Min	Max
Experience with previous insurance and related activities				
Fertilizer client at Survey 2011	0.97	0.16		
Client of BBY ever until BBY 2011 (dummy)	0.24	0.42		
Client of BBY 2011 (dummy)	0.13	0.34		
Client of BBY 2008 (dummy)	0.11	0.31		
Client of BBY 2007 (dummy)	0.07	0.26		
MBY 2012 for Rabi 2011/12				
Take-up (dummy)	0.72	0.45		
Demand (acre) if subsidy = 0%	0.70	0.76	0.0	10.0
Demand (acre) if subsidy = 25%	0.83	0.80	0.0	10.0
Demand (acre) if subsidy = 50%	0.95	0.86	0.0	10.0
Demand (acre) if subsidy = 75%	1.00	0.90	0.0	10.0
Average demand (acre) over all subsidy levels	0.87	0.87	0.0	10.0
Demand (acre) if take-up =1 and subsidy = 0%	0.92	0.75	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 25%	1.09	0.75	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 50%	1.24	0.78	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 75%	1.31	0.82	0.5	10.0
Average demand (acre) if take-up =1 over all subsidy levels	1.14	0.79	0.5	10.0
Average insured land under MBY (acre) if take-up = 1*	1.14	0.74	0.5	10.0
Premium payment (Rs)	671.5	443.0	288	5760
BBY 2012 for Kharif 2012				
Take-up (dummy)	0.41	0.49		
Demand (acre) if subsidy = 0%	0.39	0.74	0.0	10.0
Demand (acre) if subsidy = 25%	0.41	0.76	0.0	10.0
Demand (acre) if subsidy = 50%	0.44	0.78	0.0	10.0
Demand (acre) if subsidy = 75%	0.45	0.79	0.0	10.0
Average demand (acre) over all subsidy levels	0.42	0.77	0.0	10.0
Demand (acre) if take-up =1 and subsidy = 0%	0.92	0.90	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 25%	0.98	0.90	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 50%	1.04	0.90	0.5	10.0
Demand (acre) if take-up =1 and subsidy = 75%	1.07	0.91	0.5	10.0
Average demand (acre) if take-up =1 over all subsidy levels	1.01	0.90	0.5	10.0
Average insured land under BBY (acre) if take-up = 1*	1.00	0.88	0.5	10.0
Premium payment (Rs)	753.8	676.1	375	7500

Note: * This is under the price given by the lottery.

Table 12: Take-up of weather insurance

	Loni	Shahpur	Chapora	Bambhada	Phopnar	Dedtalai
Survey 2011 (Baseline)						
Landholding (acre)	4.80	3.94	4.93	2.95	11.46	8.44
	(2.96)	(3.4)	(4.66)	(2.45)	(13.72)	(6.78)
Irrigated land (acre)	4.15	3.21	4.39	2.45	11.22	6.68
	(2.73)	(3.28)	(4.76)	(2.49)	(13.78)	(6.83)
Literacy *	0.78	0.55	0.63	0.33	0.88	0.31
	(0.42)	(0.50)	(0.49)	(0.47)	(0.33)	(0.47)
SC/ST (%)	18.5	9.9	12.8	5.6	5.6	55.6
OBC (%)	88.9	77.8	84.6	92.0	77.8	36.1
Fertilizer client (%)	0.94	0.96	0.98	0.98	1.0	0.97
Kharif 2011						
Total Income (Rs)	159240.7	148993.9	134420.3	93548.8	355352.9	11796.1
	(134177.9)	(216155.3)	(138772.1)	(126835.9)	(273099.6)	(159539.4)
Crop loan from DCCB (Rs)	127722.2	88634.1	91931.6	55891.3	199529.4	44916.7
	(98893.4)	(143401.5)	(94262.3)	(51773.7)	(194008.7)	(32948.8)
Area under cotton (%)	56.3	37.1	46.6	58.1	50.6	68.0
Area under banana (%)	16.4	62.6	30.2	25.4	44.4	0.0

Table 13: Differences across cooperative societies

	Loni	Shahpur	Chapora	Bambhada	Phopnar	Dedtalai
Rabi 2011/12						
Total Income (Rs)	146781.6	141720.8	125373.9	48929.73	162271.4	125757.6
	(135214.9)	(103845.7)	(138132.7)	(72827.1)	(175838.6)	(159319.8)
Crop loan from DCCB (Rs)	87836.7	72402.6	71295.7	38216.2	115928.6	45697.0
	(64348.8)	(73207.2)	(66492.8)	(42434.9)	(106423.3)	(27000.6)
Area under cotton (%)	39.8	30.0	41.5	67.1	41.5	52.1
Area under banana (%)	12.0	56.6	22.2	13.3	25.4	0.0
MBY Take-up (dummy)	0.48	0.73	0.21	0.20	0.47	0.56
Demand MBY (acre)**	0.94	1.12	1.27	1.06	1.72	1.01
	(0.44)	(0.45)	(0.39)	(0.40)	(0.51)	(0.50)
Kharif 2012						
Crop loan from DCCB (Rs)	45426.3	24451.6	62093.5	39269.3	101428.6	20292.9
(Disbursement was in process)	(57971.3)	(43070.3)	(64626.6)	(68092.7)	(106688.4)	(27410.1)
Planned area under cotton (%)	55.3	45.3	61.1	67.4	45.2	63.5
Planned area under banana (%)	16.0	48.6	15.2	11.5	32.3	0.0
BBY Take-up (dummy)	0.15	0.33	0.68	0.30	0.18	0.36
Demand for BBY (acre)**	1.09	1.05	0.90	0.87	1.58	1.71
	(0.37)	(0.47)	(0.53)	(0.75)	(0.72)	(2.49)

Note: Mean is shown in the first row of each category. S.D. is shown in parenthesis. Corresponding total values are in the previous tables. *literacy of the respondents. ** if Take-up = 1 over all subsidy levels.

Table 14: Differences across cooperative societies (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Price	-0.000696***	-0.000693***	-0.000696***	-0.000693***	-0.000696***	-0.000689***	-0.000696***	-0.000696***	-0.000696***	-0.000686***
	(5.82e-05)	(5.82e-05)	(5.82e-05)	(5.83e-05)	(5.82e-05)	(5.77e-05)	(5.82e-05)	(5.82e-05)	(5.82e-05)	(5.78e-05)
Log income		0.195***		0.0793*						0.0262
		(0.0592)		(0.0478)						(0.0497)
Landholding			0.0602***	0.0513**						0.0655***
			(0.0198)	(0.0205)						(0.0235)
Age					-0.00294					-0.00467
					(0.00263)					(0.00290)
Education						0.0506**				-0.0140
						(0.0207)				(0.0196)
Literacy							0.278***			0.0994
							(0.0759)			(0.102)
Math								0.0418***		0.00403
								(0.0121)		(0.0178)
Distance									-0.00637**	-0.0140***
									(0.00310)	(0.00504)
Constant	1.120***	-1.089*	0.848***	-0.0106	1.271***	0.842***	0.973***	0.991***	1.178***	0.901
	(0.0505)	(0.645)	(0.0760)	(0.512)	(0.154)	(0.0978)	(0.0453)	(0.0430)	(0.0605)	(0.581)
Obs.	1,652	1,648	1,652	1,648	1,652	1,640	1,652	1,652	1,652	1,636
R-squared	0.018	0.067	0.112	0.118	0.020	0.035	0.045	0.047	0.022	0.147

Note: The demand for the temperature insurance (acre) is regressed on a vector of variables. The unit of the price and distance variables are per acre and kilometer. Robust standard errors in parentheses. Standard errors are clustered at individual level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 15: Determinant of MBY Demand

	(1)	(2)	(3)	(4)	(5)	(6)
Price	-0.000696***	-0.000696***	-0.000696***	-0.000696***	-0.000696***	-0.000696***
	(5.83e-05)	(5.82e-05)	(5.82e-05)	(5.82e-05)	(5.82e-05)	(5.82e-05)
Shahpur	-0.111		-0.111			
	(0.0929)		(0.0928)			
Bambada	-0.228*		-0.228*			
	(0.114)		(0.114)			
Phopnar	0.300		0.875***			
	(0.295)		(0.292)			
Loni	-0.615***					
	(0.105)					
Dedtalai	-0.516***					
	(0.113)					
New Society		-0.369***	-0.575***			
		(0.0804)	(0.0919)			
Previous purchase				0.297***		
				(0.0911)		
IFFCO client					0.274*	
					(0.144)	
Irrigation share						0.0661
						(0.0722)
Constant	1.326***	1.208***	1.326***	1.053***	0.853***	1.065***
	(0.0809)	(0.0566)	(0.0809)	(0.0540)	(0.140)	(0.0650)
Observations	1,652	1,652	1,652	1,652	1,652	1,652
R-squared	0.088	0.053	0.087	0.040	0.020	0.019

Note: The demand for the temperature insurance (acre) is regressed on a vector of variables. The unit of the price is per acre. Robust standard errors are in parentheses. Standard errors are clustered at individual level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 16: Determinant of MBY Demand (Continued)

	(1)	(2)	(3)	(4)
Price (per acre)	-0.000686***	-0.000601	-0.000919	-0.000585
	(5.78e-05)	(0.000816)	(0.000854)	(0.000866)
Log income	0.0723	0.0764	0.0647	0.0734
	(0.0468)	(0.0622)	(0.0617)	(0.0609)
Log income * Price		8.16e-06	1.78e-05	-3.03e-06
		(7.75e-05)	(8.16e-05)	(8.20e-05)
Landholding	0.0644***	0.0660***	0.0890***	0.0875***
	(0.0223)	(0.0247)	(0.0245)	(0.0247)
Landholding * Price		-4.07e-05	-6.48e-05**	-6.40e-05**
		(2.87e-05)	(2.93e-05)	(2.88e-05)
Education	0.0233		0.0176	0.0214
	(0.0170)		(0.0227)	(0.0226)
Education * Price			1.26e-05	5.15e-06
			(2.92e-05)	(2.89e-05)
Distance (km)	-0.00223		-0.00672	-0.00687
	(0.00461)		(0.00586)	(0.00584)
Distance (km)* Price			1.17e-05*	1.29e-05**
			(5.95e-06)	(5.86e-06)
New Society	-0.521***		-0.777***	-0.724***
	(0.117)		(0.129)	(0.133)
New Society * Price			0.000618***	0.000562***
			(0.000132)	(0.000128)
IFFCO client	0.308*			0.472**
	(0.166)			(0.185)
IFFCO client * Price				-0.000456***
				(0.000144)
Previous purchase	0.147			0.199*
	(0.0950)			(0.116)
Previous purchase * Price				-0.000146
				(0.000149)
Irrigation	-0.0170			-0.198*
	(0.0626)			(0.104)
Irrigation * Price				0.000502***
				(0.000162)
Constant	-0.292	-0.0435	0.134	-0.328
	(0.568)	(0.660)	(0.673)	(0.708)
Observations	1,636	1,648	1,636	1,636
R-squared	0.209	0.119	0.205	0.215

Note: The demand for the temperature is regressed on a vector of variables. Standard. errors are clustered at individual level. Robust standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 17: Determinant of MBY Demand (Interaction terms)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Price	-0.000116***	-0.000113***	-0.000116***	-0.000113***	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000113***
	(1.99e-05)	(2.00e-05)	(1.99e-05)	(2.00e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(2.01e-05)
Log income		0.143***		0.0645**						0.0476
		(0.0494)		(0.0287)						(0.0350)
Landholding			0.0680***	0.0632**						0.0600***
			(0.0260)	(0.0256)						(0.0228)
Age					-0.00236					-0.00366*
					(0.00216)					(0.00217)
Education						0.0250***				-0.000239
						(0.00742)				(0.00740)
Literacy							0.300***			0.0923
							(0.0711)			(0.101)
Math								0.0461***		0.00821
								(0.0128)		(0.0166)
Distance									0.00793	0.00367
									(0.00859)	(0.00684)
Constant	0.478***	-1.257**	0.171*	-0.594*	0.599***	0.317***	0.320***	0.337***	0.406***	-0.290
	(0.0407)	(0.567)	(0.0980)	(0.353)	(0.113)	(0.0421)	(0.0327)	(0.0326)	(0.0668)	(0.487)
Obs.	1,652	1,624	1,652	1,624	1,652	1,652	1,652	1,648	1,652	1,620
R-squared	0.001	0.046	0.145	0.158	0.003	0.028	0.039	0.045	0.010	0.170

Note: The demand for the rainfall insurance (acre) is regressed on a vector of variables. The unit of the price and distance variables are per acre and kilometer.

Robust standard errors are in parentheses. Standard errors are clustered at individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table 18: Determinant of BBY Demand

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Price	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-0.000116***
	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)
Shahpur	-0.162*		-0.165*					
	(0.0918)		(0.0915)					
Bambada	-0.323***		-0.327***					
	(0.0778)		(0.0775)					
Phopnar	-0.249		-0.253					
	(0.240)		(0.240)					
Loni	-0.432***							
	(0.0815)							
Dedtalai	0.00513							
	(0.283)							
New Society		-0.0957	-0.268**					
		(0.124)	(0.132)					
Purchase MBY				0.323***				
				(0.0609)				
Discount of MBY (Rs)					0.000652			
					(0.000690)			
Previous purchase						0.225**		
						(0.0880)		
IFFCO client							-0.0670	
							(0.146)	
Irrigation								0.132*
								(0.0695)
Constant	0.667***	0.498***	0.671***	0.232***	0.377***	0.429***	0.543***	0.396***
	(0.0587)	(0.0385)	(0.0583)	(0.0426)	(0.0927)	(0.0451)	(0.141)	(0.0477)
Observations	1,652	1,652	1,652	1,652	1,652	1,652	1,652	1,652
R-squared	0.046	0.004	0.030	0.033	0.006	0.016	0.001	0.008

Note: The demand for the temperature insurance (acre) is regressed on a vector of variables. Standard errors are clustered at the individual level. Robust standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 19: Determinant of BBY Demand (Continued)

	(1)	(2)	(3)	(4)
Price (per acre)	-0.000113***	0.000133	0.00181**	0.00189*
	(2.01e-05)	(0.000201)	(0.000889)	(0.000980)
Log income	0.0720**	0.0743**	0.0950**	0.0903**
	(0.0351)	(0.0326)	(0.0380)	(0.0377)
Log income * Price		-2.08e-05	-0.000152**	-0.000144**
		(1.76e-05)	(6.48e-05)	(6.43e-05)
Landholding	0.0567**	0.0627**	0.0595***	0.0588***
	(0.0222)	(0.0257)	(0.0224)	(0.0225)
Landholding * Price		9.13e-07	-0.000110***	-0.000109***
		(4.69e-06)	(3.97e-05)	(4.01e-05)
Education	0.0142**		0.0128**	0.0132**
	(0.00583)		(0.00646)	(0.00650)
Education * Price			-2.11e-05**	-2.18e-05**
			(1.04e-05)	(1.04e-05)
Distance (km)	0.0114*		0.0129*	0.0126*
	(0.00664)		(0.00701)	(0.00715)
Distance (km) * Price			-2.09e-08*	-2.05e-08*
			(1.21e-08)	(1.24e-08)
New society	-0.263***		-0.449***	-0.407***
	(0.0808)		(0.0864)	(0.0869)
New society * Price			0.000660***	0.000603***
			(0.000135)	(0.000141)
Purchased MBY	0.236***		-0.125***	-0.124***
	(0.0677)		(0.0445)	(0.0437)
Purchased MBY * Price			0.00178***	0.00178***
			(9.66e-06)	(1.01e-05)
IFFCO client	-0.0612			-0.0177
	(0.162)			(0.159)
IFFCO client * Price				-0.000130
				(0.000259)
Previous Purchase	0.111			0.139
	(0.0845)			(0.0914)
Previous Purchase * Price				-0.000174
				(0.000148)
Irrigation	-0.00299			-0.0159
	(0.0600)			(0.0681)
Irrigation * Price				6.16e-06
				(0.000109)
Constant	-0.934*	-0.709*	-0.983*	-0.936
	(0.550)	(0.395)	(0.518)	(0.570)
Observations	1,624	1,624	1,624	1,624
R-squared	0.211	0.158	0.807	0.809

Note: Full sample. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The demand for the rainfall insurance (acre) is regressed on a vector of variables. Standard errors are clustered at individual level.

Table 20: Determinant of BBY Demand (Interaction terms)

	(1)	(2)	(3)	(4)
	Temperature Insurance		Rainfall Insurance	
Discount 25%	0.132***	0.132***	0.0254***	0.0247***
	(0.0145)	(0.0146)	(0.00594)	(0.00596)
Discount 50%	0.247***	0.248***	0.0508***	0.0494***
	(0.0208)	(0.0210)	(0.00906)	(0.00913)
Discount 75%	0.296***	0.294***	0.0630***	0.0617***
	(0.0245)	(0.0246)	(0.0111)	(0.0112)
Log income		0.0493		0.0609
		(0.0475)		(0.0386)
Landholding		0.0635***		0.0582**
		(0.0235)		(0.0228)
Purchased MBY	-	-		0.212***
	-	-		(0.0681)
Distance (km)				0.0115
				(0.00701)
Previous take-up		0.0938		0.136*
		(0.0917)		(0.0787)
New society		-0.617***		-0.339***
		(0.106)		(0.0877)
Constant	0.700***	-0.341	0.389***	-0.811
	(0.0374)	(0.590)	(0.0365)	(0.635)
Other controls	N	Y	N	Y
Society dummies 1	N	Y	N	Y
Observations	1,652	1,648	1,652	1,620
R-squared	0.018	0.224	0.001	0.228

Note: Robust standard errors are in parentheses *** p<0.01,
** p<0.05,* p<0.1. The demand for
the temperature insurance (Columns (1) and (2) and for the rainfall
insurance (Columns (2) and (4) is regressed on a vector of variables
Other controls include IFFCO client, Literate, Math and Share of
Irrigation.

Table 21: Determinant of insurance demand (Price Indicators)

	(1)	(2)	(3)	(4)	(5)
Purchased MBY	0.323***				0.245***
	(0.0609)				(0.0787)
Number of HHs in Society w ho purchased MBY		0.000647			0.00283*
		(0.00149)			(0.00167)
Share of HHs in Society w ho purchased MBY			0.465		0.653
			(0.347)		(0.723)
Total number of acres in Society covered by MBY				0.369*	-0.188
				(0.188)	(0.392)
Log income					0.0758**
					(0.0360)
Landholding					0.0578**
					(0.0227)
Price (per acre)	-0.000116***	-0.000116***	-0.000116***	-0.000116***	-5.91e-05
	(1.99e-05)	(1.99e-05)	(1.99e-05)	(1.99e-05)	(4.12e-05)
Purchased MBY * Price					-7.07e-05
					(4.72e-05)
Distance (m)					1.20e-05*
					(7.14e-06)
Previous purchase					0.120
					(0.0788)
Constant	0.232***	0.430***	0.123	0.156	-1.600**
	(0.0426)	(0.131)	(0.282)	(0.181)	(0.671)
Other controls	N	N	N	N	Y
Observations	1,652	1,652	1,652	1,652	1,620
R-squared	0.033	0.001	0.006	0.012	0.222

Note: Full sample. Robust standard errors are in parentheses. .*** p<0.01, ** p<0.05, * p<0.1. The demand for the rainfall insurance (acre) is regressed on a vector of variables. Standard errors are clustered at individual level. Other controls include IFFCO client, Literate, Math and Access to Well.

Table 22: The Dynamics of Demand

Figure 1: Maps of State of Madhya Pradesh and Burhanpur District (Source: madhya-pradesh-tourism.com)

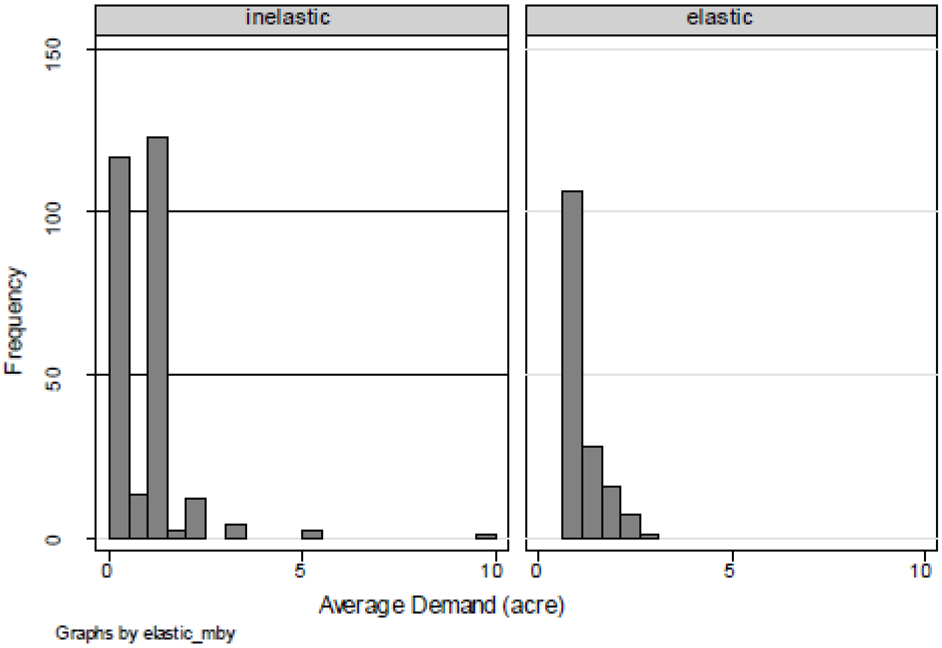

Figure 2

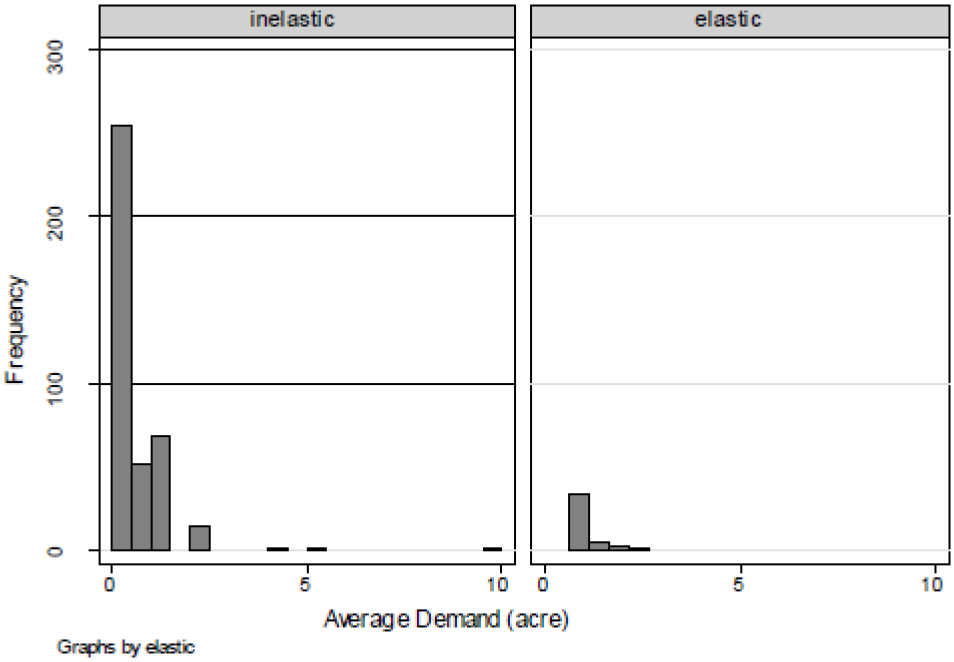

Figure 3

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Appendix

Pictures of weather measurement.

Weather station

Rain gauge

Thermometer