Weather Insured Savings Accounts

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Abstract

This paper uses a laboratory experiment in Gujarat, India to assess consumers' relative valuations of savings versus insurance when planning for risky rainfall in an attempt to measure potential demand for a new type of financial product that combines savings and rainfall insurance, which we call a Weather Insured Savings Account (WISA). We first develop a simple model to predict how demand for a WISA would change with its type, defined as the proportion of insurance versus savings that the WISA provides. Our model predicts that there will be an optimal WISA type, and that the utility provided by the WISA will decrease as one moves away from the optimum. We then present the results of a laboratory experiment that attempts to test the predictions of the model and calculate the optimal WISA type. Using a Becker-DeGroot-Marschak (BDM) mechanism, we measure participants' relative valuations of pure insurance, pure savings, and two intermediate WISA types. Contrary to predictions of our model, we find that a plurality of participants prefer both pure insurance and pure savings to any mixture of the two, and that this preference is most pronounced among those who are more risk averse. We present a number of possible explanations to try to square this result with the neoclassical model, including that these results were driven by confusion over the WISAs or uncertainty over whether future payment would actually be received. We do not find behavior consistent with these explanations. One possible explanation for our results is that subjects exhibited diminishing sensitivity to losses as proposed by prospect theory. Our results suggest that the introduction of a WISA is unlikely to be successful.[1]

1 Introduction

Although poor people can be most vulnerable to risks, many are severely underserved by insurance markets. Microinsurance is designed to bring insurance products to the poor, but these new products are still being refined to accurately meet the needs of their target populations. This paper considers the example of rainfall index insurance in India, and proposes that linking insurance to savings may be an effective mechanism for providing risk protection to poor farmers.

Rainfall index insurance was developed as a way to provide protection against rainfall shocks while also remaining affordable and accessible for poor farmers (Hess, 2004; Skees et al., 2001). However,

early trials of rainfall index insurance have shown low demand for the product, especially at market rates (Cole et al., 2010; Giné and Yang, 2009; Karlan et al., 2010; Giné et al., 2008; Cole et al., 2011). These low take-up rates do not mesh with the high theoretical benefits of rainfall index insurance (Cole et al., 2010, 2011).

As rainfall index insurance seems theoretically valuable but receives low demand, we propose that the problem may lie not with the product itself but instead with its "packaging": perhaps insurance would be more attractive when bundled with a more familiar financial product. In fact, some of the most successful trials of rainfall insurance (in terms of take-up) have come when it has been tied to credit.[2] We alternatively propose the idea of a WISA (Weather Insured Savings Account), which is a financial product that combines features of a savings account with rainfall index insurance. Money invested in a WISA would be partially allocated to insurance, with the rest allocated to savings. A WISA would provide insurance payouts when a rainfall shock occurred, but would also allow money to accumulate regardless of the state of the world. This paper develops a model to understand the theoretical demand for different types of WISA, and then conducts a lab experiment to test participants' relative demand for insurance, savings, and WISAs.

We develop a simple two-period model with risk averse agents that shows how people would value different types of WISAs allocated to them, assuming that people have access to savings but not insurance apart from the WISA. We define the proportion of insurance to savings as a WISA's type, and define a consumer's valuation of a WISA to be the minimum amount of money they would be willing to accept (WTA) to give it up. The central prediction of the model is that there is an ideal WISA type for which a consumer has a maximum WTA, and WTA alway decreasse as one moves away from this ideal. This ideal type increases with the discount factor, and under certain conditions it increases with risk aversion.

We then present the results from a laboratory experiment in Gujarat, India that tests these predictions. We invited 322 farmers into a computer lab in Ahmedabad where they were asked to assess their valuations of rainfall insurance policies, savings vehicles, and WISAs using the Becker-DeGroot-Marschak (BDM) mechanism. We measured the WTA for four financial products: pure insurance, 1/3 savings + 2/3 insurance, 2/3 savings + 1/3 insurance, and pure savings. Both the savings and insurance products used in the experiment were real, in that they offered significant monetary payouts to the participants that could be collected after the monsoon season. Contrary to the predictions of our model, we find that a strong plurality (39%) of participants value both pure savings and pure insurance more highly than any mixture of the two. Additionally, more risk averse farmers have a stronger preference for pure products, which again does not conform to theoretical predictions.

We test a number of alternative explanations for this phenomenon in an attempt to explain participants' preferences for pure products over mixtures. First, it may be possible that people value the WISAs less because they do not understand them as well as the pure products. We test whether the preference for pure products varies based on different framing strategies for the WISAs which vary in their complexity, and find that this does not have an effect, casting doubt on lack of understanding as a driver of our results. We also test the hypothesis that the results are driven by the expectation that small payouts are less likely to be collected, which could make the small guaranteed payouts of the savings/insurance mixtures less attractive. After the monsoon, farmers with higher payouts were not more likely to collect their their money than farmers with smaller payouts, making this explanation

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[2]The Weather Based Crop Insurance Scheme (WBCIS) of The Agriculture Insurance Company of India (AICI) saw large take-up of rainfall index insurance when it was required to receive agricultural loans. Similarly, the NGO Microensure provides weather insurance exclusively tied to loans. But in a cautionary note, Giné and Yang (2009) find that requiring insurance as part of a loan decreases demand for the loan.

unlikely.

One way to explain the preference for pure products is to drop the assumption of concave utility, allowing for convex utility in the loss domain as proposed by prospect theory. The intuition behind this is that people may not value small insurance payouts, as they view it as an insignificant contribution to a large loss. Therefore they value the WISAs less, as they provide insignificant amounts of insurance coverage.

The idea to combine insurance and savings is inspired by a few strands of literature, as well by observing various insurance markets. Slovic et al. (1977) have suggested that many people view insurance as a form of investment, rather than a pure risk mitigation tool. As market priced insurance generally gives a negative return on the invested premium, insurance is clearly a poor investment, and people who view it as such will tend to be dissatisfied with standard insurance options. If consumers do view insurance as an investment, then it may make sense to design insurance products that provide a positive payment in most states of the world so that consumers feel they are getting some return on their investment. Even in a lab setting, identifying investment as a motivation for purchasing insurance is very difficult, and experiments have given mixed results. For instance, Connor (1996) finds strong evidence that people view insurance as an investment, but experiments by Schoemaker and Kunreuther (1979) do not support the claim.

Despite inconclusive results in the literature, the private insurance marketplace does provide many insurance products that offer a guaranteed return on the premium through policies that offer "no claims refunds". With this type of insurance, policy holders receive part (or all) of their premium refunded to them if they do not make an insurance claim. One example is a "whole life" insurance policy, in which customers pay monthly premiums for life insurance, but receive a lump sum of all the premiums paid if they are still alive at a certain age. Customers pay extra for this service, and insurance companies make money off the ability to invest the held premiums.

If people choose "no claims refunds" policies, they show a preference for using insurance as a vehicle for savings. Similarly, people may also view savings as a type of insurance. Many studies have pointed towards preparing for potential income shocks as a primary motive for savings, especially in developing countries (Karlan et al., 2010; Rosenzweig, 2001; Fafchamps and Pender, 1997; Carroll and Samwick, 1997; Lusardi, 1998; Guiso et al., 1992). Despite the frequent usage of savings to protect against shocks, the meager savings of the rural poor are generally insufficient to guard against large aggregate shocks such as a drought. Townsend (1994) shows that rural villagers in India do a good job of informally protecting themselves against idiosyncratic shocks, but that they are still affected by aggregate shocks. In a survey of farmers participating in a rainfall insurance pilot in Andhra Pradesh, India, 88% listed drought as the greatest risk they faced (Giné et al., 2008). If people are saving primarily to protect against shocks yet these savings are not enough to buffer against the most important risk they face, they might find a savings account with an insurance component especially attractive.

While there are no products (to our knowledge) combining weather insurance with savings accounts, savings accounts offering other types of insurance do exist. In the 1990s the China Peoples' Insurance Company (CPIC) offered a savings account where customers received various types of insurance coverage instead of interest on savings (Morduch, 2006). This is potentially attractive to customers, as those with money illusion may perceive this as resulting in "free" insurance coverage, but has the drawback that small savings balances will result in minimal coverage. Similarly, many banks and credit unions in the West offer savings accounts that give the depositor auto, renters, or other types of insurance as benefits.

Savings accounts that offer some insurance in lieu of interest (such as the one offered by CPIC described above), and insurance policies offering "no claims refunds" can be seen as lying along a

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spectrum between insurance and savings. The CPIC savings accounts are mostly savings, while the "no claims refunds" policies are mostly insurance. Seemingly there is scope for these mixtures in many insurance markets, so finding the correct balance between savings and rainfall insurance can potentially result in a financial product that best meets farmers' needs for dealing with rainfall risk. The lab experiment in this paper attempts to determine which mix of savings and insurance farmers would prefer.

This paper will proceed as follows: Section 2 introduces a simple insurance demand model to explain how people choose between savings and insurance. Section 3 outlines the experimental procedure and provides summary statistics of our sample. Section 4 presents the results, and section 5 provides discussion of these results. Section 6 concludes.

2   Theory

This model provides a formal framework which shows how people would value different formulations of a WISA. In order to concentrate on the consumer's relative valuation of different WISA types, we consider a scenario where a consumer receives a gift of a fixed amount of money invested in a WISA. We then analyze how the certainty equivalent of this gift changes with the WISA type, and how the optimal WISA type varies with risk and time preference.

The model assumes that the consumer has access to savings outside of the experiment, and can therefore adjust his savings in response to any WISA or cash payment that he receives. However, it assumes that he does not have outside access to insurance.[3]

2.1   Basic Model Setup

A consumer lives in a two period world where he is subject to a negative income shock $\tilde{x}$ in the second period. In the world there are two types of investment technologies: standard savings, in which an investment of s in the first period pays net return Rs in the second period, and a WISA which consists of a mix of savings and insurance. The structure of the WISA is determined by the parameter $\gamma \in [0, 1]$, which determines the relative amount of savings and insurance that the WISA provides. An investment of w in a WISA results in $(1 - \gamma)w$ being invested in savings (which has the same interest rate R as standard savings), and γw being invested in insurance. The insurance is standard proportional coinsurance (as in Schlesinger [2000]), where the premium is equal to the expected payout times $1 + \lambda$, with λ being the loading factor. This means that if γw is invested in insurance, the customer receives a payout of $\frac{\gamma w \tilde{x}}{(1+\lambda)E(\tilde{x})}$ in the event of income shock $\tilde{x}$. We can define the payout from a WISA as follows:

$$g(w, \tilde{x}, \gamma) = (1 - \gamma)wR + \gamma w \frac{\tilde{x}}{(1 + \lambda)E(\tilde{x})} \tag{1}$$

It is worth noting that full insurance is achieved when $\gamma w = (1 + \lambda)E(\tilde{x})$. Since γ is bounded above by 1, if $w < (1 + \lambda)E(\tilde{x})$ there is no WISA which provides full insurance. To mimic our lab setup, we assume that the amount w invested in a WISA is both fixed and comes free of cost to the consumer.[4]

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[3]We think this is a realistic assumption, as local farmers can save informally but have very few (if any) formal insurance options.

[4]While the imposition of w may seem strange, it was fixed in our laboratory experiment so that we could focus on varying γ. One could easily generalize the model to make w a choice variable.

The consumer chooses s, which is savings made outside of the WISA. The timing thus proceeds as follows:

1. The consumer is endowed with first period income Y_1, and chooses the amount of savings s. He consumes the rest of his income and realizes first period utility.

2. Shock is realized and the consumer receives second period income $Y_2 - \tilde{x}$. He also receives returns of Rs from savings and $g(w, \tilde{x}, \gamma)$ from WISA. He consumes all income and realizes second period utility.

The participant has a concave utility function[5] $u'(c) > 0, u''(c) < 0$ and discount factor β. Expected utility U over the two periods is:

$$U = u(Y_1 - s) + \beta E(u(Y_2 - \tilde{x} + Rs + g(w, \tilde{x}, \gamma))) \tag{2}$$

The customer chooses savings s to maximize expected utility. We can define his indirect expected utility V as a function of his first period endowment Y_1 and the WISA payment function $g(w, \tilde{x}, \gamma)$ as follows:

$$V(Y_1, g(w, \tilde{x}, \gamma)) = \underset{s}{max} \; u(Y_1 - s) + \beta E(u(Y_2 - \tilde{x} + Rs + g(w, \tilde{x}, \gamma))) \; s.t. \; 0 \leq s \leq Y_1 \tag{3}$$

Define the optimal value of s as $s^*(\gamma)$. For simplicity define:

$$c_1 = Y_1 - s^*(\gamma)$$

$$c_2 = Y_2 - \tilde{x} + Rs^*(\gamma) + g(w, \tilde{x}, \gamma)$$

Assuming an interior solution (and valid second order condition), the following first order condition holds for $s^*(\gamma)$

$$\left. \frac{dU}{ds} \right|_{s=s^*(\gamma)} = -u'(c_1) + \beta R E(u'(c_2)) = 0 \tag{4}$$

We are interested in understanding how valuations of a WISA change as γ is varied. To do this, we define the willingness to accept (WTA) $A(\gamma)$, which makes a customer indifferent between receiving a monetary payment of $A(\gamma)$ or receiving an endowment of a WISA with parameter γ. By definition, $A(\gamma)$ satisfies the following equation:

$$V(Y_1 + A(\gamma), 0) = V(Y_1, g(w, \tilde{x}, \gamma)) \tag{5}$$

2.2 Characteristics of WTA

We are interested in how WTA changes with the WISA type. Applying the implicit function theory to Equation 5:

$$\frac{dA(\gamma)}{d\gamma} = \frac{\beta E((\frac{dg(w, \tilde{x}, \gamma)}{d\gamma}) u'(c_2))}{u'(c_1)} = \frac{\beta}{u'(c_1)} \left[E(u'(c_2)) \left[\frac{1}{1 + \lambda} - R \right] + \frac{1}{(1 + \lambda) E(\tilde{x})} cov\{u'(c_2), \tilde{x}\} \right] \tag{6}$$

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[5]We also assume the utility function is globally continuous and differentiable.

This expression reveals two effects.[6] Assuming $\frac{1}{1+\lambda} < R$, the first term represents loss from substituting away from savings, while the second term represents the gain from acquiring more insurance. $\frac{dA(\gamma)}{d\gamma}$ is of ambiguous sign, and its sign can change over the range of γ. However, we can still isolate other properties of $A(\gamma)$.

We next show that the function $A(\gamma)$ cannot contain any local minima. From the extreme value theorem, we know there must be a $0 \leq \gamma \leq 1$ which maximizes $A(\gamma)$ over this range. If $A(\gamma)$ has no local minima, $A(\gamma)$ weakly decreases as one moves away from this optimum γ.

Proposition 1. $A(\gamma)$ *has no local minima.*

Proof. We will show this in two steps:
1. Prove that if $\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) < 0$, $A(\gamma)$ has no local minima.
2. Prove that $\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) < 0$

Step 1: Show that if $\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) < 0$, $A(\gamma)$ has no local minima.

Using the definition of $V(Y_1, g(w, \tilde{x}, \gamma))$ from Equation 5 and applying the envelope theorem:

$$\frac{dV(Y_1, g(w, \tilde{x}, \gamma))}{d\gamma} = \frac{d(Y_1 + A(\gamma), 0)}{d\gamma} = \frac{dA(\gamma)}{d\gamma}u'(Y_1 + A(\gamma) + s^*(\gamma)) \tag{7}$$

$$\frac{d^2V(Y_1, g(w, \tilde{x}, \gamma))}{d\gamma^2} = \frac{d^2A(\gamma)}{d\gamma^2}u'(Y_1 + A(\gamma) + s^*(\gamma)) + \frac{dA(\gamma)}{d\gamma}\Big(\frac{dA(\gamma)}{d\gamma} + \frac{ds^*(\gamma)}{d\gamma}\Big)u''(Y_1 + A(\gamma) + s^*(\gamma)) \tag{8}$$

In general, the sign of the second term in Equation 8 is unclear. Since $A(\gamma)$ is continuous and differentiable, at any local extrema $\frac{dA(\gamma)}{d\gamma} = 0$ and the second term goes to zero. At any extrema the following equation holds:

$$\frac{d^2A(\gamma)}{d\gamma^2} = \frac{d^2V(Y_1, g(w, \tilde{x}, \gamma))}{d\gamma^2}\frac{1}{u'(Y_1 + A(\gamma) + s^*(\gamma))}$$

When $\frac{d^2V(Y_1, g(w, \tilde{x}, \gamma))}{d\gamma^2} < 0$, $\frac{d^2A(\gamma)}{d\gamma^2}$ will be less than zero because $u' > 0$. This means that any local extremum must be a maximum, and therefore no local minimum can exist. Note that Equation 7 also shows that the γ which locally maximizes $V(Y_1, g(w, \tilde{x}, \gamma))$ will also locally maximize $A(\gamma)$.

Step 2: Prove that $\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) < 0$

Using the envelope theorem:

$$\frac{d}{d\gamma}V(Y_1, g(w, \tilde{x}, \gamma)) = \beta E\Big(\frac{dg(w, \tilde{x}, \gamma)}{d\gamma}u'(c_2)\Big) \tag{9}$$

$$\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) = \beta E\Big(\Big(\frac{dg(w, \tilde{x}, \gamma)}{d\gamma}\Big)^2 u''(c_2)\Big) + \beta R E\Big(\frac{dg(w, \tilde{x}, \gamma)}{d\gamma}\frac{ds(\gamma)^*}{d\gamma}u''(c_2)\Big) \tag{10}$$

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[6]Also, note that continuity and differentiability of the utility function guarantee that $\frac{dA(\gamma)}{d\gamma}$ is defined everywhere, and therefore $A(\gamma)$ is globally continuous and differentiable.

The first term is negative, but the second is of ambiguous sign. In order to sign the expression, we can leverage the first order condition for s. Applying the implicit function theorem to Equation 4, we get the following expression for $\frac{ds(\gamma)^*}{d\gamma}$:

$$\frac{ds^*(\gamma)}{d\gamma} = -\frac{\frac{d}{d\gamma}\frac{dU}{ds}}{\frac{d}{ds^*(\gamma)}\frac{dU}{ds}} = -\frac{\beta RE(\frac{dg(w,\tilde{x},\gamma)}{d\gamma}u''(c_2))}{u''(c_1) + \beta R^2 E(u''(c_2))} \tag{11}$$

Rearranging terms and multiplying both sides by $\frac{ds^*(\gamma)}{d\gamma}$ yields the following equation.

$$\left(\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_1) + \beta E\left(\left(R\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_2)\right) + \beta E\left(R\frac{ds^*(\gamma)}{d\gamma}\frac{dg(w,\tilde{x},\gamma)}{d\gamma}u''(c_2)\right) = 0$$

As the above expression is equal to zero, we can add it to the right hand side of Equation 10.

$$\frac{d^2}{d\gamma^2}V(Y_1, g(w,\tilde{x},\gamma)) = \beta E\left(\left(\frac{dg(w,\tilde{x},\gamma)}{d\gamma}\right)^2 u''(c_2)\right) + \beta RE\left(\frac{dg(w,\tilde{x},\gamma)}{d\gamma}\frac{ds(\gamma)^*}{d\gamma}u''(c_2)\right) +$$

$$\left(\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_1) + \beta E\left(\left(R\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_2)\right) + \beta E\left(R\frac{ds^*(\gamma)}{d\gamma}\frac{dg(w,\tilde{x},\gamma)}{d\gamma}u''(c_2)\right)$$

Collecting and factoring the terms under the expectation operator:

$$\frac{d^2}{d\gamma^2}V(Y_1, g(w,\tilde{x},\gamma)) = \left(\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_1) + \beta E\left(\left(\frac{dg(w,\tilde{x},\gamma)}{d\gamma} + R\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_2)\right) \tag{12}$$

Both terms are clearly negative due to the concavity of the utility function. Therefore, $\frac{d^2}{d\gamma^2}V(Y_1, g(w,\tilde{x},\gamma)) < 0$. This combined with the proof in Step 1 shows that $A(\gamma)$ cannot have any local minima. $\square$

2.3 Risk Aversion

Models of classical insurance demand (such as Schlessinger [2000]) predict insurance demand to be increasing in risk aversion. In our model this is not necessarily the case, as intertemporal smoothing also plays a role. The goal in this section is to characterize how $\underset{\gamma}{argmax} A(\gamma)$ changes with risk aversion.

Consider the γ^* and s^*, which jointly maximize expected utility U given utility function $u(c)$.

$$\gamma^*, s^* \equiv \underset{\gamma, s}{argmax}\ u(c_1) + \beta E(u(c_2))\ s.t.\ 0 \le s \le Y_1,\ 0 \le \gamma \le 1 \tag{13}$$

Assuming for the moment that the restrictions do not bind, the following first order conditions will hold:

$$\frac{dU}{ds} = 0 = -u'(c_1) + \beta RE(u(c_2))$$

$$\frac{dU}{d\gamma} = 0 = \beta E\left(\frac{dg(w,\tilde{x},\gamma^*)}{d\gamma}u'(c_2)\right) \tag{14}$$

Define a function $v(c)$ which is globally more risk averse (as defined in Pratt[1964]) than the original utility function $u(c)$. We would like to to understand how $A(\gamma)$ will differ for a person with utility function $v(c)$ compared with someone with utility function $u(c)$. The following exposition closely follows

the proof of Proposition 3 in Schlessinger (2000), which proves (in a world without external savings) that an increase in risk aversion increases insurance demand.

Pratt (1964) guarantees the existence of a function h such that $v(c) = h(u(c))$, $h' > 0$, $h'' < 0$. Substituting h into the expected utility function, we have the following utility, which represents a person with utility function v who has selected γ^* and s^* (which are the optimal choices for someone with utility function u):

$$U = h(u(c_1)) + \beta E(h(u(c_2))) \tag{15}$$

For someone with utility function v, how does the choice of γ^* compare to their optimal γ? Taking the derivative of Equation 15, consider how utility changes when we increase γ above γ^*

$$\frac{dU}{d\gamma}\Big|_{\gamma=\gamma^*} = \frac{ds^*}{d\gamma}\left[-h'(u(c_1))u'(c_1) + \beta RE\big(h'(u(c_2))u'(c_2)\big)\right] + \beta E\left[h'(u(c_2))u'(c_2)\frac{dg(w,\tilde{x},\gamma^*)}{d\gamma}\right] \tag{16}$$

Since U is convex in γ (shown in Proposition 1), if $\frac{dU}{d\gamma} > 0$ then γ^* lies below the new γ which maximizes U. This means that an increase in risk aversion would increase $\overset{argmax}{\gamma} A(\gamma)$. However, the sign of $\frac{dU}{d\gamma}\big|_{\gamma=\gamma^*}$ is not immediately apparent. Multiplying the first order condition for savings (Equation 4) by $\frac{ds^*}{d\gamma}h'(u(c_1))$, we arrive at the following equation.

$$\frac{ds^*}{d\gamma}h'(u(c_1))(-u'(c_1) + \beta RE(u'(c_2))) = 0 \tag{17}$$

Subtracting this expression from Equation 16, this allows us to rewrite $\frac{dU}{d\gamma}\big|_{\gamma=\gamma^*}$ as

$$\frac{dU}{d\gamma}\Big|_{\gamma=\gamma^*} = \beta\left[E\big(\frac{dg(w,\tilde{x},\gamma^*)}{d\gamma}h'(u(c_2))u'(c_2)\big)\right] + \frac{ds^*}{d\gamma}\left[E(h'(u(c_2))u'(c_2)) - h'(u(c_1))E(u'(c_2))\right] \tag{18}$$

The first term represents the benefits of insurance in the second period, and is greater than zero. (For proof, see Schlessinger [2000]). The second term represents the intertemporal smoothing effects of the WISA, and is of ambiguous sign. Intuitively, if someone has a very high marginal utility of consumption in the first period such that $E(h'(u(c_2))u'(c_2)) - h'(u(c_1))E(u'(c_2)) < 0$, they will prefer higher first period consumption as risk aversion increases. This makes them prefer a lower γ, as the savings component of the WISA can act as a substitute for savings, allowing them to increase first period consumption.

We assumed before that the restrictions on s^* and γ^* were not binding. If one of the restrictions on s^* are binding, then s^* will not change if γ changes. In this case, the first term of Equation 16 goes to zero, and an increase in risk aversion unambiguously increases $\overset{argmax}{\gamma} A(\gamma)$. If one of the restrictions on γ^* is binding, then a marginal change in risk aversion will not change γ^*, making $\overset{argmax}{\gamma} A(\gamma)$ constant in risk aversion.

One important point is that our model does not include basis risk, meaning there is no chance that a customer suffers a shock yet receives no payout. With the index insurance used in our experiment, this is certainly possible. As discussed in Clarke (2011) and Cole et al. (2010), a model of insurance demand incorporating basis risk can cause insurance demand to decrease with risk aversion, potentially skewing the above results.

3 The Experiment

3.1 Laboratory Experiments

In order to test what is the optimal WISA type, we invited 322 farmers from rural areas surrounding Ahmedabad, India to participate in a laboratory experiment. The session was conducted entirely on a computer, where the subjects participated in games designed to elicit their preferences about risk, time, savings, and insurance. The participants were recruited using personal connections and are not meant to represent a random sample of Gujarati farmers. Since many of the participants were uncomfortable using computers, each participant was paired with an enumerator who read all the questions out loud and entered the answers into the computer. Summary statistics on the experimental population are presented in Table 1.

The experiment consisted of two primary parts: eliciting risk and discount parameters, and then eliciting valuations for various WISA types. In this section we give a brief overview of the methodology used, while further details can be found in the Appendix. Risk preferences were calculated using a Binswanger lottery, as in Binswanger (1981). Subjects were asked to pick from a menu of lotteries where the payout would be determined by a (virtual) coin flip. At the end of the session the coin flip was performed, and subjects were paid their outcome on the spot. The maximum payout was Rs 200 (around US $4), which roughly corresponds to the wages of 2-3 days of agricultural labor.

Discount rates were calculated using a set of hypothetical questions about whether farmers would rather accept Rs 80 (around US $2) now or a certain sum later. The sum to be paid later is increased question by question up to a maximum of Rs 280. Assuming that the subject starts by preferring Rs 80 now and then at some point switches to preferring money in the future, we can establish bounds on the discount rate.

The central part of the experiment revolves around figuring out participants' valuations for four savings and insurance products by eliciting their willingness-to-accept (WTA) using a Becker-DeGroot-Marschak (BDM) mechanism (Becker et al., 1964). Establishing the WTA using BDM is relatively straightforward, and we will give an example of a participant playing the BDM game for an insurance policy. The participant is given an insurance policy as a gift, and is then asked how much money he would be willing to accept to give up the policy (this is his "bid"). He then draws a random "offer price". If the offer price is above the bid, the participant must give up the insurance and instead receives the amount of the offer in cash. If the offer is less than the bid, he simply keeps the insurance.

Under standard expected utility theory, the dominant strategy under BDM is to state the true minimum WTA, but there is plenty of criticism as to its ability to assess accurate valuations in practice. For instance, if subjects have preferences that cannot be expressed using expected utility, BDM can give biased results (Karni and Safra, 1987; Horowitz, 2006). Furthermore, Berry et al. (2011) show BDM gives systematically lower valuations when compared to people making decisions using fixed prices when playing for a water filter in Ghana.

Regardless of BDM's ability to elicit "true" valuations for goods, we believe our experimental design warrants the use of BDM since it relies not on the absolute valuations of the products but instead their relative valuations. Even if BDM is giving biased valuations, our experiment will still be valid as long as those biases do not change based on the type of product being offered.[7]

In our experiment, farmers are asked to play the BDM game to elicit their WTA for gifts of savings (in the form of delayed payments), insurance, and mixes between the two. For instance, in one question

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[7]This assertion may be debatable since Karni and Safra's critique of BDM is based around how subjects would express WTA for lotteries, and our WISAs are all different types of lotteries. However, it is difficult to think of any way that this critique could explain our central results.

Table 1: Summary Statistics

Summary Statistics	
Personal Characteristics	
Sex is Male	100.00%
	(0)
Age	43.14
	(13.48)
Land Owner	86.65%
	(0.34)
Village Distance from Ahmedabad (Km)	23.20
	(3.12)
Have a Telephone	43.17%
	(0.50)
Decision Parameters	
Discount Factor between experiment and Post-Monsoon	0.78
	(0.65)
Estimate of Coefficient of Partial Risk Aversion	2.23
	(3.07)
Rainfall Risk Exposure	
If there was a severe drought during the upcoming monsoon season, would the income of you or your family be affected?	
Yes, A Lot	82.92%
Yes, A Little	16.46%
No	0.31%
Have Government Crop Insurance	12.73%
Roughly how much money could you gain from drawing on savings and selling assets if there was an emergency? (Rs.)	7574.34
	(3366.06)
Roughly how much money could you borrow if there was an emergency? (Rs.)	5559.78
	(3654.97)
If there was a serious drought in the upcoming monsoon, how would you and your family cope?	
Draw upon cash savings	36.65%
Sell Assets Such as Gold, Jewlery, Animals	40.68%
Rely on help from friends and family	49.38%
The government would step in to help	52.80%
Take a Loan	44.10%
Number of Respondents	322
Standard deviations are in parenthesis	

the farmers are asked to express their WTA for a "large" rainfall insurance policy, which is equivalent to owning three units of the insurance policy described in the Appendix. The exact question text (translated into English) is as follows:

> Consider you have been given a gift of 1 large rainfall insurance policy. This policy can be purchased for Rs 180 and pays out a maximum of Rs 1500 in the event of bad rainfall. What is the minimum amount of immediate payment you would accept to give up the insurance policy? Our offer to purchase this policy from you will be between Rs 10 and Rs 250. You would receive the payout at the end of today's session.

As Indian law has very strict regulations about the holding of deposits, we were not able to officially create savings accounts for the participants. However, we proxied for savings by giving the participants coupons which could be redeemed for cash after the monsoon, at the same time as insurance payouts are given. These guaranteed payouts are theoretically equivalent to giving the farmers a gift of a fixed-term savings account that matures after the monsoon. However, this strategy has the drawback that farmers may not perceive guaranteed payouts in the same way they would perceive savings.

Since the point of the exercise is to understand relative valuations of savings and insurance, the farmers are asked to give their valuations for four different products:

- A "large" insurance policy with maximum sum insured of Rs 1500

- A "medium" insurance policy with maximum sum insured of Rs 1000 plus a guaranteed payment of Rs 60

- A "small" insurance policy with maximum sum insured of Rs 500 plus a guaranteed payment of Rs 120

- A guaranteed payment of Rs 180 after the monsoon

The market price of Rs 500 of insurance coverage is Rs 60, making all the bundles of roughly equal monetary value.[8]

The farmers gave their minimum WTA for each of these 4 bundles, and then the computer randomly selected one of the games to be played for real.[9] After the selection of the 'real' game is made, the offer choice was shown, and the farmer either kept the bundle or was given money equal to the offer price.

We also undertook a framing experiment, where subjects were randomly shown one of the three descriptions of the financial products. The text shown above, given to 25% of the participants, is the "Bundle Frame", where the WISAs are described as an insurance projects plus a voucher for guaranteed money. 25% of the participants were shown the "Insurance Frame", in which the WISAs were presented as an insurance policy with a minimum payout equal to the voucher size. This frame was designed to mimic "no claim refund" insurance policies. The rest of the participants were shown the ICICI Bundle Frame, which is the same as the bundle frame. but explicitly mentions that the farmer could purchase the policy from the insurance company ICICI-Lombard. Full text of all these frames is given in the Appendix.

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[8]The actual quoted price for the policy was Rs 66, but the prices were rounded to make comparisons between bundles easier.

[9]Additionally, for the first three bundles (the ones which contain some insurance), the subjects were asked to give their WTA under the circumstance that the money paid to give up the bundle would be paid not on the day of the experiment, but post-monsoon. These results are not reported in this paper.

We took a number of steps to ensure that the subjects understood the BDM game. Prior to playing the game with insurance, subjects played a BDM game to elicit their WTA for a bar of chocolate. This game was immediately resolved, with subjects receiving either real money (up to Rs 15) or keeping the chocolate bar. During the BDM game for insurance products, the enumerators began by reading the question aloud. They then used props of sample insurance enrolment forms and/or vouchers to simulate the products being given as gifts. For instance, when a subject was playing the game for an insurance policy with a maximum sum insured of Rs 1000 and a guaranteed payment of Rs 60, they were physically handed two insurance policies with a sum insured of Rs 500 plus a voucher worth Rs 60. The enumerator then explained that they would keep this gift if the computer's offer was less than their bid, but would get the value of the offer at the end of the session if the computer's offer was greater than their bid. In informal conversations with the farmers after the sessions, all farmers who we spoke to claimed that they understood how the BDM game worked.
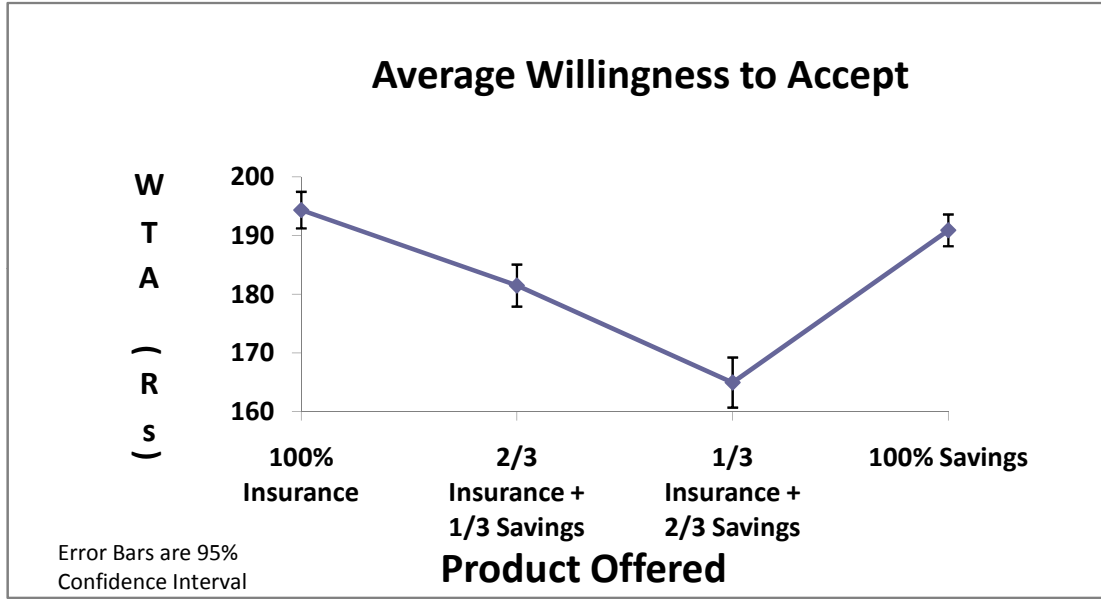
3.2   Delayed Payments

One challenge of conducting a laboratory experiment with products such as savings and insurance is that an experiment must take place in a short amount of time, while real insurance and savings products have delayed benefits. To increase the realism of the lab experiments we offered real financial products that paid out money after the monsoon. Delayed payouts (which proxied for savings) were delivered in the form of a voucher, which could be redeemed for cash by bringing the voucher to our Ahmedabad laboratory. Participants had two months after the end of the monsoon to come to Ahmedabad to redeem their vouchers.[10] They also had the options of sending the voucher with someone else to collect the money.

There are two main problems with making delayed payments a part of our experiment. First the participants may not believe that the lab would actually provide the promised delayed payouts. This belief would most likely hold for both voucher payouts and insurance payouts, which means that the relative valuations of insurance and savings would be unaffected. The second problem is that since the farmers live in surrounding villages, the cost of coming to redeem the voucher may be greater than the amount of money they would receive. We dealt with this problem by providing a large span of time to collect the vouchers, and also allowing participants to send friends or relatives to redeem the vouchers. Many farmers living in local villages travel occasionally to Ahmedabad to visit family or do business, and once in Ahmedabad the marginal cost of coming to our office to pick up the voucher would be quite low.

Once the vouchers were ready to be redeemed, we called all participants who had given us a phone number multiple times to remind them that they had money to pick up and explained to them the procedure for redeeming the voucher. On the second phone call, we stressed that the farmer did not have to come in themselves to pick up the money but could instead send it with friends or family. Despite these attempts, only 42% of people with vouchers came to pick them up. We will discuss the possibility that uncertainty over whether the vouchers would actually be redeemed could be driving our results in Section 5.

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[10]Specifically, they were told that they could redeem their vouchers after the Hindu holiday of Dashera, which corresponded roughly with the end of both the monsoon season and the insurance policy.

Figure 1: Average Willingness to Accept for all Products

Average Willingness to Accept

Error Bars are 95% Confidence Interval

4 Results

In this section we will present a number of results from the experiment. The first section will summarize the main results, which show average WTA of insurance, savings, and their mixtures, and will also explore the heterogeneity of the WTA patterns. We will then look at how the relative valuations of insurance and savings change with risk aversion and discount factors.

4.1 Main Results on Insurance and Savings Preferences

Our main empirical result is that most farmers prefer both pure savings and pure insurance to any mixture of the two. Figure 1 shows a plot of the average valuation versus the ratio of savings to insurance.

As Figure 1 shows, participants have the highest valuation of pure savings or pure insurance, with these bids being statistically indistinguishable. Valuations for both mixtures of savings and insurance are significantly lower than those for pure products. This graph shows that the WTA has a local minimum in the percentage of insurance, which is a clear violation of Proposition 1 of our model.

Figure 1 indicates that, on average, subjects show a preference for either pure insurance or pure savings over a combination, but this average could obscure heterogeneity. To explore this further we group the subjects according to various patterns of the bids, which indicate distinct preferences over insurance or savings. These groups are shown in Table 2.

18% of respondents were indifferent, which means they had the same valuation for each product. 7% preferred savings, which means their bids were weakly decreasing in the percentage of insurance contained in the product. 13% showed a preference for insurance, meaning their bids were weakly increasing in the percentage of insurance contained in the product. 11% preferred a mix, which means

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Table 2: Heterogeneity of Preferences

Preference	Percentage of Respondents
Indifferent	18%
Prefer Savings	7%
Prefer Insurance	13%
Prefer Mix	11%
Prefer Pure Product	39%
Other	12%

Table 3: Proportion of Insurance and Willingness-to-Accept

	Dependent Var is WTA Bid	
	(1)	(2)
Percentage of Insurance	0.0820**	-0.783***
	(0.0302)	(0.101)
Percentage of Insurance Squared		0.00864***
		(0.000970)
Constant	178.8***	188.5***
	(1.874)	(2.104)
Observations	1,288	1,288
R-squared	0.695	0.718
Robust Standard errors in parentheses	Percentage of Insurance is 0-100	
*** p<0.01, ** p<0.05, * p<0.1	Individual Fixed Effects Included	

they had the highest bid for one of the mixture products, with the bids weakly decreasing as one moves away from the highest bid. A strong plurality (39%) of the subjects had preferences that corresponded to the average, meaning they showed a preference for both pure insurance and pure savings over any of the mixtures. 12% of subjects did not express clear preferences, meaning that their bids changed directions twice as the percentage of insurance increased.

To get a more quantitative estimate of how product valuations vary based on the proportion of insurance we can use one observation for each bid, and regress the WTA on the percentage of insurance in the product. Based on the curvature of bids seen in Figure 1, we adopt a quadratic functional form for the percentage of insurance. Results are shown in Table 3. Column 1 contains only the linear term of the percentage of insurance, and we find it enters positively and significantly. In Column 2 we add the squared term, and now the linear term is negative while the squared term is positive, which is consistent with the U-shape seen in Figure 2.

4.2 Risk and Time Preferences

Our theoretical model predicted that people with higher levels of risk aversion or higher discount factors would have an optimal WISA with a higher percentage of insurance than those with lower risk

Table 4: Risk Factors

	Dependent Variable is Willingness to Accept			
	(1)	(2)	(3)	(4)
Percentage Insurance	-0.843***	-0.625***	-0.789***	-0.512**
	(0.131)	(0.186)	(0.226)	(0.251)
Perc. Insurance Squared	0.00926***	0.00726***	0.00897***	0.00645***
	(0.00129)	(0.00184)	(0.00222)	(0.00248)
Perc. Ins. X Risk Aversion		-0.0977*		-0.102**
		(0.0508)		(0.0507)
Perc. Ins. Sq X Risk Aversion		0.000896*		0.000924*
		(0.000505)		(0.000505)
Perc. Ins X Discount Factor			-0.0698	-0.135
			(0.233)	(0.234)
Perc. Ins Sq X Discount Factor			0.000371	0.000967
			(0.00233)	(0.00233)
Risk Aversion	-2.283**			
	(0.989)			
Discount Factor	10.81**			
	(4.907)			
Constant	187.0***	190.2***	190.2***	190.2***
	(5.445)	(2.245)	(2.263)	(2.244)
Individual Fixed Effects	NO	YES	YES	YES
Observations	1,104	1,104	1,104	1,104
R-squared	0.057	0.715	0.713	0.715
Robust standard errors in parentheses	All Errors custered at Individual Level			
*** p<0.01, ** p<0.05, * p<0.1	Percentage of Insurance Ranges from 0-100			

aversion. As the previous section showed that most people do not have a unique optimal WISA type, we know that it is going to be impossible to measure how the movement of this optimum changes with risk or time preferences. However, in Table 4 we look at how risk and time preferences affect relative WTA.

We first look at the direct correlations between WTA and risk and discount factors for all products. While we did not address the direct effects of these parameters on WTA in the theory section, it is trivial to show that the theory predicts higher WTA for people with higher discount factors, while there are no clear predictions for risk aversion. Column 1 shows that people with higher discount factors have higher WTA and those who are more risk averse have lower WTA. In Column 2 we interact the risk parameter with the proportion of insurance offered, and find that people with higher risk aversion have a stronger preference for pure products over mixtures. Column 3 interacts the proportion of insurance with the discount rate, and the interaction terms have no significance. Column 4 includes both risk and discount factors.

The main conclusion from this analysis is that people who were more risk averse tended to have a relative preference for pure products as opposed to the mixtures. Time preference had no significant effect on relative preferences.

5   Discussion

Our theoretical model predicted that participants' WTA would not have a local minimum in the WISA type. However, the results showed that most people preferred pure savings and pure insurance to any

mixture of the two, which is not a result not anticipated by our expected utility model. Looking at the heterogeneity of preferences in Table 2, we see that only 49% of the respondents gave results consistent with our theoretical model.

In the next section we consider a few possible explanation for these unexpected results.

5.1 Uncertainty Aversion

One explanation for our results could be that people were simply confused about the WISAs, as they are more difficult to understand than the pure products. If this was true, uncertainty about the WISAs could cause people to value them less due to uncertainty aversion, as in Gneezy et al. (2003).

In order to provide an empirical test on whether uncertainty was driving our results, we can draw some information from our results on framing. As explained earlier, participants were shown one of three frames describing the WISAs: the Bundle Frame, Insurance Frame, and ICICI Bundle Frame. While the Bundle Frames explained the financial product as an insurance product plus a voucher, the insurance frame explained them as simply an insurance policy with a minimum payout. Arguably, the insurance frame is much simpler to understand, as it presents the farmers with just one product instead of two. If this is true, we would expect the preference for pure products to be greater for participants shown the Bundle Frames as opposed to the Insurance Frame. However, as shown in Table 5, framing had little effect on participants' bids.

In Column 1 we introduce dummies for the frames directly to see how they affected subjects' average bids (the Bundle Frame is the omitted category). We see that compared to the Bundle Frame, the other two frames received modestly higher bids, but only the ICICI Frame is significant (and even then, only marginally so). In Column 2 we interact dummies for each of the frames with the percentage insurance (linear and squared) to see whether the framing affects the relative valuation of savings versus insurance. None of the coefficients are significant, indicating that framing of the question had little effect on the results.

Finally, one would certainly think that rainfall index insurance itself is a confusing product compared to a simple savings voucher. If uncertainty aversion was driving the results, the WTA for pure insurance should be lower than that of pure savings. However, the mean WTA for these two products are not statistically distinguishable.

While we do not have explicit tests for whether uncertainty aversion caused subjects to value the WISAs less than pure products, the available evidence suggests that this is not the case. Regardless, we must consider uncertainty aversion as a possible explanation for our results.

5.2 Probability of Redeeming Vouchers

Another possible explanation for why participants valued the WISAs less than pure products is that they held certain expectations about their chances of picking up vouchers. After the experiment, 197 participants (61% of total) were given a voucher that could be redeemed for cash after the monsoon, and only 42% of these people eventually redeemed their vouchers. If during the experiments the farmers took into account the possibility that they might not redeem their vouchers, this could have affected the valuations of the financial products. Specifically, if they thought that the voucher size would affect their probability of actually redeeming their vouchers, this could affect their relative valuations of savings and insurance.

One way to think about this is to assume that farmers have fixed costs for redeeming the voucher. For instance, assume that a farmer anticipates that he will not redeem any voucher worth less than

Table 5: Framing

	(1)	(2)
Percentage Insurance	-0.796***	-1.016***
	(0.120)	(0.294)
Percentage Insurance Squared	0.00877***	0.0113***
	(0.00119)	(0.00297)
Insurance Frame X Percentage Insurance		0.281
		(0.380)
Insurance Frame X Perc Insurance Sq		-0.00269
		(0.00381)
ICICI Frame X Percentage Insurance		0.324
		(0.356)
ICICI Frame X Perc Insurance Sq		-0.00409
		(0.00355)
ICICI Frame	12.48*	
	(7.030)	
Insurance Frame	8.904	
	(7.646)	
Constant	180.6***	188.6***
	(5.282)	(2.058)
Individual Fixed Effects	NO	YES
Observations	1,288	1,288
R-squared	0.033	0.720
Robust standard errors in parentheses	Errors Clustered at Ind. Level	
*** p<0.01, ** p<0.05, * p<0.1		

Table 6: Voucher Size and Picking Up Payouts

Dependent Variable:	Voucher is Picked Up		Voucher is Picked Up Before Second Phone Call		Voucher is Picked Up After the Second Phone Call	
	(1)	(2)	(3)	(4)	(5)	(6)
Log Amount of Voucher	-0.0989	-0.101	0.0436	0.0505	-0.143**	-0.147*
	(0.0789)	(0.0843)	(0.0329)	(0.0309)	(0.0660)	(0.0839)
Log of Total Vouchers in Village		0.0618		0.0292		0.073
		(0.122)		(0.0903)		(0.146)
Distance from Ahmedabad		-0.0281		-0.0119		-0.0262
		(0.0228)		(0.0150)		(0.0249)
Have Phone Number	0.0828	0.136	0.0324	-0.00294	0.0504	0.155
	(0.0704)	(0.0879)	(0.0603)	(0.0433)	(0.0676)	(0.0993)
Log of Total Village Vouchers Remaining After Second Phone Call						0.0733
						(0.146)
Constant	0.853**	1.066	-0.0881	-0.0312	0.942***	1.077
	(0.377)	(1.223)	(0.151)	(0.718)	(0.314)	(1.216)
Village Fixed Effects	YES	NO	YES	NO	YES	NO
Observations	197	197	197	197	197	171
R-squared	0.528	0.072	0.372	0.024	0.561	0.083

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Rs 130. As both savings/insurance mixtures contained guaranteed payments of less than Rs 130, the participant would not redeem the voucher in the event the insurance did not pay out, making the bundles relatively unattractive. This could explain why WTA for the financial products decreased with the percentage of insurance until the voucher was worth Rs 180.

We can test this theory by taking a look at whether the chance of picking up the vouchers was influenced by the size of the voucher to be picked up. These results are presented in Table 6.

In Columns 1 and 2 of Table 6 we see that the total voucher amount held by the individual does not have a positive effect on the chance that the farmer redeems the voucher. In fact, the point estimates are all negative. In Column 1 we include village-level fixed effects, while in Column 2 we include village-level controls for the distance a farmer lives from Ahmedabad and the total amount of vouchers to be redeemed in the village, as we expect that these factors would influence the probability that they came to redeem the voucher. However, coefficients on these variables are insignificant.

Farmers who had vouchers waiting to be redeemed were called on the telephone two times to remind them to get their vouchers (if they had provided a telephone number at the time of the experiment).[11] In the second call, farmers were explicitly reminded that they did not need to show up in person to redeem their voucher but could instead send it with a friend or relative. Therefore it may be possible that before this phone call farmers with low voucher amounts were less likely to redeem them, as they thought they had to come to Ahmedabad themselves. In fact, after the second phone call there were a few instances where one farmer from a village collected many vouchers and came to redeem them all.

In Columns 3 and 4 the dependent variable is a dummy which takes the value of 1 if the farmer redeemed his voucher before the second phone call and zero otherwise. In these regressions the coefficient on voucher size is positive, though it is not significantly different than zero. In Columns 5 and 6 the dependent variable is a dummy which takes a value of 1 if the farmer redeemed his voucher after the second phone call and zero otherwise. Here we see that farmers with lower voucher sizes are more likely to redeem their vouchers after the second phone call, reflecting the fact that in this period some villages pooled a number of small vouchers and sent a single representative to redeem them. However,

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[11]43% of participants gave us phone numbers.

Table 7: WTA and Picking Up Vouchers

	Dependent Variable is WTA		
	(1)	(2)	(3)
Proportion of Insurance	-0.645***	0.0140	-0.324
	(0.143)	(0.0493)	(0.207)
Proportion of Insurance Squared	0.00683***		0.00338*
	(0.00136)		(0.00195)
Picked Up Voucher X Prop of Insurance		0.0571	-0.752**
		(0.0747)	(0.331)
Picked Up Voucher X Prop Insurance Sq			0.00809**
			(0.00316)
Picked Up Voucher	-20.10***		
	(7.401)		
Constant	202.2***	186.0***	193.6***
	(5.130)	(1.853)	(2.641)
Individual Fixed Effects	NO	YES	YES
Observations	788	788	788
R-squared	0.040	0.741	0.760
Robust standard errors in parentheses	Errors Clustered at Indiv. Level		
	Sample Includes only those who		
*** p<0.01, ** p<0.05, * p<0.1	had vouchers to pick up		

the total amount of vouchers still to be redeemed in the villages does not enter significantly.

The above regressions do not exactly paint a clear picture, but they would be consistent with an argument that farmers did not expect to redeem small vouchers, but only did so when reminded on the phone that they could send them to Ahmedabad with a representative. This could mean that when they were formulating their WTA for the financial products, they considered the chance of actually redeeming vouchers to be increasing in voucher size.

If we assume that the fixed costs to redeem vouchers are heterogeneous, we would expect that farmers who did not end up redeeming their vouchers anticipated higher costs and therefore would have expressed a higher preference for pure products (and lower valuations of all products). We can test these predictions by looking at the WTAs of people who actually picked up their vouchers versus those who did not pickup. We test this hypothesis in Table 7.

Column 1 looks at the direct effect of picking up the voucher on WTA. Here we see that people who picked up their vouchers had an average WTA that was Rs 20 lower than those who did not pick up their vouchers. This is counterintuitive, as we would think that people who were less likely to pick up delayed payments would have lower WTA for all products. In Column 2 we look at how WTA varies with the proportion of insurance, and interact the proportion of insurance with a dummy for those who picked up their vouchers. We find that people who picked up the voucher had no significant difference on the relative valuation of savings versus insurance. The point estimate is positive, suggesting that people who were more likely to pick up their vouchers were more likely to prefer insurance, which is not in line with our hypothesis. Finally, in Column 3 we introduce the square of the proportion of insurance and also interact this term with the dummy for picking up the voucher. Both interaction terms are significant and very large, suggesting that people who picked up their vouchers showed a higher preference for pure products. Overall the results of Table 7 do not support the hypothesis that peoples' bids were affected by taking the transaction costs of redeeming the vouchers into account.

One final point is that if customers expected their chance of receiving delayed payouts to be increasing in the size of those payouts, we would expect that the WISA with the smallest voucher to have the lowest valuation. This is the 1/3 Savings + 2/3 Insurance product, which has a voucher of only Rs 60. However, the bids for the 2/3 Savings + 1/3 Insurance bundle (which has a voucher of Rs 120) were significantly lower even though the voucher size was larger.

Overall, the empirical evidence does not support the hypothesis that our results are driven by participants' consideration of whether or not they will actually receive delayed payouts.

5.3 Diminishing sensitivity

The main assumption that drives our theoretical result that $A(\gamma)$ cannot have a local minimum is the concavity of the utility function. If we relax this assumption, then the theory would allow local minima for $A(\gamma)$. While the assumption of risk averse agents is generally standard, prospect theory (Kahneman and Tversky, 1979) predicts that people have diminishing sensitivity around a reference point, which results in risk-seeking for losses. For someone with diminishing sensitivity, the utility function for someone with reference point r satisfies the following:

$$\begin{cases} u''(c) < 0 & if \ c > r \\ u''(c) > 0 & if \ c < r \end{cases}$$

If people exhibited diminished sensitivity around a reference point, this means that their utility function is convex for losses below a reference point, and Proposition 1 fails to hold. In order to see this, let's take a look again at the central result of Proposition 1. Define the reference level of consumption in each period to be r_1 and r_2 respectively. Equation 12 now becomes:

$$\frac{d^2}{d\gamma^2}V(Y_1, g(w, \tilde{x}, \gamma)) = \left(\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_1 - r_1) + \beta E\left(\left(\frac{dg(w, \tilde{x}, \gamma)}{d\gamma} + R\frac{ds^*(\gamma)}{d\gamma}\right)^2 u''(c_2 - r_2)\right) \quad (19)$$

In a world where people exhibit diminishing sensitivity, $u''(c)$ is no longer universally less than zero, so the above expression is not necessarily negative. Instead, the sign will be determined by the specific shape of the utility function and the choice of the reference point.

In the first period, we can consider the reference point r_1 to be the amount of first period consumption in a world where the consumer has not recieved a gift of a WISA. If the gift of a WISA causes the consumer to increase (decrease) savings, then $c_1 - r_1$ will be less than (greater than) zero. Unfortunately, the model does not contain clear predictions about how the gift of the WISA will change savings, and therefore the first term has ambiguous sign.

In the second period, the choice of the reference point is less clear. One reasonable choice would be the level of consumption reached there if was no gift of a WISA and when $\tilde{x} = E(\tilde{x})$.[12] In this case, second period consumption can be above or below the reference point, and therefore the utility function is neither globally convex or concave, making the second term also ambiguous in sign.

We can resolve this ambiguity with a few simplifying assumptions. Assume that savings is fixed and that the second period reference point is the level of consumption when $\tilde{x} = 0$. In farming situations, this reference point is not unrealistic, as losses may come during rare catastrophic events while most seasons bring good harvests. In this scenario, we can drop the first term of Equation 19 as first period

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[12]Using expectations as references is suggested by Köszegi and Rabin (2006).

utility is always equal to reference utility. The second term is positive, as $c_2 - r_2$ is always either zero or negative.[13] In this scenario, $A(\gamma)$ can have a local minimum.

In general, the necessary conditions for $A(\gamma)$ to have a local internal minimum is that there is a γ over the range of $0 < \gamma < 1$ that solves the first order condition for γ (found in Equation 9), and also satisfies the following second order condition :

$$(\frac{ds^*(\gamma)}{d\gamma})^2 u''(c_1 - r_1) + \beta E\big((\frac{dg(w, \tilde{x}, \gamma)}{d\gamma} + R\frac{ds^*(\gamma)}{d\gamma})^2 u''(c_2 - r_2)\big) > 0$$

The intuition behind this effect is as follows. When people have diminishing sensitivity to losses, partial insurance is especially unattractive because the marginal utility of wealth is very low after a large loss. For instance, a person would be willing to pay less than half the premium for an insurance policy which offered half coverage (compared to full insurance). Therefore, the low amount of insurance offered as part of a WISA is unattractive, making the WISA unattractive overall compared to the pure products.

Our experiment does not shed light on whether the above necessary conditions are satisfied for people who showed a local minimum in $A(\gamma)$. However, results of our experiment are consistent with predictions of a model with agents who exhibit diminishing sensitivity around a reference point. This would be an interesting topic for further research.

6   Conclusion

This study has explored Indian farmers' relative preferences for savings and insurance when planning for the monsoon season. We found that, contrary to theoretical predictions, most farmers preferred both pure savings and pure insurance to any mixture of the two. This finding suggests that a combined savings/insurance product such as a WISA would not be an attractive product for most Indian farmers.

Although the reasons for these choices are not entirely clear, we propose a couple of primary explanations for the preference for pure products. First of all, it is possible that farmers were uncertainty averse and confusion about the WISAs caused them to value them less. This suggests that introducing a complex financial product such as a WISA is likely to be unsuccessful.

Alternatively, lower valuation of mixed products would be consistent with a model where participants experience diminishing sensitivity to wealth changes around a reference point. People who have diminishing sensitivity to losses would show a strong preference for full insurance over partial insurance. If this was true, then a WISA would be an inherently unattractive product as it would provide less insurance than a pure insurance product.

There are a number of drawbacks of this experiment that may cause it to underestimate the potential demand for a WISA. One possibly attractive feature of a WISA is that it could be framed as a savings account and the insurance payments could just be paid using foregone interest payments. Unfortunately we were unable to adequately create this scenario in the laboratory, as this scheme requires relatively large deposits to provide meaningful coverage, and Indian banking regulations prevented us from acting as a bank and actually opening savings accounts. This scenario would present an interesting route for future study.

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[13]Note that $u''(c - r)$ is technically undefined when $c = r$. However, we can finesse this issue by assuming that in a world where savings does not adjust, first period utility will always be zero and should therefore be removed from the indirect utility function altogether. For the second term, we simply consider the expectation for all situations where $c_2 \neq r_2$.

Another potential formulation for mixing savings and weather insurance would be to follow the example of "whole life" life insurance policies to develop a type of financial product called "whole weather". With this product, policy holders would purchase a fixed multi-year policy where they would pay premiums each year and receive insurance coverage for each monsoon. If at the end of the term they had not recovered at least the amount of premiums paid in payouts, then they would be refunded the extra premiums. The insurance would be funded by the difference between the nominal premium paid and the expected present value of the future refunds. Based on the success of whole life insurance products, the product would potentially be attractive to customers, as the premium refund makes it seem as if there is no risk of losing money with the product. We hope to explore this type of product in future studies.

7   References

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Table A.1: Policy Termsheet

Cover Phase	I	II	III
Duration	35 days	35 days	40 days
DEFICIT			
Strike (mm)	150	80	-
Exit (mm)	50	10	-
Amount Paid per mm (Rs / mm)	2.00	2.00	-
Policy Limit (Rs)	200	200	-
EXCESS			
Strike (mm)	-	-	550
Exit (mm)	-	-	650
Amount Paid per mm (Rs / mm)	-	-	1.00
Policy Limit (Rs / Acre)	-	-	100

8 Appendix: Description of Experimental Procedures

8.1 Rainfall Index Insurance

This experiment uses rainfall index insurance policies underwritten by the Indian insurance company ICICI-Lombard. Rainfall index insurance creates a contract based on rainfall at a local weather station, and daily rainfall readings from this station are used to calculate the insurance payout. Our policy is written based upon rainfall at a weather station administered by the Indian Meteorological Department located near the airport in Ahmedabad. All of our subjects lived within 30km of this rainfall station, so the rainfall at the station and on their farms should be similar.

The policy provides insurance coverage for three phases of the monsoon, and each phase provides coverage for excess or deficit rainfall. For deficit (excess) policies, payouts are made if the cumulative payout is below (above) a certain threshold. The specifics of the product used in this paper are outlined in Table A.1. The policy begins when 50mm of rain have accumulated during the month of June, but starts on July 1st if this threshold is not met in June. The first phase lasts 35 days, and offers a payout of Rs 2 for each millimeter of rain below the "strike" of 150mm that accumulates during the phase. Phase 2 has similar conditions, though it also has a lower threshold known as an "exit". When rainfall falls below the exit, the payout for Phase 2 jumps to the policy limit of Rs 200. Phase 3 provides coverage for excess rainfall during the harvest period, starting payouts when rainfall is above 500mm.

The policy offers a maximum payout of Rs 500 per unit, and was priced by ICICI-Lombard at Rs 66. Based on historical data from the Indian Meteorological Department from 1965-2002, the policy would have paid out an average of Rs 22.[14] The offers of pure insurance gave the participants three units of coverage, while the 2/3 insurance + 1/3 savings bundles gave them two units, and the 1/3 insurance + 2/3 savings bundles gave them one unit.

The policies used in this experiment provided coverage for the monsoon season in 2010. The 2010 monsoon around Ahmedabad was one of above-average rains, resulting in good crop outcomes for most farmers, and therefore the insurance policy did not give a payout.

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[14]This is a normal amount of loading for market priced insurance.

8.2 Discount Factors

In order to calculate discount factors we asked customers a sequence of questions about whether they would like to receive Rs 80 now or a certain amount of money in the future. These questions were all hypothetical, with no actual money being dispensed. In the first question the future amount of money was Rs 60, and it increased in intervals of Rs 20 to Rs 280. Subjects with consistent time preferences who prefer present consumption to future consumption would be expected to initially prefer Rs 80 now, but at some point would switch to receiving money in the future. This switching point can provide bounds on the discount factor. Sample question wording (translated into English) is as follows:

Would you rather receive Rs 80 today or Rs 120 guaranteed in November?

- Rs 80 today

- Rs 120 in November

- Don't Know

The below table shows the implied discount factors generated by certain switching points as well as the percentage of respondents in each category. When performing regressions using the discount factor, we used the mean of the discount factor bounds where they were well defined. For people whose discount rates were unbounded from below we used a rate of .28, which implies that people would have switched to preferring a future payment of Rs 300. For people who were unbounded from above we used a discount factor of 2, implying that people would be indifferent between Rs 80 now or Rs 40 in the future. People who had multiple switching points do not have a well defined discount factor, and are therefore dropped from regressions requiring discount factors.

| Money Offerered Now | Switching Point | Implied Discount Factor | | | Percentage Of Respondents |
		Lower Bound	Upper Bound	Used for Regressions	
Rs 80	Always Prefer Future	1.33	∞	2	13.04
Rs 80	Rs 80	1	1.33	1.165	4.66
Rs 80	Rs 100	0.8	1	0.9	36.96
Rs 80	Rs 120	0.67	0.8	0.735	9.32
Rs 80	Rs 140	0.57	0.67	0.62	3.11
Rs 80	Rs 160	0.5	0.57	0.535	4.04
Rs 80	Rs 180	0.44	0.5	0.47	1.55
Rs 80	Rs 200	0.4	0.44	0.42	1.55
Rs 80	Rs 220	0.36	0.4	0.38	0.062
Rs 80	Rs 240	0.33	0.36	0.345	0.062
Rs 80	Rs 260	0.31	0.33	0.32	0.031
Rs 80	Rs 280	0.29	0.31	0.3	1.55
Rs 80	Always Prefer Present	-∞	0.29	0.28	17.7
Rs 80	Multiple Switches				4.97

Appendix Table 2: Elicitation of Discount Rates

8.3 Risk Attitudes

We elicit risk attitudes with gambles played for real money using the exact same question set used in Binswanger (1980). The exercise consists of a list of 8 lotteries where the subject has a 50% chance of gaining each possible outcome. The first lottery offers the subject Rs 50 with probability 1. As you move down the list, the lotteries increase in both expected value and variance. The exact text of the question (translated into English) is as follows:

> In this question you will be presented with a number of possible gambles to take. In each there is a coin flip, and you get a certain amount of money if it lands on heads and a different amount if it lands on tails. Note that this game will be played FOR REAL MONEY, so think carefully! If you choose 'I don't know', you won't play the game and will not have the opportunity to win any extra money.
>
> Please note that the 'coin flip' will be done on the computer, which will randomly show you either Heads or Tails. The flip will be done at the end of the session.
>
> Which of the following gambles would you prefer?

- Rs 50 for Heads, Rs 50 for Tails
- Rs 45 for Heads, Rs 95 for Tails
- Rs 40 for Heads, Rs 120 for Tails
- Rs 35 for Heads, Rs 125 for Tails
- Rs 30 for Heads, Rs 150 for Tails
- Rs 20 for Heads, Rs 160 for Tails
- Rs 10 for Heads, Rs 190 for Tails
- Rs 0 for Heads, Rs 200 for Tails
- I don't know

In order to assist with understanding, the enumerators showed each participant a coin and explained that they would receive the money at the end of the session based on a virtual coin flip. Based on the chosen lottery, we can classify the level or risk aversion of each subject. We adopt the partial risk aversion coefficient as the measure of risk aversion. The risk aversion coefficients and the number of subjects in each group are presented in Table A.2.

8.4 BDM Game

Valuations of insurance and guaranteed payments were elicited using a BDM game. In this section participants were asked to give their valuations of four separate objects:

- A "large" insurance policy with maximum sum insured of Rs 1500
- A "medium" insurance policy with maximum sum insured of Rs 1000 plus a guaranteed payment of Rs 60
- A "small" insurance policy with maximum sum insured of Rs 500 plus a guaranteed payment of Rs 120

Table A.2: Elicitation of Risk Aversion

Gamble	Head Payoff	Tails Payoff	Risk Level	Approximate Partial Risk Aversion Coefficient			Percentage of Respondents
				Upper Bound	Lower Bound	Coeff Used for Regressions	
1	50	50	Extreme	∞	7.51	8	17.08
2	45	90	Severe	7.51	1.74	4.625	9.63
3	40	120	Intermediate	1.74	0.812	1.276	9.01
4	35	125	Inefficient			Observation Dropped	7.76
5	30	150	Moderate	0.812	0.316	0.564	12.42
6	20	160	Inefficient			Observation Dropped	5.9
7	10	190	Slight-to-Neutral	0.316	0	0.158	18.32
8	0	200	Neutral-to-Negative	0 to -∞		0	19.25
9	"I don't Know" selected						0.062

- A guaranteed payment of Rs 180 after the monsoon

After giving their valuations, one of the games was played at random for real money, vouchers, and insurance policies. Before giving their valuations, subjects are shown the following text on the computer, which is read aloud by the numerator. Translated into English, it is:

> In the next section you will again need to make decisions about how much you would need to be paid in order to give up certain objects. However, in this case the objects will not be physical things. Instead, they will either be rainfall insurance policies, coupons for payment in the future or both. I'll call each gift a "bundle" because it may be multiple things.

> For each question you are to consider that you have been given one of these bundles. You then have to state what is the minimum amount of money you would need to give up this bundle. For each bundle you have to state how much money you would need to give up the bundle if the money was paid to you right now, and also if the money was paid to you in November.

> After you tell how much money you would need to give up each of these bundles, one of the games will randomly be played for real. One of the bundles will be picked at random and given to you. You will then be randomly offered an offer to buy back the bundle. If this offer price is greater than the minimum price you said you were willing to accept to give up the bundle, you will be paid this offer price. If the offer price is less than your minimum, you will keep the bundle. The offer price will be somewhere in between Rs 10 and Rs 250.

> It is in your best interests to think about each question thoroughly and give the actual minimum price you would accept for each one!

In the question text, participants are randomly shown one of three frames:

1. Bundle Frame - In this frame the savings/insurance mixtures are explained as a separate insurance policy and a voucher for guaranteed money.

2. Insurance Frame - In this frame the savings/insurance mixtures are explained as an insurance policy with a minimum payout.

3. ICICI Bundle Frame- In this frame we mention that the policy could be purchased from the ICICI-Lombard insurance company. The savings/insurance mixtures are described in the same way as the bundle frame.

As an example of the wording in the three frames, here is the text for the bundle of one insurance policy with maximum payout of Rs 1000 and a voucher for Rs 60. Note that this question appears after asking for a valuation for a pure insurance product, so there is a line clarifying the difference between this offer and the last one.

Bundle Frame:

> Consider you have been given a gift of 1 medium rainfall insurance policy and a voucher for Rs 60 that can be redeemed for cash in November. The policy would normally cost Rs 120 and pays out a maximum of Rs 1000 in the event of bad rainfall. The Rs 60 voucher is just a piece of paper that you can exchange for Rs 60 cash in November. This gift might be especially useful if there is a poor harvest. What is the minimum amount of immediate payment you would accept to give up the insurance policy and coupon? Our offer to purchase this bundle from you will be between Rs 10 and Rs 250. You would receive the payout at the end of today's session.

> The difference between this and the previous questions is that now the insurance policy you are offered has a maximum payout of Rs 1000 instead of Rs 1500. However, this time you also will get a gift of Rs 60 paid in November regardless of rainfall.

Insurance Frame:

> Consider you have been given a gift of a special "payout guaranteed" rainfall insurance policy. As before, this policy will pay out in the event of poor rainfall, but it will pay out at least Rs 60 regardless of rainfall. This policy would normally cost Rs 180 and will pay out a maximum of Rs 1060 in the event of bad rainfall. What is the minimum amount you would be willing to accept to give up the insurance policy? Our offer to purchase this policy from you will be between Rs 10 and Rs 250. You would receive the payment at the end of today's session.

> The main difference between this and the previous questions is that now the rainfall insurance policy has a maximum payout of Rs 1060 instead of Rs 1500, but it will pay out a minimum or Rs 60 instead of zero.

ICICI Bundle Frame:

> Consider you have been given a gift of 1 medium rainfall insurance policy and a voucher for Rs 60 that can be redeemed for cash in November. The policy can be purchased from the ICICI-LOMBARD insurance company for Rs 120 and pays out a maximum of Rs 1000 in the event of bad rainfall. The Rs 60 voucher is just a piece of paper that you can exchange for Rs 60 cash in November. This gift might be especially useful if there is a poor harvest. What is the minimum amount of immediate payment you would accept to give up the insurance policy and coupon? Our offer to purchase this bundle from you will be between Rs 10 and Rs 250. You would receive the payout at the end of today's session.

> The difference between this and the previous questions is that now the insurance policy you are offered has a maximum payout of Rs 1000 instead of Rs 1500. However, this time you also will get a gift of Rs 60 paid in November regardless of rainfall.