Informal Risk Sharing and Index Insurance: Theory with Experimental Evidence

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Abstract

When does informal risk sharing act as barrier or support to the take-up of index-based insurance? We evaluate this substitutability or complementarity interaction by considering the case of an individual who endogenously chooses to join a group and make decisions about index insurance. The presence of an individual in a risk sharing arrangement reduces his risk aversion, termed “Effective Risk Aversion”— a sufficient statistic for index decision making. Our analysis establishes that such reduction in risk aversion can lead to either reduced or increased take up of index insurance. These results provide alternative explanations for two empirical puzzles: unexpectedly low take-up for index insurance and demand being particularly low for the most risk averse. Experimental evidence based on data from a panel of field trials in India, lends support for several testable hypotheses that emerge from our baseline analysis.

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> "*...and when basis risk is large, having an informal network can help by providing insurance against basis risk. Thus the presence of informal risk sharing actually increases demand for index-based insurance in the presence of basis risk...*" -- **World Development Report (2014)**

1 Introduction

The business of agriculture is inherently risky, particularly for the poor, due to a myriad of unpredictable weather and climate events. Recently, innovative index-based weather insurance has emerged as a way to help society insure against weather related events.[1] A standard index-based contract pays out when some constructed-index falls below or above a given non-manipulable threshold.[2]

The justification for index insurance is that it overcomes several market frictions e.g., moral hazard, that plague traditional indemnity-based insurance and financial instruments. Index-based insurance differs in the sense that the contractual terms (premiums and payouts) are based on publicly observable and non-manipulable index (local weather). However, this innovation comes with a cost: "basis risk". In particular, there is a potential mismatch between the payouts triggered by the local weather and the actual losses associated with weather realizations of the insurance policy holder. This mismatch or "basis risk" arises because weather realized on an individual farm unit may not perfectly correlate with the local weather index—whose construction is typically based on observations recorded at weather stations that surround the policy holder.[3]

Empirical studies about weather index-based insurance are growing (e.g., Cai et al. 2009;

[1]The design and coverage for index-based weather insurance can be wide ranging. Hazell et al. (2010) cites at least 36 pilot index insurance projects that were underway in 21 developing countries. Examples include: India–rainfall insurance (Mobarak and Rosenzweig 2012; Cole et al. 2013); Ethiopia–rainfall (Hazell et al. 2010; McIntosh et al. 2013; Duru 2016); China–drought and extreme temperature (Hazzel et al. 2010); Mexico–drought and excess moisture (Hazell et al. 2010); Ghana–rainfall (Karlan et al. 2014); Kenya and Ethiopia–"livestock" weather-insurance (Jensen et al. 2014).

[2]See Carter et al. (2017) for a recent survey about index insurance in developing countries.

[3]Satellite measurements are used in some cases (e.g., Carter et al. 2017; IRI 2013). Even so, the individual weather realizations is not perfectly correlated with the satellite index.

Giné and Yang 2009; Cole et al. 2013; Karlan et al. 2014), which in turn have noted two fundamental puzzles. The first is that, demand for index products has been lower than expected. The second is that, the demand seems to be especially low from the most risk averse consumers. Despite its promise, scaling up index insurance will require our understanding about the various constraints to its take-up. Several candidate reasons for the low demand have been offered including: financial illiteracy, lack of trust, poor marketing, credit constraints, present bias, complexity of index contracts, "basis risk" and price effects.

Another suggested explanation for the thin index insurance market in poor populations is pre-existing informal risk-sharing arrangements. Indeed, the extent to which informal risk-sharing networks affect the demand for index-based insurance remains an open question, both empirically and theoretically. In this paper, we focus on microfounded reasons underlying the relation between informal risk schemes and formal index insurance. Specifically, we ask: *When does an informal risk sharing scheme impede or support the take-up of formal index insurance?* We analyze this question in an environment where an individual endogenously chooses to join an informal group and make purchase decisions about index insurance. Our analysis show that the presence of an individual in a risk sharing arrangement reduces his risk aversion — a phenomenon we term "Effective Risk Aversion". The paper documents that "Effective Risk Aversion" is a paramount statistic that underlies individual's purchase decisions about index-based insurance.

Appealing to "Effective Risk Aversion", it is shown that informal schemes may either reduce or increase the take-up of index insurance. The main intuition follows from the simple observation that in the presence of a risk-sharing arrangement, an individual's risk tolerance is higher.[4] This has two implications for the take-up of index insurance. First, the individual being more risk-tolerant makes him less willing to buy insurance. Second, the individual becomes more tolerant to the basis risk, and so is more likely to take-up. These

[4]This intuition is comparable to Itoh (1993), who studies optimal incentive contracts in a group. He shows that side contracts can serve as mutual insurance for members in a group and can induce effort at a cheaper cost when members of the group can monitor each other's effort by coordinating their choice of effort. While Itoh (1993) looks at effort decisions, we analyze insurance decisions.

two forces have opposite effects on the decision to purchase index insurance. Consider the case of a highly risk averse individual who will not buy index insurance if acting alone because of his sensitivity to basis risk. Being in a group reduces his risk aversion "effectively" making him more tolerant towards basis risk and thus more likely to purchase index insurance. Now consider the case of an individual with intermediate risk aversion who would buy index insurance if acting alone. The presence of informal insurance may crowd out his take-up for index insurance due to his lower willingness to pay. Our analysis thus has implications for informal schemes acting as a substitute or complement to index insurance.

Several testable hypotheses emerge from our theoretical analysis, which are useful for the design of index insurance contracts and understanding the development or commercial success of such innovative financial products. We develop a tractable empirical framework to investigate these hypotheses using data from a panel of field experimental trials in rural India. First, we provide empirical evidence that the overall effect of informal risk-sharing on the take-up of index insurance is ambiguous. There is evidence that informal risk sharing schemes may support take-up, finding that when downside basis risk is high, risk-sharing increases the index demand by approximately 13 to 40 percentage points. In addition, we provide evidence that the existence of risk-sharing arrangement makes individuals more sensitive to price changes, with an estimated increased elasticity of about 0.34.

Finally, we show that an increase in the size of risk-sharing groups decreases take-up. This effect is stronger once we have conditioned on basis risk – a counter force. Strikingly, this result stand in contrast to standard information diffusion models, in which an increase in exposed group size should facilitate uptake of index insurance (e.g., Jackson and Yariv 2010; Banerjee et al. 2013). For example, Banerjee et al. (2013) show that information passage or diffusion within a social network increases the likelihood of participation in a microfinance program across 43 villages in South India. Similarly, Cole, Tobacman and Stein (2014) attributed the observed increase in take-up of index insurance to information generated by village-wide insurance payouts. Our analysis documents that the effective reduction in risk aversion following individuals' exposure to risk-sharing group treatments explains the findings.

Our paper is related to the broader literatures on risk sharing (e.g., Itoh 1993; Townsend 1994; Munshi 2011; Munshi and Rosenzweig 2009 and many subsequent others), take-up of index insurance (e.g., Giné, Townsend and Vickery 2008; Mobarak and Rosenzweig 2012; Cole et al. 2013; Cole, Stein and Tobacman 2014; Karlan et al. 2014; Clarke 2016; Casaburi and Willis 2017) and the linkages between informal institutions and formal markets (e.g., Arnott and Stiglitz 1991; Kranton 1996; Duru 2016). Clarke (2016) studies the relation between individual risk aversion and the take-up of index insurance. He finds that demand is hump-shaped with demand for the index being higher in the intermediate risk averse region. Unlike Clarke (2016), we incorporate pre-existing risk-sharing arrangements to study their effect on the take-up.

Perhaps, most related is Mobarak and Rosenzweig (2012), who show that the existence of informal risk-sharing networks increases demand for index insurance, consistent with their empirical analysis. Our paper is distinct in several ways. Our model is microfounded, allowing for heterogeneity among individuals and endogenous decisions to join risk sharing groups. Results are based on the notion of "Effective Risk Aversion"—a consequence of efficient risk sharing. This allows us to identify new channels underlying the effect of informal schemes on demand for formal index insurance, and provides novel explanations for the two empirical puzzles based on their interactions. As mentioned previously, one of our channels relates to the increase in tolerance to basis risk, implying an increase in take-up - this reaffirms previous results found in Mobarak and Rosenzweig suggesting that informal risk sharing schemes support take-up of formal index insurance. The additional channel is connected to the increase in tolerance to aggregate gambles, implying a reduced demand for index insurance. Finally, we analyze the take-up of index insurance at the extensive margin, unlike Mobarak and Rosenzweig (2012) and Clarke (2016) who looked at the intensive margin.

The rest of the paper is organized as follows. Section 2 presents the model. Results from several analysis are contained in Sections 3 and 4. Section 5 presents testable hypotheses from our model and investigates them empirically using field experimental data for a specific index contract "rainfall insurance". Section 6 concludes. All formal proofs, tables and figures are relegated to the Appendix.

2 The Model

To investigate the coexistence and interactions between pre-existing (informal) institutional risk sharing and (formal) index-based insurance, it is crucial to specify preferences, shocks and informal arrangements in the economy.

Setup

We consider an individual i with absolute risk aversion parameter $\gamma_i > 0$ and receive utility $u_i(z) = -e^{-\gamma_i z}$ from consuming income z. The individual faces uncertain income realization according to

$$z_i = w_i + h_i$$

where w_i and h_i denotes the deterministic and the stochastic component of the individual's income. The stochastic component consists of two parts, $h_i = \varepsilon_i + v$: where ε_i is the individual's idiosyncratic risk (e.g., disease shocks), and v is the aggregate shock (e.g., drought, rainfall). As we describe below, ε_i corresponds to the part of the stochastic component which can be insured via informal risk-sharing while v corresponds to the portion that can be insured via formal index insurance. We assume the following

$$\varepsilon_i \sim N(0, \sigma_i^2)$$

$$v = \begin{cases} 0 & \text{with probability } 1-p \\ -L & \text{with probability } p \end{cases}$$

Informal risk sharing: There exists a group g that individual i has the option to join. We think of the group as a representative agent with a CARA utility function and absolute risk aversion denoted by γ_g. We denote the income realization of that group as

$$z_g(\epsilon) = w_g + h_g$$

where w_g and $h_g \sim N(0, \sigma_g^2)$ denotes the deterministic and the stochastic component of the group's income. In this case, the stochastic component can only be insured through risk-sharing arrangements. Following Udry (1990), we assume perfect information: group-idiosyncratic variances are public information and the realizations of shocks are also perfectly observed by all individuals when they occur in the society. This provides enforcement for the informal relationships.

Individual i has the choice of entering into a risk-sharing arrangement with the group. An unmatched individual receives his random income. If the individual joins the group, he can enter into a binding agreement prior to the realization of their incomes, specifying how their pooled income is going to be shared.

Index Insurance: There are no financial markets allowing any individual to insure himself against his idiosyncratic risks. However, with the introduction of index-weather based insurance it is possible to insure against v. Aggregate shocks can be insured by *formal* index-based insurance which is subject to basis risk (e.g., Cole et al. 2013). We model basis risk as in Clarke (2016):

[Table 1 about here.]

Where in Table 1: individual i suffers aggregate risk which can take the value 0 with probability $1-p$ or $-L$ with probability p. There is also an index which can take the value 1 (i.e., payout) with probability q or 0 (i.e., no payout) with probability $1-q$. As usual, the index may not be perfectly correlated with the aggregate risk and so there are four possible joint realizations of the aggregate risk and index. In this case, r denotes the probability that a negative aggregate shock is realized but the index suggests no payouts. This corresponds to the downside basis risk faced by the consumer if he purchases index insurance. Similarly, $q+r-p$ corresponds to an upside basis risk where an insured agent does not suffer an aggregate shock and yet payouts are triggered. Note that both downside and upside basis risks are increasing in r. We also assume that the index is informative about the aggregate loss that is $Prob(v=0, I=0) \times Prob(v=1, I=1) > Prob(v=0, I=1) \times Prob(v=1, I=0)$ which implies that $r < p(1-q)$.

3 Demand for Index Insurance: no informal access

Suppose that individual i is faced with the choice of either buying index insurance, denoted by **1** or not, denoted by **0**. We first consider the case where the individual does not have access to an informal risk-sharing arrangement. In order to determine demand for index insurance, we compare the certainty equivalents for buying versus not buying the index.

Formally, consider individual i whose income process is given by

$$z_i^0(\epsilon) = w_i + \varepsilon_i + v$$

where the independent shocks are

$$\varepsilon_i \sim N(0, \sigma_i^2)$$
$$v = \begin{cases} 0 & \text{with probability } 1-p \\ -L & \text{with probability } p \end{cases}$$

If individual does **not buy** the index: the expected utility of individual i is

$$\begin{aligned} E(-e^{-\gamma_i z_i^0}) &= E(-e^{-\gamma_i (w_i + \varepsilon_i + v)}) \\ &= -E(e^{-\gamma_i w_i})E(e^{-\gamma_i \varepsilon_i})E(e^{-\gamma_i v}) \\ &= -e^{-\gamma_i w_i} e^{\frac{\gamma_i^2 \sigma_i^2}{2}}([1-p] + pe^{\gamma_i L}) \end{aligned}$$

For individual i with CARA utility function with income z_i, we derive the certainty equivalent (CE_i) according to:

$$-e^{-\gamma_i CE_i} = E(-e^{-\gamma_i z_i})$$

Thus, the certainty equivalent for individual with no index insurance is given by

$$\begin{aligned} CE_i^0 &= -\frac{1}{\gamma_i} \log E(e^{-\gamma_i z_i^0}) \\ &= -\frac{1}{\gamma_i}(-\gamma_i w_i + \frac{\gamma_i^2 \sigma_i^2}{2} + \log([1-p] + pe^{\gamma_i L}) \\ &= w_i - \frac{\gamma_i \sigma_i^2}{2} - \frac{1}{\gamma_i} \log([1-p] + pe^{\gamma_i L}) \end{aligned}$$

If the individual buys insurance he pays a fixed premium π and receives a stochastic payout η which depends on the level of coverage and on the value of the index. If the individual buys index insurance and the Index=1, the insurance company pays the individual βL. For Index=0, there is no transfer from the insurance company to the individual. Thus, the actuarially fair premium is $q\beta L$. Due to loading, administrative costs and lack of competition, the premium is typically not actuarially fair. This is captured as $\pi = mq\beta L$ for $m > 1$. If the individual buys insurance, his income process is now given by:

$$z_i^1(\epsilon) = w' + \varepsilon_i + v'$$

where $w' \equiv w_i - \pi$ and $v' \equiv v + \eta$. Thus v' and ε_i are independent and the distribution of v' is given by

$$v' = \begin{cases} 0 & \text{with probability } 1-q-r \\ -L & \text{with probability } r \\ \beta L & \text{with probability } q+r-p \\ -L+\beta L & \text{with probability } p-r \end{cases}$$

So, if the individual **buys** the index: the expected utility is

$$\begin{aligned} E(-e^{-\gamma_i z_i^1}) &= E(-e^{-\gamma_i(w'+\varepsilon_i+v')}) \\ &= -E(e^{-\gamma_i w'})E(e^{-\gamma_i \varepsilon_i})E(e^{-\gamma_i v'}) \\ &= -e^{-\gamma_i w'} e^{\frac{\gamma_i^2 \sigma_i^2}{2}}([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i \beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) \end{aligned}$$

Thus, the certainty equivalent for individual with index insurance is given by

$$\begin{aligned} CE_i^1 &= -\frac{1}{\gamma_i} \log E(e^{-\gamma_i z_i^1}) \\ &= -\frac{1}{\gamma_i}(-\gamma_i w' + \frac{\gamma_i^2 \sigma_i^2}{2} + \log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i \beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) \\ &= w' - \frac{\gamma_i \sigma_i^2}{2} - \frac{1}{\gamma_i} \log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i \beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) \end{aligned}$$

Thus, the individual buys insurance if $CE_i^1 \geq CE_i^0$. Using the expressions for CEs from above this condition can be rewritten as

$$w' - \frac{\gamma_i\sigma_i^2}{2} - \frac{1}{\gamma_i}\log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i\beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) \geq w_i - \frac{\gamma_i\sigma_i^2}{2} - \frac{1}{\gamma_i}\log([1-p] + pe^{\gamma_i L})$$
$$-mq\beta L - \frac{1}{\gamma_i}\log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i\beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) \geq -\frac{1}{\gamma_i}\log([1-p] + pe^{\gamma_i L})$$
$$-\frac{1}{\gamma_i}\log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i\beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) + \frac{1}{\gamma_i}\log([1-p] + pe^{\gamma_i L}) \geq mq\beta L$$

where the second inequality uses $w' \equiv w_i - \pi$. Observe that $-\frac{1}{\gamma_i}\log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i\beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) = CE_i(v')$ i.e., the CE for individual faced with v' gamble. Equivalently:$-\frac{1}{\gamma_i}\log([1-p] + pe^{\gamma_i L}) = CE_i(v)$. Thus the individual buys index insurance if

$$CE_i(v') - CE_i(v) \quad \geq \quad mq\beta L$$

We obtain the individual's decision to buy the index in two ways: small losses (analytically) versus large losses (numerically).

3.1 Small Losses:

Let's suppose losses are small. Then, we can approximate the CEs as follows

$$CE_i(v) \quad \approx \quad -pL - \frac{1}{2}\gamma_i\sigma_v^2$$

and

$$CE_i(v') \quad \approx \quad -pL + \beta Lq - \frac{1}{2}\gamma_i\sigma_{v'}^2$$

where the variances of v and v' are σ_v^2 and $\sigma_{v'}^2$ respectively. This means the individual buys the index if the following condition is satisfied

$$\frac{1}{2}\gamma_i(\sigma_v^2 - \sigma_{v'}^2) \quad \geq \quad (m-1)q\beta L$$

Since $m > 1$, the RHS is always positive. For $\sigma_{v'}^2 \geq \sigma_v^2$ the LHS is non-positive and hence the individual will not buy index insurance. $\sigma_{v'}^2$ captures two parts: reduction in variance from buying insurance and an increase in variance due to the presence of basis risk. It is therefore possible for $\sigma_{v'}^2 \geq \sigma_v^2$ depending on these effects. However even for $\sigma_{v'}^2 < \sigma_v^2$ the individual may not buy index insurance for low values of γ_i. Thus, there exist a threshold $\gamma^* = \max(0, \frac{2(m-1)q\beta L}{\sigma_v^2 - \sigma_{v'}^2})$ such that the individual with risk aversion parameter $\gamma_i < \gamma^*$ will not buy the index insurance. Since the index insurance is actuarially unfair $m > 1$ the individual suffers a reduction in expected income. However, there is a change in variance from buying index insurance. The individual compares these two forces. If the variance does not decrease then nobody buys the index. But if the variance decreases, then individuals with high risk aversion will assign more weight to this reduction in variance; hence will buy the index. Whereas for individuals with low risk aversion, this reduction in variance may not be enough to compensate for the loss in expected income; hence will not buy the index. The above discussion is summarized in Proposition 1 below

PROPOSITION 1: Consider an individual with CARA utility function and risk aversion parameter $\gamma_i > 0$. Under small losses and actuarially unfair index insurance $m > 1$, the following two results hold.

(1) The individual will purchase an index cover β *iff* $\frac{1}{2}\gamma_i(\sigma_v^2 - \sigma_{v'}^2) \geq (m-1)q\beta L$

(2) In particular, if $\sigma_{v'}^2 < \sigma_v^2$ the individual will purchase the index *iff* $\gamma_i > \gamma^* = \max(0, \frac{2(m-1)q\beta L}{\sigma_v^2 - \sigma_{v'}^2})$

3.2 Large Losses

So far we have been analyzing the implications of informal arrangements on the decisions to buy index insurance assuming small losses. In this subsection, we extend the analysis to the case of large losses. It is still the case that an individual with risk aversion γ_i if acting individually chooses to buy the index insurance if

$$CE_i(v') - CE_i(v) \quad \geq \quad mq\beta L$$

which is equivalent to

$$-\frac{1}{\gamma_i}\log([1-q-r] + re^{\gamma_i L} + [q+r-p]e^{-\gamma_i \beta L} + [p-r]e^{-\gamma_i(-L+\beta L)}) + \frac{1}{\gamma_i}\log([1-p] + pe^{\gamma_i L}) \geq mq\beta L$$

We illustrate the condition numerically in Figure 1. The red curve represents the left side of the inequality that is the difference in the CEs while the green line represents the right side of the inequality: $mq\beta L$. The x-axis represents different values for risk aversion, indicating that individuals with risk-aversion levels in between the two vertical black lines purchase index insurance. Unlike the case of small loses, the decision to buy index insurance is bounded between two $\gamma-$ thresholds. Within this interval, the above inequality is satisfied and individuals purchase the index cover. Next, observe that individuals with sufficiently high or low risk-aversion will choose not to buy index insurance. The simple intuition is that high risk-averse individuals do not buy because of the basis risk while low risk-averse individuals choose not to buy because of loading of premium ($m > 1$). This is similar to the findings of Clarke (2016) who examines purchases of index insurance at the intensive margin.

4 Demand for Index Insurance: informal group access

4.1 Informal Risk Sharing

This subsection discusses the informal risk sharing arrangements before the introduction of index insurance. Since our set up has a non-transferable utility (NTU) representation, we first show that the model has a transferable utility (TU) representation under certainty equivalents (CE). The set-up is NTU because of the heterogeneity in risk-aversion where one unit of income yields utility $u_i(1) = -exp(-\gamma_i)$ for an individual i with risk aversion γ_i, but utility $u_g(1) = -exp(-\gamma_g) \neq u_i(1)$ for a representative agent acting for the group g with risk aversion γ_g. We work with certainty equivalent units, which allows for TU representations. This is stated in the following Lemma.

LEMMA 1: The NTU model has a TU representation, where CEs are transferable across individuals (i, g).

Next, since CE is transferable, we also have the following lemma.

LEMMA 2: Suppose individual i decides to join the group g and risk is shared efficiently between them. Then under transferable CEs we can think of the pair (i, g) as a representative agent with risk aversion parameter γ_{i^*} where $\frac{1}{\gamma_{i^*}} = \frac{1}{\gamma_i} + \frac{1}{\gamma_g}$. This implies that $\gamma_{i^*} < \min(\gamma_i, \gamma_g)$.

Lemma 2 allows us to conveniently analyze the decision of individual i to take index insurance in the presence of risk sharing arrangements. It also shows that the risk aversion of the individual i will be effectively lower if he is in a group, as compared to if he was acting as an individual. The latter is summarized in Definition 1 below.

DEFINITION 1: γ_{i^*} as "Effective Risk Aversion": This refers to the risk aversion parameter for a representative agent i^* representing group consisting of (i, g) that shares risk efficiently.

REMARK: We can now examine whether it is optimal for individual i to join the group g. To do this we compare the CE of the group if they were sharing risk efficiently to the sum of CEs for the individual i and group g if they were acting separately. Indeed, joining the group provide welfare gains to the individual (and the group). The argument is similar to Wilson (1968). For contradiction: suppose that i and g are un-matched, then i and g can form a pair where each consumes his income. In this case, each is at least as well-off in the pair, as compared to remaining unmatched. However, by the mutuality principle, both can be better-off when in the group. This requires their income shares to rise and fall together with the independent random part of their incomes. The following lemma formally shows that if is efficient for i and g to form a pair.

LEMMA 3: Suppose risk is shared efficiently within a group. Then it is efficient for individual i to join group g.

4.2 Extensive Margin 0-1: with informal group access

Consider now the demand for index insurance for the individual who has access to informal risk-sharing arrangement. From LEMMA 2, this is the same as the demand for index insurance of a representative agent with risk aversion parameter γ_{i^*} where $\frac{1}{\gamma_{i^*}} = \frac{1}{\gamma_i} + \frac{1}{\gamma_g}$. Thus, we can apply the preceding analysis to evaluate the decision of an individual in a group to purchase index insurance.

The representative agent's income process in the absence of index insurance is given by

$$z_{i^*}^0 = w_i + w_g + h_g + \varepsilon_i + v$$

If individual does **not buy** the index: the expected utility of representative agent is

$$E(-e^{-\gamma_{i^*} z^0_{i^*}}) \quad = \quad -e^{-\gamma_{i^*}(w_i+w_g)} e^{\frac{\gamma^2_{i^*}(\sigma^2_i+\sigma^2_g)}{2}}([1-p]+pe^{\gamma_{i^*}L})$$

and the certainty equivalent with no index insurance is given by

$$CE^0_{i^*} \quad = \quad w_i + w_g - \frac{\gamma_{i^*}(\sigma^2_i+\sigma^2_g)}{2} - \frac{1}{\gamma_{i^*}} \log([1-p]+pe^{\gamma_{i^*}L})$$

Next, if individual **buys** index insurance, the group's income process is now given by:

$$z^1_{i^*} = w' + h_g + \varepsilon_i + v'$$

where $w'_{i^*} \equiv w_i + w_g - \pi$ and $v' \equiv v + \eta$.

If the individual buys the index: the expected utility of the representative agent is

$$E(-e^{-\gamma_{i^*} z^1_{i^*}}) \quad = \quad -e^{-\gamma_{i^*} w'_{i^*}} e^{\frac{\gamma^2_{i^*}(\sigma^2_i+\sigma^2_g)}{2}}([1-q-r]+re^{\gamma_{i^*}L}+[q+r-p]e^{-\gamma_{i^*}\beta L}+[p-r]e^{-\gamma_{i^*}(-L+\beta L)})$$

The certainty equivalent for the representative agent with index insurance is given by

$$CE^1_{i^*} \quad = \quad w'_{i^*} - \frac{\gamma_{i^*}(\sigma^2_i+\sigma^2_g)}{2} - \frac{1}{\gamma_{i^*}} \log([1-q-r]+re^{\gamma_{i^*}L}+[q+r-p]e^{-\gamma_{i^*}\beta L}+[p-r]e^{-\gamma_{i^*}(-L+\beta L)})$$

Thus, the individual buys insurance if $CE^1_{i^*} \geq CE^0_{i^*}$ which we can rewrite as

$$CE_{i^*}(v') - CE_{i^*}(v) \quad \geq \quad mq\beta L$$

where $-\frac{1}{\gamma_{i^*}} \log([1-q-r]+re^{\gamma_{i^*}L}+[q+r-p]e^{-\gamma_{i^*}\beta L}+[p-r]e^{-\gamma_{i^*}(-L+\beta L)}) = CE_{i^*}(v')$ and $-\frac{1}{\gamma_{i^*}} \log([1-p]+pe^{\gamma_{i^*}L}) = CE_{i^*}(v)$.

Using the approximation for small losses, the index insurance purchase rule is

$$\frac{1}{2}\gamma_{i^*}(\sigma^2_v - \sigma^2_{v'}) \quad \geq \quad (m-1)q\beta L$$

The next result evaluates the impact of informal risk sharing arrangement on the take-up of index insurance.

PROPOSITION 2: Consider an individual with risk aversion parameter γ_i who joins a group with parameter γ_g. Then, under small losses and actuarially unfair index insurance $m > 1$, the following results hold.

(1) Independent of his presence in the group, the individual i will not purchase index insurance if $\gamma_i < \gamma^*$.

(2) Independent of his risk aversion parameter γ_i, the individual i will not purchase index insurance if $\gamma_g \leq \gamma^*$.

(3) However, the individual may buy index insurance if $\gamma_i \geq \gamma^*$ and $\gamma_g \geq \gamma^*$ are satisfied. Particularly, he buys the index cover in the presence of the group if $\sigma^2_{v'} < \sigma^2_v$ and $\gamma_{i^*} = \frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} > \gamma^* = \max(0, \frac{2(m-1)q\beta L}{\sigma^2_v - \sigma^2_{v'}})$.

Proposition 2 shows that informal risk-sharing arrangements can impede the discrete (0-1) take-up of index insurance. The intuition is based on the fact that the "effective" risk aversion of individuals forming a group are lower than the risk aversion of the individuals if they were acting individually. Essentially the group lowers the individual's aversion to risk (Lemma 2) which in turn might move the individual from a purchase zone to the non-purchase zone based on γ^*.

4.3 The Case of Large Losses

The results from Proposition 2 can be modified to fit the case of large losses. When losses are small, an individual $i's$ decision to not buy index insurance remain unchanged in the presence of informal arrangements. However if losses are large, our theory suggests that informal insurance might facilitate in taking up of index insurance. This happens for instance if an individual is initially too risk averse to buy index insurance on his own, however in the presence of informal arrangements his effective risk aversion might be such that he ends up purchasing the index cover. To illustrate, consider Figure 1. An individual with risk aversion parameter 6 would not have purchased the index insurance if he was acting individually. However if he pairs with a group that brings his effective risk aversion to the range (0.8, 4.7), then he chooses to purchase the index cover. We also see that it is possible that informal insurance acts as a barrier to take up. For example, consider an individual with risk aversion parameter 3. Acting individually, he will buy the index insurance, however if the presence of a risk-sharing arrangement reduces his effective risk aversion to below 0.8, then he will choose not to buy the index insurance. The analysis provides explanations and predictions for several empirical findings which are discussed in the next section.

5 Model-Implications and Experimental Evidence

Our theoretical evaluation of the interaction between informal risk sharing schemes and demand for index insurance provide several testable hypotheses with implications for the design of index insurance contracts. This section discusses the emerging hypothesis and explores them empirically combining field experimental data from multiple sources for a specific index contract "rainfall insurance". We begin with a discussion of the testable hypotheses, and then follow this with a description of the data and experimental design. For each hypothesis, we present the testing procedure and the resulting empirical results.

5.1 Discussions, and testable implications

First, why might more risk averse individuals not take up index insurance? Our framework suggests a plausible answer. *Absent* risk-sharing arrangements, low take-up among high risk averse individuals may be due to aversion to basis risk (Clarke 2016). However, another plausible reason may be due to the *presence* of informal risk sharing groups (i.e., based on our theory, Section 4). The presence of risk sharing groups leads to effective reduction in an individual's risk aversion, making him more tolerant towards aggregate risk and more sensitive to the price of index insurance. For this reason, more risk averse people may end up not buying index insurance, as compared to an individual with the same risk aversion parameter who might take it up if the individual was unmatched.

Second, why is the take-up for index insurance unexpectedly low? Possible answers lie in the role of existing informal arrangements. In particular, (1) When does informal arrangement *support* the index take up? Our analysis suggests that high risk averse individuals in risk sharing arrangements containing intermediate risk averse members are more likely to purchase index insurance. Acting alone, basis risk will act as a disincentive to the take-up of index insurance; however, the presence of the group makes the individual more tolerant to basis risk; (2) When does informal pairing not-*support* index take up? From our analysis, low to intermediate risk averse individuals that enter any risk sharing group are less likely to purchase index insurance. Their effective risk aversion is lower, and thus has lower willingness to pay for index insurance. The above discussions lead to the following sets of predictions.

Prediction #1: The link between informal risk-sharing and the take of index insurance is ambiguous. This is because of the existence of the two identifiable forces: sensitivity to either basis risk or price of the index contract. Ultimately, the overall impact of informal risk-sharing schemes on the demand for index insurance depends on which of these two forces dominate.

Prediction #2: Informal risk-sharing is more likely to complement the take-up of index insurance in regions with high aggregate (especially, if un-insurable by group) and basis risk. This follows because the presence of an informal risk sharing group helps to make the individual more tolerant to the basis risk, holding other forces constant. In addition, in the presence of risk-sharing arrangements, the sensitivity of index demand to price changes is higher, as individuals become effectively less risk averse.

Prediction #3: The take-up for index insurance may be higher if the size of the group is smaller. This is because smaller groups are likely more risk averse, all else equal. For instance, under small losses (e.g., relative to w and ε), villages where there are more informal transfers, which can be proxied by the number of pairs in our model, are likely to see lower take-ups once price and basis risk are controlled for. With controls for price effects and basis risk, individual's risk aversion from joining the larger group may be effectively lower leading to less demand for insurance. This prediction contradicts those that connect information diffusion and group size.

5.2 Data and sources

Ideally, we require data about the demand for index insurance contracts, informal risk sharing, a measure of basis risk, insurance premiums, and risk aversion. For this purpose, we draw on available data sets from a panel of experimental trials that were conducted across randomly selected rural farming households and villages in Gujarat, India.[5] Data on risk aversion come from Cole et al. (2013), which is based on field experiments across 100 villages in 2006/2007. The measure of risk aversion follows Binswanger (1980), whereby respondents are asked to choose among cash lotteries varying in risk and expected return. The lotteries were played for real money, with payouts between zero and Rs. 110. The lottery choices are then mapped into an index between 0 and 1, where high values indicate greater risk aversion.[6]

From Cole, Tobacman and Stein (2014), we obtain data about the take-up of index insurance, premiums, and premium discounts available between 2006-2013 for 60 villages cumulatively. Most of these villages and households overlap with the 100 villages in Cole et al. (2013). This allows us to match households and villages between the two data sets. Our

[5] All villages are located within $30km$ of a rainfall station. Design of rainfall insurance contracts uses information from these rainfall stations.

[6] A value 1 is assigned to individuals that choose the safe lottery. For those who choose riskier lotteries, the $[0, 1)$ mapping indicates the maximum rate at which they are revealed to accept additional risk (standard deviation) in return for higher expected return ($\frac{\Delta E}{\Delta risk}$). Additional details are available in Cole et al. (2013).

final data are merged from these two sources. We summarize the timeline of the rainfall-index insurance experiments and the available data in Figure 2 (of the Appendix).

5.2.1 Rainfall-index contracts and experimental setting

The specific index insurance contract that we examine is "rainfall insurance" whose payouts are based on a publicly observable rainfall index. This contract provides coverage against adverse rainfall events (i.e., covering drought and flood) for the summer ("Kharif") monsoon growing season. Design of this contract is based on daily rainfall readings at local rainfall stations, specifying payouts as a function of cumulative rainfall during fixed time periods over the entire June 1-August 31 Kharif season. Typically, the maximum possible payout for a unit-policy is about Rs. 1500. Households have the option to purchase any number of policies to achieve their desired level of insurance coverage. The contracts are offered and paid-out year-to-year, whereby a marketing team visits households in the selected sample each year in April-May to offer the insurance policies. Households are required to opt-in to re-purchase each year to sustain their coverage.

"Group Identity" as risk-sharing proxy: The marketing teams for rainfall insurance used multiple strategies to sell the policies. Their strategies include the use of flyers, videos, and discount coupons, and involved randomization of these three marketing methods at the household level. More importantly, flyers were randomized along two dimensions with the aim of testing how formal insurance interacts with informal risk-sharing arrangements (cf: Cole et al. 2013). The flyers emphasized and provided cues on "group identity", which has been found to be key for informal risk-sharing (Karlan et al., 2009). The treatments for group identity included:[7]

> **Religion** (Hindu, Muslim, or Neutral): *A photograph on the flyer depicted a farmer in front of a Hindu temple (Hindu Treatment), a Mosque (Muslim Treatment), or a neutral building. The farmer has a matching first name,*

[7] More details of the data and group treatments are available in our two primary sources of data: Cole et al. (2013); Cole, Tobacman and Stein (2014).

which is characteristically Hindu, characteristically Muslim, or neutral.

Individual or Group (Individual or Group): *In the Individual treatment, the flyer emphasized the potential benefits of the insurance product for the individual buying the policy. The Group flyer emphasized the value of the policy for the purchaser's family.*

Note that the use of cues on group identity as a proxy for risk-sharing has been used in previous literature (e.g., Cole et al. 2013), which we follow here. While such approach may have the downside of not capturing actual risk-sharing since people generally choose who to group and share risk with (possibly, over and beyond religious and family lines), it has an empirical appeal: it allows for randomization of risk-sharing which is extremely useful for identification purposes, at least, as compared to cases where groups form endogenously and share risk.

5.2.2 Measuring basis risk

Each season, households were asked if they had experienced crop loss due to weather in the household panel experiments. We combine this with unique market information about whether the household i located in village v in a contract year t received an insurance payout to define a measure of basis risk

$$briskDOWNSIDE_{ivt} = \mathbf{1}(loss_{ivt} > payout_{ivt})$$
$$briskUPSIDE_{ivt} = \mathbf{1}(loss_{ivt} < payout_{ivt})$$

which are indicators that capture the potential mismatch or discrepancy between insurance payouts and the actual crop loss or income loss suffered by the policy holder prior to the payout decisions. For instance, this may be due to the fact that the measured rainfall index is imperfectly correlated with rainfall at any individual farm plot. As illustrated, our measure of basis risk allows for the distinction between upside and downside risks, and follows directly from previous discussions in Section 2.[8]

5.2.3 Summaries

The summary statistics of all relevant variables in our sample are reported in Table 2. The first two moments and order statistics of each variable are displayed. As shown, the data is made up of information about the demand for rainfall-index insurance, premium and randomized discounts, crop and revenue loss experience of households, treatments for risk-sharing as proxied by cues on "group identity", and basis risks, respectively. The overall data spans 2006-2013, covering 645 households across a pool of 60 villages. Considerable variations exist among the variables which we shall exploit for identifying variation. Our main outcome of interest is binary, denoted "Bought". Bought is defined based on whether households purchased index insurance in given market year. In our sample, about 39% of households bought rainfall-index insurance over the entire panel period.

The average risk aversion is 0.53 with a standard deviation of about 0.32. The overall share of households that received cues on Group, Hindu and Muslim treatments are about 4.0%, 2.8% and 2.9%, respectively. Our measure of basis risk that relies on the mismatch between pre-insurance crop losses and index payouts suggest higher relative frequency for downside basis risk (25.5%), as compared to upside basis risk (8.2%). For our basis risk measure that relies on the mismatch between pre-insurance revenue losses[9] and index payouts, the relative frequency of downside and upside basis risks are quite close. A visual illustration for both downside and upside basis risks are shown in Figure 3. Empirical tests for the various predictions combine these variables with exogenous variations induced by the random

[8] Since crop losses (but not payouts) are self-reported, there is a potential tendency for households to misreport, e.g., overstate losses, and thus might impact our measurement of basis risk up/down. To assess such potential misreporting, we regress households reported-crop loss experience on a vector of seventeen (17) household characteristics: spanning socio-demographics, educational level, asset holdings, access to formal insurance, per capita monthly expenditure, risk aversion, and indicators for whether a respondent has a muslim name and irrigates the farm. Results are reported in Table 15. None of these 17 variables is statistically significant at conventional levels, an evidence inconsistent with misreporting. The evidence is more consistent with a reporting behavior whereby crop losses occur due to weather shocks and then households report them as such. This finding hold across the wide range of model specifications, which differ based on the included controls.

[9] Revenue is measured for market years in which households reported a crop loss, and captures the "amount" of crop loss: calculated as the difference between that market year's agricultural output and the mean value of output in all previous years where crop loss was not reported.

assignment of price discounts and risk-sharing marketing treatments.[10]

5.3 Empirical tests and results

The testing procedure and empirical results are presented in this section. Additional robustness checks on our main results are discussed.

5.3.1 Empirical strategy and results: predictions #1 and #2

To test predictions #1 and #2, we estimate a model that links changes in take-up for index insurance $D_{ivt} = \mathbf{1}(bought = Yes)_{ivt}$ to the vector of risk-sharing treatments $\boldsymbol{RShare}_{ivt}$ and their unrestricted interaction with basis risk $brisk_{ivt}$ and exogenous variation in the price for insurance $Discount_{ivt}$

$$D_{ivt} = \gamma \boldsymbol{RShare}_{ivt} \times brisk_{ivt} + \beta_d Discount_{ivt} + \mu_i + \delta_t + \epsilon_{ivt}$$

$$D_{ivt} = \gamma \boldsymbol{RShare}_{ivt} \times Discount_{ivt} + \beta_b brisk_{ivt} + \mu_i + \delta_t + \epsilon_{ivt}$$

where i, v and t index the household, village and market year respectively. This specification includes a set of unrestricted household dummies, denoted by μ_i, which capture unobserved differences that are fixed across households such as access to other forms of insurance. The market-year fixed effects, δ_t control for aggregate changes that are common across households, e.g. prices, and national policies. Our key parameter of interest γ is identified by household-level exogenous variation in the various treatments for risk-sharing and their interactions with the two forces: basis risk and insurance premium. Errors are clustered at the village level to allow for arbitrary correlations.

The results are reported separately for the two measures of basis risk: crop-loss mismatch with index payouts versus revenue-loss mismatch with index payouts. For the first Equation, which interacts risk sharing with basis risk, Tables 3 and 4 contain the estimates for crop-

[10]Ensuring balance across risk-sharing treatment groups e.g., assignment of group, Hindu and muslim cues is crucial for the experimental results. We ascertain balance using observable characteristics of the households. In Table 16 of the Appendix, we test whether the various household characteristics significantly differ across the risk sharing treatments. The results provide strong evidence in favor of balance (except for about two variables which are barely significant at 10% level).

mismatch while Tables 5 and 6 contains the estimates for revenue-mismatch. Columns differ based on the included risk-sharing treatments and interactions with basis risk, and controls for premium discount and upside basis risk. In Tables 3 and 5, columns (2)-(4) include the various interaction terms, while column (1) omits the interactions. However, in Tables 4 and 6, column (1) includes the various interaction terms with basis risk, column (2) adds a control for premium discount, while column (3) adds controls for both premium discounts and upside basis risk.

Downside basis risk is negative and significant at conventional levels, upside basis risk is significantly positive, and premium discount is significantly positive across all specifications. The estimated price discount effects range between 0.0032 - 0.0035; with an average estimate of about 0.0034. An average estimate of 0.0034 implies that a 10 percent decline in the price of index insurance increases the probability of purchase by 0.034 percentage points, or 0.113 percent of the conditional mean take-up rate (~0.30). The implied elasticity is 0.0113. While households negative demand-response to downside basis risk is substantial, this is less than their positive response to upward basis risk. Turning to our key coefficients of interest, there is evidence that informal risk-sharing significantly supports the take-up of index insurance, and that when downside basis risk is high risk-sharing increases the index demand by 13.0% points (column 4; Table 3) to 40.1% points (column 4; Table 6).

Next, for the second equation, which interacts risk sharing with exogenous changes in premium, the results for crop-mismatch are contained in Tables 7 and 8, and those for revenue-mismatch are in Tables 9 and 10. Again, across all model specifications, downside basis risk is significantly negative, upside basis risk is positive and large, and premium discount is positive. For our main coefficients of interest, there is evidence that the existence of risk-sharing arrangement makes individuals more sensitive to price changes since both the direct and interaction terms on discount are positive. For example, when group cues are combined with discounts (Table 7; column 4), the sensitivity increases by about 10.1 percentage points which implies an increased elasticity of 0.337.

In addition, there is evidence that informal risk-sharing significantly either support or not-support the take-up of rainfall-index insurance. For instance, while Group cues has negative effect on index take-up (column 4; Table 7), Group cues treatment combined with Muslim cues has a significant positive effect on take-up (column 3; Table 8). However, when the various risk-sharing cues are combined with premium discount, most of the terms have significant positive effect on the take-up of insurance.

Taken together, these results (i.e., Tables 3-10) provide evidence that informal risk-sharing has ambiguous effects on index take-up, empirically. With high downside basis risk, informal networks increase take-up, but under price effects, informal networks may have negative effect on take-up; making the overall impact of risk-sharing on the take-up of index insurance ambiguous. As shown in Proposition 2, risk aversion plays a central role in explaining these effects. Thus, we turn to the role of risk aversion in the subsequent analysis.[11]

5.3.2 Empirical strategy and results: prediction #2

We modify previous specifications to investigate how risk aversion (effective) interacts with the two forces: sensitivities to either basis risk or insurance premium

$$D_{ivt} = \gamma riskAversion_{ivt} \times brisk_{ivt} + \beta_d Discount_{ivt} + \mu_i + \delta_t + \epsilon_{ivt}$$

$$D_{ivt} = \gamma riskAversion_{ivt} \times Discount_{ivt} + \beta_b brisk_{ivt} + \mu_i + \delta_t + \epsilon_{ivt}$$

where all the terms are defined similarly as in previous sections, and errors are clustered at the village level. The results are reported in Table 11. Columns differ based on the included interactions with risk aversion. Column (1) uses market year dummies to control for potential sensitivity to changes in premium, and includes an interaction between basis

[11] Since our theoretical analysis relies on CARA (with a simplifying property of no wealth effects), we examine how sensitive or robust our main results are to potential wealth effects. To do this, we re-estimate our empirical model with an additional control for households wealth. We used Factor analysis to estimate the wealth of housholds based on eight (8) asset holdings or ownership: **1**(Electricity=Yes), **1**(Mobile Phone=Yes), **1**(Sew Machine=Yes), **1**(Tractor=Yes), **1**(Thresher=Yes), **1**(Bull cart=Yes), **1**(Bicycle=Yes), and **1**(Motorcycle=Yes); where **1**(.) is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Figure 5 shows the estimated distribution of wealth. The implied results are also shown in Tables 17 and 18. The estimate on wealth is positive but not significant. However, the estimates for our key parameter of interest γ are similar to the main results (i.e., very close and well within the confidence intervals of the main estimates).

risk and risk aversion. This interaction allows us to focus on the response of basis risk to changes in risk aversion I.e., we ask whether increase in risk aversion alter the demand-response to basis risk. In columns (2)-(3), we directly control for potential sensitivity to basis risk, and include interactions between premium discounts and risk aversion to evaluate how households sensitivity to prices respond to changes in risk aversion.[12]

Note that the direct coefficient on risk aversion is not estimable (but its interaction with other variables are) since we included household-level dummies which soaks-up any fixed household-level terms. From column (1), downside basis risk has significant negative effect on take-up (-12.0% points); its interaction with risk aversion is also negative (but not significant at conventional levels). This seems to suggest that, after controlling for price effects, an increase in individual's risk aversion increases the negative sensitivity of index take-up to increases in basis risk. The result that basis risk when combined with risk-sharing cues positively affect take-up (Table 3 and 6; Muslim cues) can be explained by this negative effect of risk aversion on basis risk . Recall that joining a group effectively reduces individual's risk aversion (LEMMA 2).

The results in columns (2)-(3) show that premium discounts have significantly positive impact on take-up, increasing index take-up by 0.369 to 0.396 percentage points (similar to previous estimates). The interaction with risk aversion is negative. The negative sign implies that increasing risk aversion has negative effect on the positive impact of premium discounts on insurance demand (although not statistically significant) and vice versa. This likely explains the positive effect of premium discount when combined with the various risk-sharing cues on index take-up (Tables 7-10), when combined with the result in LEMMA 2.

[12]There is an empirical appeal to use the observed risk aversion values here (rather than the theory-derived risk aversion values). The sample is at the individual household level with larger size for the observed values. We do not have to calculate risk aversion values at the village level–which is an approach we will have take to obtain the theory-based values. Figure 4 illustrates the distribution of observed vs theory-derived risk aversion values.

5.3.3 Empirical strategy and results: prediction #3

We evaluate prediction #3 by linking observed changes in take-up for index insurance to a measure of group-size while controlling for the effect of basis risk and variations in insurance premium at the village level,

$$D_{vt} = \gamma GSize_{vt} + \beta_b brisk_{vt} + \beta_d Discount_{vt} + \mu_v + \delta_t + \epsilon_{vt}$$

where group size, $GSize_{vt}$, is defined as the number of households that received cues on "group identity" per village. μ_v are village-level fixed effects, capturing time-invariant potential unobserved heterogeneity. The results for alternative model specifications are reported in Tables 12-14. Our preferred specification is column (4), which examines the effect of group size on the demand for index insurance along with full controls for downside basis risk, upside basis risk and premium discounts. These additional controls are meant to soak-up household sensitivities to both basis risk and insurance premium within the framework of our theoretical model.

Consistent with prediction #3, the estimate on group size is negative, statistically significant across all specifications, and hold across alternative measures of group size which are based on the various risk-sharing treatments. Estimates from our preferred specification suggest that providing cues on "group identity" for an additional household in a village will result in about 2.8% points decrease in index take-up, all else equal (column 4; Table 12).[13] This represents 5.9% reduction in insurance insurance take-up, relative to the conditional mean defined over the entire sample period. The negative effects of group size on take-up are much larger in the model specification that controls for only downside basis risk (column 1). This is expected and can be understood based on our theory: the countervailing force to reduced index demand is "upside basis risk" when individuals become effectively less

[13] We examine the sensitivity of our main results to potential wealth effects by including wealth as a control. Results are displayed in Tables 19 and 20. The estimate on wealth is positive but hardly significant. However, the estimates on group size are negative, significant and very close to our baseline results.

risk averse following more group exposure. Thus, controlling to eliminate this force should yield larger negative effects of increasing group size. Next, as expected, the results indicate that downside basis risk significantly reduces the demand for index insurance (about 10% points), upside basis risk increases index take-up (about 62% points), while offering premium discounts significantly increase the take-up (approximately 0.33%).

These results are inconsistent with theoretical and empirical findings in studies of information diffusion which will predict increased uptake of index insurance with an increase in exposed group size (e.g., Jackson and Yariv 2010; Banerjee et al. 2013).

6 Conclusions

Our evaluation of the effect of informal risk sharing schemes on the take-up for index insurance, documents that the effects are ambiguous and driven by two forces: sensitivities to basis risk and insurance premium, which operate through risk aversion. In our model, we consider the case of an individual who endogenously chooses to join a group and make decisions about index insurance. The presence of an individual in a risk sharing arrangement reduces his risk aversion, termed "Effective Risk Aversion". We appeal to this phenomenon of "Effective Risk Aversion" to establish that such reduction in risk aversion can lead to either reduced or increased take up of index insurance, and emphasize how these results provide alternative explanations for two empirical puzzles: unexpectedly low take-up for index insurance and demand being particularly low for the most risk averse. Our model provide several testable hypotheses with implications for the design of index insurance contracts. Drawing on data from a panel of field experimental trials in India, we provide evidence for several predictions that emerge from our analyses.

Our study is an initial step towards the broader understanding of the linkages between informal risk-sharing and the market for formal index insurance. In ongoing research, we test the predictions from the model both in the laboratory and the field. Further, we aim to draw on the literature on network analysis and multi-dimensional matching to analyze the interactions between index insurance and informal arrangements to inform the design of policy and index contracts. This line of work has broader implications for the design and introduction of insurance and financial contracts that aim at mitigating environmental risks among low-income societies.

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7 Appendix 1

Proof of Lemma 1

The proof for Lemma 1 is similar to arguments in Wang (2014).

Let z_i and z_g denote the income of individual i and representative individual g. Suppose i and g form a pair. We denote the combined income of the pair, $z_{i^*} \equiv z_i + z_g$. If i wishes to promise utility ξ to his partner g, then the corresponding efficient sharing rule $(z_{i'} - s(z_{i^*}, \xi),\, s(z_{i^*}, \xi))$ must satisfy

$$s^*(z_{i^*}, \xi) \equiv \arg\max_s Eu_i(z_{i^*} - s) \quad s.t. \quad Eu_g(s) \geq \xi \tag{1}$$

Varying ξ, the solutions s^* describe the set of efficient sharing rules.

Let $f(z_{i^*})$ denote the joint density function for combined income. Plugging in the utility functions of the individuals allows us to restate the above optimization program as

$$\max \int -e^{-\gamma_i (z_{i^*} - s(z_{i^*}))} f(z_{i^*}) dz$$
$$s.t. \int -e^{-\gamma_g s(z_{i^*})} f(z_{i^*}) dz \geq -e^{-\xi}$$

The inequality in the constraint will hold with equality since transferring income to individual g comes at the cost of reducing i's income.

Solving the constrained optimization problem gives us

$$s^*(z_{i^*}) \quad = \quad \frac{\gamma_i}{\gamma_i + \gamma_g} z_{i^*} + \frac{1}{\gamma_g} \log\left(\int -e^{-\frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} z_{i^*}} f(z_{i^*}) dz\right) + \frac{1}{\gamma_g} \xi$$

This allows us to rewrite individual i's expected utility as

$$Eu_i(\xi) \quad = \quad -e^{\frac{\gamma_i}{\gamma_g} \xi} \left(\int -e^{-\frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} z_{i^*}} f(z_{i^*}) dz\right)^{\frac{\gamma_i + \gamma_g}{\gamma_g}}$$

where as individual g's expected utility can be written as

$$Eu_g(\xi) \quad = -e^{-\xi}$$

For individual i with CARA utility function with income z_i, there is a simple relation between the certainty equivalent (CE_i) and the expected utility:

$$-e^{-\gamma_i CE_i} = E(-e^{-\gamma_i z_i})$$

which gives us

$$CE_i = -\frac{1}{\gamma_i} \log E(e^{-\gamma_i z_i})$$

We apply this to the efficient risk sharing problem to get

$$CE_g = \frac{\xi}{\gamma_g}$$

and

$$CE_i = -(\frac{1}{\gamma_i} + \frac{1}{\gamma_g}) \log(\int -e^{-\frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} z_{i^*}} f(z_{i^*}) dz) - \frac{1}{\gamma_g} \xi$$

Thus we observe that increasing certainty individual of individual g by one unit leads to a reduction in certainty equivalent of individual i by one unit. Hence certainty equivalents are transferable across individuals and since expected utility is a monotonic transformation of certainty equivalent, we get that the expected utility is transferable as well. This concludes the proof of Lemma 1.

Proof of Lemma 2

From the proof of Lemma 1, we found that if risk is shared efficiently then we get

$$\begin{aligned} CE_i + CE_g &= -(\frac{1}{\gamma_i} + \frac{1}{\gamma_g}) \log(\int -e^{-\frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} z_{i^*}} f(z_{i^*}) dz) \\ &= -\frac{1}{\gamma_{i^*}} \log(\int -e^{-\gamma_{i^*} z_{i^*}} f(z_{i^*}) dz) \\ &= -\frac{1}{\gamma_{i^*}} \log E(e^{-\gamma_{i^*} z_{i^*}}) \end{aligned}$$

With TU, the sum of the CEs correspond to the joint maximization of the group (i, g)'s welfare. From the last equality, this is identical to the maximization problem of a representative individual with risk aversion parameter $\gamma_{i^*}$and income process z_{i^*}.

Further, since $\frac{1}{\gamma_{i^*}} = \frac{1}{\gamma_i} + \frac{1}{\gamma_g}$ we have that $\gamma_{i^*} = \frac{\gamma_i \gamma_g}{\gamma_i + \gamma_g} < \min(\gamma_i, \gamma_g)$.

Proof of Lemma 3

Let CE_g^0, CE_{i*}^0 denote the certainty equivalent for the group g without individual i and the certainty equivalent for group g with individual i joining respectively. We want to show that $CE_{i*}^0 > CE_g^0 + CE_i^0$. Notice that:

$$CE_{i*}^0 \quad = \quad w_i + w_g - \frac{\gamma_{i^*}(\sigma_i^2 + \sigma_g^2)}{2} - \frac{1}{\gamma_{i^*}} \log([1-p] + pe^{\gamma_{i^*} L})$$

and

$$CE_g^0 \quad = \quad w_g - \frac{\gamma_g \sigma_g^2}{2}$$

Hence it is sufficient to show that

$$\begin{aligned} w_i + w_g - \frac{\gamma_{i^*}(\sigma_i^2 + \sigma_g^2)}{2} - \frac{1}{\gamma_{i^*}} \log([1-p] + pe^{\gamma_{i^*} L}) &> w_g - \frac{\gamma_g \sigma_g^2}{2} + w_i - \frac{\gamma_i \sigma_i^2}{2} - \frac{1}{\gamma_i} \log([1-p] + pe^{\gamma_i L}) \\ -\frac{\gamma_{i^*}(\sigma_i^2 + \sigma_g^2)}{2} - \frac{1}{\gamma_{i^*}} \log([1-p] + pe^{\gamma_{i^*} L}) &> -\frac{\gamma_g \sigma_g^2}{2} - \frac{\gamma_i \sigma_i^2}{2} - \frac{1}{\gamma_i} \log([1-p] + pe^{\gamma_i L}) \end{aligned}$$

The last inequality follows from the following two claims:

CLAIM 1: $\frac{\gamma_g \sigma_g^2}{2} + \frac{\gamma_i \sigma_i^2}{2} > -\frac{\gamma_{i^*}(\sigma_i^2 + \sigma_g^2)}{2}$

Proof: This follows from observing that $\gamma_{i^*} < \min(\gamma_g, \gamma_i)$ by lemma 2.

CLAIM 2: $-\frac{1}{\gamma_{i^*}} \log([1-p] + pe^{\gamma_{i^*} L}) > -\frac{1}{\gamma_i} \log([1-p] + pe^{\gamma_i L})$

Proof: This follows from observing that the LHS is the CE for a representative agent with risk aversion γ_{i^*} for a gamble v while the RHS is the CE for an individual with risk aversion $\gamma_i > \gamma_{i^*}$ for the same gamble v. Since CE is decreasing in risk aversion, the claim follows.

8 Appendix 2

[Figure 1 about here.]

[Figure 2 about here.]

[Figure 3 about here.]

[Figure 4 about here.]

[Table 2 about here.]

[Table 3 about here.]

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[Figure 5 about here.]

Table 1: TWO SIDED BASIS RISK: JOINT PROBABILITY STRUCTURE

	Index=0	Index=1	
$v = 0$	$1 - q - r$	$q + r - p$	$1 - p$
$v = -L$	r	$p - r$	p
	$1 - q$	q	

Table 2: SUMMARY STATISTICS

VARIABLE	Obs.	Mean	Std. Dev.	Min	Max
Index-Demand					
1(Bought=Yes)	4,948	0.390	0.488	0	1
Risk Aversion	4,919	0.528	0.316	0	1
Price and Discounts					
Premium	4,948	159.4	56.08	44	257
Discount	4,871	5.352	17.51	0	90
1(Got Payout=Yes)	4,948	0.119	0.324	0	1
Payout Per Policy	1,929	63.75	56.50	0	257
Payout Amount	4,948	0.0567	0.265	0	3.208
Pre-Insurance Losses					
1(Crop loss=Yes)	4,948	0.292	0.455	0	1
1(Revenue loss=Yes)	4,948	0.0940	0.292	0	1
Risk-Share Treatments					
1(Group cues)	4,871	0.0396	0.195	0	1
1(Hindu cues)	4,871	0.0277	0.164	0	1
1(Muslim cues)	4,871	0.0287	0.167	0	1
Basis Risk					
BR DOWNSIDE--crop loss	4,948	0.255	0.436	0	1
BR UPSIDE--crop loss	4,948	0.0821	0.274	0	1
BR DOWNSIDE--rev. loss	4,948	0.0821	0.274	0	1
BR UPSIDE--rev. loss	4,948	0.107	0.309	0	1
Number of Years				2006	2013
Number of Households				645	645
Number of Villages				60	60
Number of Districts				3	3

Notes: Table reports the summary statistics of the panel data used for our empirical analysis. This include information about take-up of rainfall-index insurance, premium and randomized discounts, crop and revenue loss experience of households, multiple treatments for risk-sharing, proxied by cues on "group identity", and basis risks respectively. **1**(.) is a logical indicator that takes the value 1 whenever the argument in the bracket is true, and zero otherwise. The merged data spans 2006-2013, covering 645 households across a pool of 60 villages. These are located in three districts in the state of Gujarat, namely: Ahmedabad, Anand and Patan.

Table 3: CROP MISMATCH **t1**: INDEX DEMAND-GROUP IDENTITY LINK VS BASIS RISK

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Risk-share Treatments				
Group cues	-0.0557	-0.0621	-0.0581	-0.0496
	(0.0567)	(0.0612)	(0.0603)	(0.0580)
brisk DOWNSIDE		-0.161***	-0.160***	-0.104***
		(0.0239)	(0.0236)	(0.0227)
Group cues **X** brisk DOWNSIDE		0.0158	0.0172	-0.0232
		(0.105)	(0.101)	(0.0991)
Hindu cues	-0.0320	-0.0518	-0.0424	-0.0234
	(0.0580)	(0.0598)	(0.0582)	(0.0588)
Hindu cues **X** brisk DOWNSIDE		0.0487	0.0453	-0.00995
		(0.0952)	(0.0930)	(0.0897)
Muslim cues	-0.0645	-0.106	-0.102	-0.0874
	(0.0593)	(0.0685)	(0.0675)	(0.0651)
Muslim cues **X** brisk DOWNSIDE		0.158*	0.160*	0.130*
		(0.0827)	(0.0818)	(0.0776)
Discount			0.00348***	0.00327***
			(0.000589)	(0.000565)
brisk UPSIDE				0.523***
				(0.0247)
Constant	0.226***	0.350***	0.349***	0.300***
	(0.0373)	(0.0411)	(0.0409)	(0.0397)
Observations	6,490	6,490	6,490	6,490
R-squared	0.112	0.127	0.133	0.221
Number of Households	989	989	989	989
Mkt Year FEs	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(4) differ based on the included risk-sharing treatments and interactions with basis risk, and controls for premium discount and upside basis risk. Columns (2) - (4) include the various interaction terms, while column (1) omits the interactions. Errors are clustered at the village level. Stars indicate significance: ∗∗∗, ∗∗, and ∗ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 4: CROP MISMATCH **t2**: INDEX DEMAND-GROUP IDENTITY LINK VS BASIS RISK

VARIABLES	(1) bought	(2) bought	(3) bought
Risk-share Treatments			
Hindu cues	-0.0774	-0.0628	-0.0424
	(0.0802)	(0.0781)	(0.0783)
Group cues	-0.103	-0.0910	-0.0713
	(0.0992)	(0.0971)	(0.0918)
Hindu cues **X** Group cues	0.0939	0.0767	0.0651
	(0.131)	(0.128)	(0.128)
brisk DOWNSIDE	-0.162***	-0.161***	-0.105***
	(0.0241)	(0.0239)	(0.0230)
Hindu cues **X** brisk DOWNSIDE	0.124	0.117	0.0623
	(0.127)	(0.126)	(0.122)
Group cues **X** brisk DOWNSIDE	0.154	0.154	0.0847
	(0.167)	(0.162)	(0.157)
Hindu cu. **X** Group cu. **X** brisk DOW.	-0.309	-0.302	-0.274
	(0.277)	(0.269)	(0.266)
Muslim cues	-0.121	-0.113	-0.0872
	(0.0889)	(0.0876)	(0.0837)
Muslim cues **X** Group cues	0.0631	0.0509	0.0198
	(0.147)	(0.146)	(0.138)
Muslim cues **X** brisk DOWNSIDE	0.195*	0.197*	0.144
	(0.112)	(0.112)	(0.105)
Muslim cu.**X**Group cu.**X** brisk DOW.	-0.211	-0.211	-0.137
	(0.254)	(0.248)	(0.245)
Discount		0.00347***	0.00327***
		(0.000587)	(0.000562)
brisk UPSIDE			0.523***
			(0.0248)
Constant	0.350***	0.350***	0.301***
	(0.0413)	(0.0411)	(0.0399)
Observations	6,490	6,490	6,490
R-squared	0.127	0.134	0.221
Number of Households	989	989	989
Mkt Year FEs	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(3) differ based on the included risk-sharing treatments and interactions with basis risk and premium discount. Columns (1) includes the various interaction terms with basis risk, column (2) adds a control for premium discount, while column (3) adds controls for both premium discounts and upside basis risk. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 5: REVENUE MISMATCH **t1**: INDEX DEMAND-GROUP IDENTITY LINK VS BASIS RISK

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Risk-share Treatments				
Group cues	-0.0557	-0.0521	-0.0479	-0.0454
	(0.0567)	(0.0584)	(0.0572)	(0.0540)
brisk DOWNSIDE		-0.124***	-0.123***	-0.0430*
		(0.0249)	(0.0248)	(0.0236)
Group cues **X** brisk DOWNSIDE		-0.172	-0.170	-0.170
		(0.292)	(0.286)	(0.273)
Hindu cues	-0.0320	-0.0316	-0.0227	-0.00980
	(0.0580)	(0.0577)	(0.0560)	(0.0568)
Hindu cues **X** brisk DOWNSIDE		0.101	0.0976	0.00164
		(0.223)	(0.222)	(0.214)
Muslim cues	-0.0645	-0.0708	-0.0660	-0.0564
	(0.0593)	(0.0596)	(0.0586)	(0.0561)
Muslim cues **X** brisk DOWNSIDE		0.208	0.206	0.141
		(0.274)	(0.271)	(0.243)
Discount			0.00351***	0.00319***
			(0.000601)	(0.000563)
brisk UPSIDE				0.599***
				(0.0223)
Constant	0.226***	0.249***	0.249***	0.229***
	(0.0373)	(0.0378)	(0.0377)	(0.0363)
Observations	6,490	6,490	6,490	6,490
R-squared	0.112	0.116	0.123	0.263
Number of Households	989	989	989	989
Mkt Year FEs	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(4) differ based on the included risk-sharing treatments and interactions with basis risk, and controls for premium discount and upside basis risk. Columns (2) - (4) include the various interaction terms, while column (1) omits the interactions. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 6: REVENUE MISMATCH **t**2: INDEX DEMAND-GROUP IDENTITY LINK VS BASIS RISK

VARIABLES	(1) bought	(2) bought	(3) bought
Risk-share Treatments			
Hindu cues	-0.0438	-0.0296	-0.0145
	(0.0740)	(0.0718)	(0.0718)
Group cues	-0.0664	-0.0542	-0.0409
	(0.0932)	(0.0906)	(0.0860)
Hindu cues **X** Group cues	0.0373	0.0201	0.00863
	(0.121)	(0.117)	(0.122)
brisk DOWNSIDE	-0.124***	-0.123***	-0.0429*
	(0.0249)	(0.0247)	(0.0236)
Hindu cues **X** brisk DOWNSIDE	0.0580	0.0499	-0.0379
	(0.239)	(0.238)	(0.228)
Group cues **X** brisk DOWNSIDE	-0.593**	-0.596**	-0.0843
	(0.235)	(0.224)	(0.315)
Hindu cu. **X** Group cu. **X** brisk DOW.			--
			--
Muslim cues	-0.0744	-0.0660	-0.0461
	(0.0847)	(0.0831)	(0.0790)
Muslim cues **X** Group cues	0.0164	0.00410	-0.0235
	(0.137)	(0.135)	(0.128)
Muslim cues **X** brisk DOWNSIDE	0.523***	0.526***	0.401***
	(0.0749)	(0.0743)	(0.0704)
Muslim cu.**X**Group cu.**X** brisk DOW.			-0.427
			(0.352)
Discount		0.00350***	0.00320***
		(0.000599)	(0.000559)
brisk UPSIDE			0.599***
			(0.0223)
Hindu cu. **X** Group cu. **X** brisk DOW.	0.514	0.529	
	(0.389)	(0.381)	
Muslim cu.**X**Group cu.**X** brisk DOW.	--	--	
	--	--	
Constant	0.249***	0.249***	0.229***
	(0.0377)	(0.0376)	(0.0362)
Observations	6,490	6,490	6,490
R-squared	0.116	0.123	0.263
Number of Households	989	989	989
Mkt Year FEs	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(3) differ based on the included risk-sharing treatments and interactions with basis risk and premium discount. Column (1) includes the various interaction terms with basis risk, column (2) adds a control for premium discount, while column (3) adds controls for both premium discounts and upside basis risk. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 7: CROP MISMATCH **t1**: INDEX DEMAND-GROUP IDENTITY LINK VS PRICE EFFECTS

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Risk-share Treatments				
Group cues	-0.0557	-0.208***	-0.210***	-0.207***
	(0.0567)	(0.0331)	(0.0333)	(0.0313)
Discount		0.00311***	0.00308***	0.00287***
		(0.000616)	(0.000606)	(0.000585)
Group cues **X** Discount		0.104***	0.102***	0.101***
		(0.0100)	(0.0104)	(0.0101)
Hindu cues	-0.0320	-0.268***	-0.275***	-0.276***
	(0.0580)	(0.0380)	(0.0390)	(0.0365)
Hindu cues **X** Discount		0.131***	0.129***	0.135***
		(0.00978)	(0.00979)	(0.00894)
Muslim cues	-0.0645	-0.266***	-0.266***	-0.264***
	(0.0593)	(0.0451)	(0.0482)	(0.0426)
Muslim cues **X** Discount		0.131***	0.130***	0.132***
		(0.0126)	(0.0122)	(0.0113)
brisk DOWNSIDE			-0.147***	-0.0938***
			(0.0225)	(0.0218)
brisk UPSIDE				0.527***
				(0.0242)
Constant	0.226***	0.227***	0.340***	0.293***
	(0.0373)	(0.0368)	(0.0397)	(0.0384)
Observations	6,490	6,490	6,490	6,490
R-squared	0.112	0.160	0.173	0.262
Number of Households	989	989	989	989
Mkt Year FEs	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(4) differ based on the included risk-sharing treatments and interactions with premium discount, and controls for both downside and upside basis risks. Columns (2) - (4) include the various interaction terms, while column (1) omits the interactions. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 8: CROP MISMATCH **t2**: INDEX DEMAND-GROUP IDENTITY LINK VS PRICE EFFECTS

VARIABLES	(1) bought	(2) bought	(3) bought
Risk-share Treatments			
Hindu cues	-0.364***	-0.376***	-0.374***
	(0.0485)	(0.0484)	(0.0458)
Hindu cues **X** Group cues	-0.445***	-0.458***	-0.438***
	(0.0565)	(0.0575)	(0.0534)
Discount	0.435***	0.456***	0.433***
	(0.0674)	(0.0672)	(0.0615)
Hindu cues **X** Discount	0.00303***	0.00299***	0.00278***
	(0.000617)	(0.000608)	(0.000587)
Group cues **X** Discount	0.174***	0.173***	0.177***
	(0.0109)	(0.0113)	(0.00932)
Hindu cu. **X** Group cu. **X** Discount	0.196***	0.196***	0.190***
	(0.0132)	(0.0139)	(0.0131)
Muslim cues	-0.197***	-0.201***	-0.192***
	(0.0242)	(0.0252)	(0.0214)
Group cues	-0.388***	-0.394***	-0.379***
	(0.0586)	(0.0610)	(0.0551)
Muslim cues **X** Group cues	0.443***	0.461***	0.424***
	(0.0715)	(0.0757)	(0.0668)
Hindu cues **X** Discount	0.170***	0.169***	0.168***
	(0.0154)	(0.0150)	(0.0137)
Muslim cu. **X** Group cu. **X** Discount	-0.173***	-0.174***	-0.163***
	(0.0217)	(0.0213)	(0.0189)
brisk DOWNSIDE		-0.149***	-0.0951***
		(0.0224)	(0.0217)
brisk UPSIDE			0.526***
			(0.0241)
Constant	0.227***	0.341***	0.294***
	(0.0368)	(0.0398)	(0.0385)
Observations	6,490	6,490	6,490
R-squared	0.165	0.178	0.267
Number of Households	989	989	989
Mkt Year FEs	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(3) differ based on the included risk-sharing treatments and interactions with premium discount and basis risk. Column (1) includes the various interaction terms with premium discount, column (2) adds a control for [downside] basis risk, while column (3) adds controls for both downside and upside basis risks. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 9: REVENUE MISMATCH **t1**: INDEX DEMAND-GROUP IDENTITY LINK VS PRICE EFFECTS

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Risk-share Treatments				
Group cues	-0.0557	-0.208***	-0.207***	-0.205***
	(0.0567)	(0.0331)	(0.0338)	(0.0309)
Discount		0.00311***	0.00311***	0.00278***
		(0.000616)	(0.000616)	(0.000583)
Group cues **X** Discount		0.104***	0.102***	0.103***
		(0.0100)	(0.0103)	(0.00916)
Hindu cues	-0.0320	-0.268***	-0.265***	-0.276***
	(0.0580)	(0.0380)	(0.0387)	(0.0363)
Hindu cues **X** Discount		0.131***	0.131***	0.140***
		(0.00978)	(0.00991)	(0.00836)
Muslim cues	-0.0645	-0.266***	-0.267***	-0.263***
	(0.0593)	(0.0451)	(0.0460)	(0.0403)
Muslim cues **X** Discount		0.131***	0.130***	0.132***
		(0.0126)	(0.0125)	(0.0112)
brisk DOWNSIDE			-0.113***	-0.0346
			(0.0244)	(0.0227)
brisk UPSIDE				0.603***
				(0.0215)
Constant	0.226***	0.227***	0.248***	0.228***
	(0.0373)	(0.0368)	(0.0371)	(0.0356)
Observations	6,490	6,490	6,490	6,490
R-squared	0.112	0.160	0.164	0.306
Number of Households	989	989	989	989
Mkt Year FEs	Yes	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(4) differ based on the included risk-sharing treatments and interactions with premium discount, and controls for both downside and upside basis risks. Columns (2) - (4) include the various interaction terms, while column (1) omits the interactions. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 10: REVENUE MISMATCH **t**2: INDEX DEMAND-GROUP IDENTITY LINK VS PRICE EFFECTS

VARIABLES	(1) bought	(2) bought	(3) bought
Risk-share Treatments			
Hindu cues	-0.364***	-0.361***	-0.368***
	(0.0485)	(0.0488)	(0.0454)
Hindu cues **X** Group cues	0.435***	0.438***	0.412***
	(0.0674)	(0.0675)	(0.0609)
Discount	0.00303***	0.00302***	0.00270***
	(0.000617)	(0.000618)	(0.000585)
Hindu cues **X** Discount	0.174***	0.174***	0.181***
	(0.0109)	(0.0111)	(0.00812)
Group cues **X** Discount	0.196***	0.195***	0.192***
	(0.0132)	(0.0138)	(0.0120)
Hindu cu. **X** Group cu. **X** Discount	-0.197***	-0.196***	-0.189***
	(0.0242)	(0.0248)	(0.0194)
Muslim cues	-0.388***	-0.392***	-0.373***
	(0.0586)	(0.0592)	(0.0529)
Group cues	-0.445***	-0.446***	-0.426***
	(0.0565)	(0.0571)	(0.0512)
Muslim cues **X** Group cues	0.443***	0.450***	0.408***
	(0.0715)	(0.0720)	(0.0638)
Hindu cues **X** Discount	0.170***	0.170***	0.169***
	(0.0154)	(0.0153)	(0.0137)
Muslim cu. **X** Group cu. **X** Discount	-0.173***	-0.174***	-0.166***
	(0.0217)	(0.0219)	(0.0186)
brisk DOWNSIDE		-0.114***	-0.0351
		(0.0243)	(0.0226)
brisk UPSIDE			0.602***
			(0.0213)
Constant	0.227***	0.248***	0.228***
	(0.0368)	(0.0371)	(0.0355)
Observations	6,490	6,490	6,490
R-squared	0.165	0.169	0.311
Number of Households	989	989	989
Mkt Year FEs	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on a vector of treatments for risk-sharing proxied by cues on "group identity" and their interactions with basis risk and discount assignments–exogenous variation in insurance premium at the household level. Columns (1)-(3) differ based on the included risk-sharing treatments and interactions with premium discount and basis risk. Columns (1) includes the various interaction terms with premium discount, column (2) adds a control for [downside] basis risk, while column (3) adds controls for both downside and upside basis risks. Errors are clustered at the village level. Stars indicate significance: ∗∗∗, ∗∗, and ∗ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 11: EXAMINING TWO FORCES: BASIS RISK VS PRICE SENSITIVITIES

VARIABLES	(1) bought	(2) bought	(3) bought
Discount (Premium)		0.00396***	0.00369***
		(0.00111)	(0.00110)
Risk aversion	N/A	N/A	N/A
Discount **X** Risk aversion		-0.000863	-0.000749
		(0.00137)	(0.00133)
brisk DOWNSIDE	-0.120***	-0.131***	-0.0817***
	(0.0280)	(0.0236)	(0.0227)
brisk DOWNSIDE **X** Risk aversion	-0.0255		
	(0.0413)		
brisk UPSIDE			0.532***
			(0.0257)
Constant	0.288***	0.331***	0.287***
	(0.0371)	(0.0385)	(0.0373)
Observations	4,919	4,842	4,842
R-squared	0.134	0.135	0.223
No. of Households	645	645	645
Mkt Year FEs	Yes	Yes	Yes
Household FEs	Yes	Yes	Yes

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on basis risk and discount assignments–exogenous variation in insurance premium and their interactions with risk aversion at the household level. Columns (1)-(3) differ based on the included interactions with risk aversion. Columns (1) use market year dummies to control for sensitivity to changes in premium, and includes an interaction between [downside] basis risk and risk aversion, while column (2)-(3) directly controls for sensitivity to basis risk, and include interactions between premium discounts and risk aversion. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 12: Group cues: DOES LARGER GROUP SIZE LEAD TO LOWER INDEX DEMAND?

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Group size	-0.0267***	-0.0291***	-0.0261***	-0.0278***
	(0.00138)	(0.00136)	(0.00129)	(0.00135)
brisk DOWNSIDE		-0.162***	-0.102***	-0.101***
		(0.0210)	(0.0210)	(0.0211)
brisk UPSIDE			0.632***	0.623***
			(0.0235)	(0.0239)
discount				0.00328***
				(0.000544)
Constant	0.278***	0.453***	0.429***	0.470***
	(0.0386)	(0.0425)	(0.0412)	(0.0416)
Observations	4,299	4,299	4,299	4,222
No. of Villages	53	53	53	53
R-squared	0.146	0.162	0.288	0.292
Mkt Year FEs	Yes	Yes	Yes	Yes
Village FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on group size (i.e, number of households that received "Group" cues), along with controls for basis risk and exogenous changes in premium at the household level. Columns (1)-(4) differ based on the included controls. Column (1) excludes all controls, column (2) adds a control for sensitivity to [downside] basis risk, column (3) adds controls for both downside and upside basis risks, while column (4) sequentially adds a control for premium discounts. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 13: Hindu cues: DOES LARGER GROUP SIZE LEAD TO LOWER INDEX DEMAND?

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Group size	-0.107***	-0.117***	-0.104***	-0.111***
	(0.00552)	(0.00545)	(0.00514)	(0.00538)
brisk DOWNSIDE		-0.162***	-0.102***	-0.101***
		(0.0210)	(0.0210)	(0.0211)
brisk UPSIDE			0.632***	0.623***
			(0.0235)	(0.0239)
discount				0.00328***
				(0.000544)
Constant	0.278***	0.453***	0.429***	0.470***
	(0.0386)	(0.0425)	(0.0412)	(0.0416)
Observations	4,299	4,299	4,299	4,222
No. of Villages	53	53	53	53
R-squared	0.146	0.162	0.288	0.292
Mkt Year FEs	Yes	Yes	Yes	Yes
Village FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on group size (i.e, number of households that received "Hindu" cues), along with controls for basis risk and exogenous changes in premium at the household level. Columns (1)-(4) differ based on the included controls. Column (1) excludes all controls, column (2) adds a control for sensitivity to [downside] basis risk, column (3) adds controls for both downside and upside basis risks, while column (4) sequentially adds a control for premium discounts. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 14: Muslim cues: DOES LARGER GROUP SIZE LEAD TO LOWER INDEX DEMAND?

VARIABLES	(1) bought	(2) bought	(3) bought	(4) bought
Group size	-0.0267***	-0.0291***	-0.0261***	-0.0278***
	(0.00138)	(0.00136)	(0.00129)	(0.00135)
brisk DOWNSIDE		-0.162***	-0.102***	-0.101***
		(0.0210)	(0.0210)	(0.0211)
brisk UPSIDE			0.632***	0.623***
			(0.0235)	(0.0239)
discount				0.00328***
				(0.000544)
Constant	0.278***	0.453***	0.429***	0.470***
	(0.0386)	(0.0425)	(0.0412)	(0.0416)
Observations	4,299	4,299	4,299	4,222
No. of Villages	53	53	53	53
R-squared	0.146	0.162	0.288	0.292
Mkt Year FEs	Yes	Yes	Yes	Yes
Village FEs	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of take-up for rainfall-index insurance on group size (i.e, number of households that received "Muslim" cues), along with controls for basis risk and exogenous changes in premium at the household level. Columns (1)-(4) differ based on the included controls. Column (1) excludes all controls, column (2) adds a control for sensitivity to [downside] basis risk, column (3) adds controls for both downside and upside basis risks, while column (4) sequentially adds a control for premium discounts. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 15: REPORTED-CROP LOSS EXPERIENCE ON HOUSEHOLD CHARACTERISTICS

VARIABLES	(1) **1**(Crop loss=Yes)	(2) **1**(Crop loss=Yes)	(3) **1**(Crop loss=Yes)	(4) **1**(Crop loss=Yes)	(5) **1**(Crop loss=Yes)
1(Head=Male)	-0.000248	0.00116	0.000837	0.00282	0.00257
	(0.0151)	(0.0154)	(0.0155)	(0.0156)	(0.0157)
Log(Age)	0.0164	0.0140	-0.00161	-0.00434	-0.00495
	(0.0584)	(0.0587)	(0.0601)	(0.0600)	(0.0604)
Log(Household Size)	0.0191	0.0189	0.0215	0.0234	0.0278
	(0.0155)	(0.0155)	(0.0162)	(0.0163)	(0.0175)
1(=>Secondary Educ)		-0.0111	-0.00758	-0.00691	-0.00845
		(0.0207)	(0.0208)	(0.0208)	(0.0209)
1(Electricity=Yes)			0.0111	0.0122	0.0150
			(0.0162)	(0.0163)	(0.0165)
1(Mobile Phone=Yes)			0.0313	0.0299	0.0250
			(0.0359)	(0.0360)	(0.0360)
1(Sew Machine=Yes)			0.0272	0.0303	0.0319
			(0.0315)	(0.0316)	(0.0317)
1(Tractor=Yes)			0.0575	0.0530	0.0626
			(0.0713)	(0.0718)	(0.0737)
1(Thresher=Yes)			0.121	0.124	0.120
			(0.0785)	(0.0786)	(0.0819)
1(Bull cart=Yes)			-0.0168	-0.0180	-0.0214
			(0.0388)	(0.0392)	(0.0394)
1(Bicycle=Yes)			0.00114	0.00281	0.00197
			(0.0142)	(0.0143)	(0.0144)
1(Motorcycle=Yes)			-0.0366	-0.0364	-0.0389
			(0.0323)	(0.0324)	(0.0331)
1(Any Insurance=Yes)				-0.0132	-0.0128
				(0.0141)	(0.0142)
Log(1+Per Capita m.Exp)					0.00918
					(0.0107)
Risk Aversion					-0.00507
					(0.0221)
1(Muslim name=Yes)					-0.0343
					(0.0285)
1(Irrigate=Yes)					0.0614
					(0.0413)
Constant	86.43***	86.44***	85.77***	85.78***	85.13***
	(6.731)	(6.732)	(6.756)	(6.775)	(6.799)
Observations	4,293	4,293	4,272	4,238	4,206
No. of Villages	60	60	60	60	60
R-squared	0.274	0.274	0.275	0.276	0.278
Linear Trend	Yes	Yes	Yes	Yes	Yes
Village FEs	Yes	Yes	Yes	Yes	Yes

Notes: Table reports the results from regressions of reported-crop loss experience on a vector of household characteristics. **1**(.) is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Columns (1)-(5) differ based on the included controls. Column (1) includes only demographic characteristics, column (2) adds a control for educational level, column (3) adds controls for household assets, column (4) adds an indicator for whether the household has any formal insurance, while column (5) adds controls for per capita monthly expenditure, risk aversion, and indicators for whether respondent has a muslim name and irrigates farm. Errors are robust to heteroskedasticity. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 16: BALANCE ON HOUSEHOLD CHARACTERISTICS

VARIABLES	(1) **1**(GroupT=Yes)	(2) **1**(HinduT=Yes)	(3) **1**(MuslimT=Yes)
1(Head=Male)	-0.00967	-0.000126	-0.0117*
	(0.00828)	(0.00691)	(0.00698)
Log(Age)	-0.0152	0.0298*	0.0173
	(0.0187)	(0.0169)	(0.0141)
Log(Household Size)	-0.0101	0.00575	0.00517
	(0.00864)	(0.00700)	(0.00682)
1(=>Secondary Educ)	0.000470	0.00660	0.00176
	(0.0117)	(0.0104)	(0.0107)
1(Electricity=Yes)	-0.00720	-0.000691	0.00262
	(0.00791)	(0.00729)	(0.00719)
1(Mobile Phone=Yes)	0.0151	-0.00119	0.00197
	(0.0176)	(0.0140)	(0.0155)
1(Sew Machine=Yes)	0.00966	-0.00391	0.0131
	(0.0168)	(0.0121)	(0.0142)
1(Tractor=Yes)	-0.0213	0.0127	-0.00773
	(0.0160)	(0.0415)	(0.0274)
1(Thresher=Yes)	-0.0168	0.0288	-0.00903
	(0.0170)	(0.0435)	(0.0169)
1(Bull cart=Yes)	0.00812	0.0100	-0.0108
	(0.0165)	(0.0176)	(0.0132)
1(Bicycle=Yes)	0.00492	0.000767	-0.00261
	(0.00758)	(0.00675)	(0.00633)
1(Motorcycle=Yes)	-0.0236	0.00167	0.00264
	(0.0145)	(0.0152)	(0.0161)
1(Any Insurance=Yes)	0.00529	0.00132	-0.00491
	(0.00696)	(0.00578)	(0.00604)
Log(1+Per Capita m.Exp)	-0.00262	-0.000892	0.00382
	(0.00502)	(0.00449)	(0.00417)
Risk Aversion	-0.0135	0.000140	-0.00285
	(0.0113)	(0.00937)	(0.00933)
1(Muslim name=Yes)	-0.0116	-0.0167	0.00908
	(0.0133)	(0.0104)	(0.0116)
1(Irrigate=Yes)	-0.0189	-0.0260**	-0.00407
	(0.0150)	(0.0115)	(0.0134)
Constant	54.98***	38.03***	39.49***
	(3.777)	(3.196)	(3.257)
Observations	4,133 [60]	4,133 [60]	4,133 [60]
R-squared	0.095	0.069	0.076
Mkt Year FEs	Yes	Yes	Yes
Linear Trend	Yes	Yes	Yes
Village FEs	Yes	Yes	Yes

Notes: Table reports the results from regressions of risk-sharing treatment groups on a vector of household characteristics. **1**(.) is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Columns include the set of all seventeen (17) demographic characteristics. Errors are robust to heteroskedasticity. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 17: WEALTH CONTROL: INDEX DEMAND-GROUP IDENTITY LINKAGES

VARIABLES	(1) bought	(2) bought
Group cues	-0.188***	-0.188***
	(0.0273)	(0.0270)
Discount	0.00290***	0.00279***
	(0.000549)	(0.000548)
Group cues **X** Discount	0.0992***	0.0995***
	(0.00768)	(0.00771)
Hindu cues	-0.317***	-0.317***
	(0.0372)	(0.0369)
Hindu cues **X** Discount	0.156***	0.156***
	(0.00713)	(0.00714)
Muslim cues	-0.294***	-0.294***
	(0.0350)	(0.0349)
Muslim cues **X** Discount	0.150***	0.150***
	(0.00494)	(0.00489)
brisk DOWNSIDE [Crop]	-0.0233	
	(0.0183)	
brisk UPSIDE [Crop]	0.630***	
	(0.0236)	
Wealth score	0.00262	0.00337
	(0.00613)	(0.00544)
brisk DOWNSIDE [Revenue]		0.00747
		(0.0235)
brisk UPSIDE [Revenue]		0.691***
		(0.0220)
Constant	0.245***	0.226***
	(0.0454)	(0.0410)
Observations	4,848	4,848
R-squared	0.276	0.326
Mkt Year FEs	Yes	Yes
Household FEs	No	No
Mismatch	CROP	REVENUE
Effects	PRICE	PRICE

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on basis risk and discount assignments–exogenous variation in insurance premium, and interactions with risk-sharing treatments, while controlling for potential wealth effects. Columns (1) and (2) differ based on how basis risk is defined: mismatch between payouts and crop losses in column (1) versus mismatch between payouts and revenue losses in column (2). Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 18: WEALTH CONTROL: INDEX DEMAND-GROUP IDENTITY LINKAGES

VARIABLES	(1) bought	(2) bought
Group cues	-0.0351	-0.0402
	(0.0544)	(0.0521)
bri sk DOWNSIDE [Crop]	-0.0250	
	(0.0195)	
Group cues **X** bri sk DOWNSIDE[Crop]	-0.0492	
	(0.106)	
Hindu cues	-0.0102	-0.0120
	(0.0688)	(0.0654)
Hindu cues **X** bri sk DOWNSIDE[Crop]	-0.0727	
	(0.102)	
Muslim cues	-0.0744	-0.0567
	(0.0663)	(0.0616)
Muslim cu. **X** bri sk DOWNSIDE[Crop]	0.104	
	(0.0892)	
Discount	0.00335***	0.00324***
	(0.000530)	(0.000527)
bri sk UPSIDE [Crop]	0.629***	
	(0.0238)	
Wealth score	0.00229	0.00291
	(0.00660)	(0.00572)
bri sk DOWNSIDE [Revenue]		0.00717
		(0.0238)
Group cues **X** bri sk DOWNSIDE [Rev]		-0.194
		(0.244)
Hindu cues **X** bri sk DOWNSIDE [Rev]		-0.0330
		(0.192)
Muslim cu. **X** brisk DOWNSIDE [Rev]		0.312
		(0.259)
bri sk UPSIDE [Revenue]		0.691***
		(0.0221)
Constant	0.247***	0.226***
	(0.0459)	(0.0411)
Observations	4,848	4,848
R-squared	0.218	0.267
Mkt Year Fes	Yes	Yes
Household Fes	No	No
Mi smatch	CROP	REVENUE
Effects	BASIS RISK	BASIS RISK

Notes: Table shows the results from regressions of take-up for rainfall-index insurance on basis risk and discount assignments–exogenous variation in insurance premium, and interactions with risk-sharing treatments, while controlling for potential wealth effects. Columns (1) and (2) differ based on how basis risk is defined: mismatch between payouts and crop losses in column (1) versus mismatch between payouts and revenue losses in column (2). Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 19: WEALTH CONTROL: DOES LARGER GROUP LEAD TO LOWER DEMAND?

VARIABLES	(1) bought	(2) bought	(3) bought
Group size [Group cu.]	-0.0128***		
	(0.00466)		
brisk DOWNSIDE	-0.101***	-0.0999***	-0.105***
	(0.0182)	(0.0175)	(0.0181)
brisk UPSIDE	0.633***	0.636***	0.633***
	(0.0201)	(0.0194)	(0.0200)
Discount	-0.000851	-0.000836	-0.000876
	(0.000538)	(0.000537)	(0.000544)
Wealth score	0.00143	0.00297	0.00309
	(0.00606)	(0.00609)	(0.00643)
Group size [Hindu cu.]		-0.0175***	
		(0.00570)	
Group size [Muslim cu.]			-0.0104*
			(0.00594)
Constant	0.418***	0.416***	0.400***
	(0.0273)	(0.0266)	(0.0247)
Observations	4,848	4,848	4,848
R-squared	0.157	0.157	0.152
Mkt Year FEs	No	No	No
Village FEs	No	No	No
Group size definition	$\sum_{v} \mathbf{1}(\text{GroupT} = \text{Yes})$	$\sum_{v} \mathbf{1}(\text{HinduT} = \text{Yes})$	$\sum_{v} \mathbf{1}(\text{MislimT} = \text{Yes}$

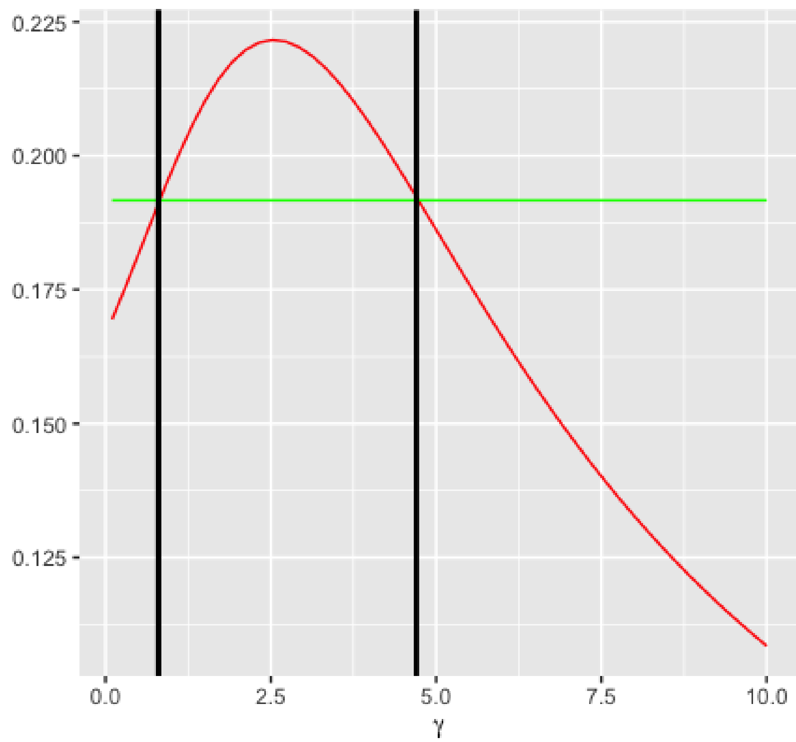
Notes: Table reports the results from regressions of take-up for rainfall-index insurance on group size, along with controls for basis risk, exogenous changes in premium and potential wealth effects. $\mathbf{1}(.)$ is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Columns (1)-(3) differ based on how group size is defined. In column (1), group size refers to the number of households that received "Group" cues. In column (2), group size refers to the number of households that received "Hindu" cues. In column (3), group size refers to the number of households that received "Muslim" cues. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Table 20: NONLINEAR WEALTH CONTROL: DOES LARGER GROUP LEAD TO LOWER DEMAND?

VARIABLES	(1) bought	(2) bought	(3) bought
Group size [Group cu.]	-0.0127***		
	(0.00468)		
brisk DOWNSIDE	-0.105***	-0.104***	-0.109***
	(0.0181)	(0.0172)	(0.0179)
brisk UPSIDE	0.632***	0.635***	0.632***
	(0.0203)	(0.0195)	(0.0201)
Discount	-0.000836	-0.000818	-0.000859
	(0.000540)	(0.000538)	(0.000545)
Wealth Quintile 2	0.0119	0.00938	0.00655
	(0.0230)	(0.0232)	(0.0235)
Wealth Quintile 4	-0.0342	-0.0379	-0.0367
	(0.0249)	(0.0247)	(0.0246)
Wealth Quintile 5	0.0460*	0.0496*	0.0489*
	(0.0250)	(0.0256)	(0.0256)
Group size [Hindu cu.]		-0.0178***	
		(0.00568)	
Group size [Muslim cu.]			-0.0104*
			(0.00585)
Constant	0.416***	0.416***	0.401***
	(0.0308)	(0.0298)	(0.0309)
Observations	4,848	4,848	4,848
R-squared	0.159	0.160	0.155
Mkt Year FEs	No	No	No
Village FEs	No	No	No
Group size definition	$\sum_v \mathbf{1}(\text{GroupT} = \text{Yes})$	$\sum_v \mathbf{1}(\text{HinduT} = \text{Yes})$	$\sum_v \mathbf{1}(\text{MislimT} = \text{Yes}$

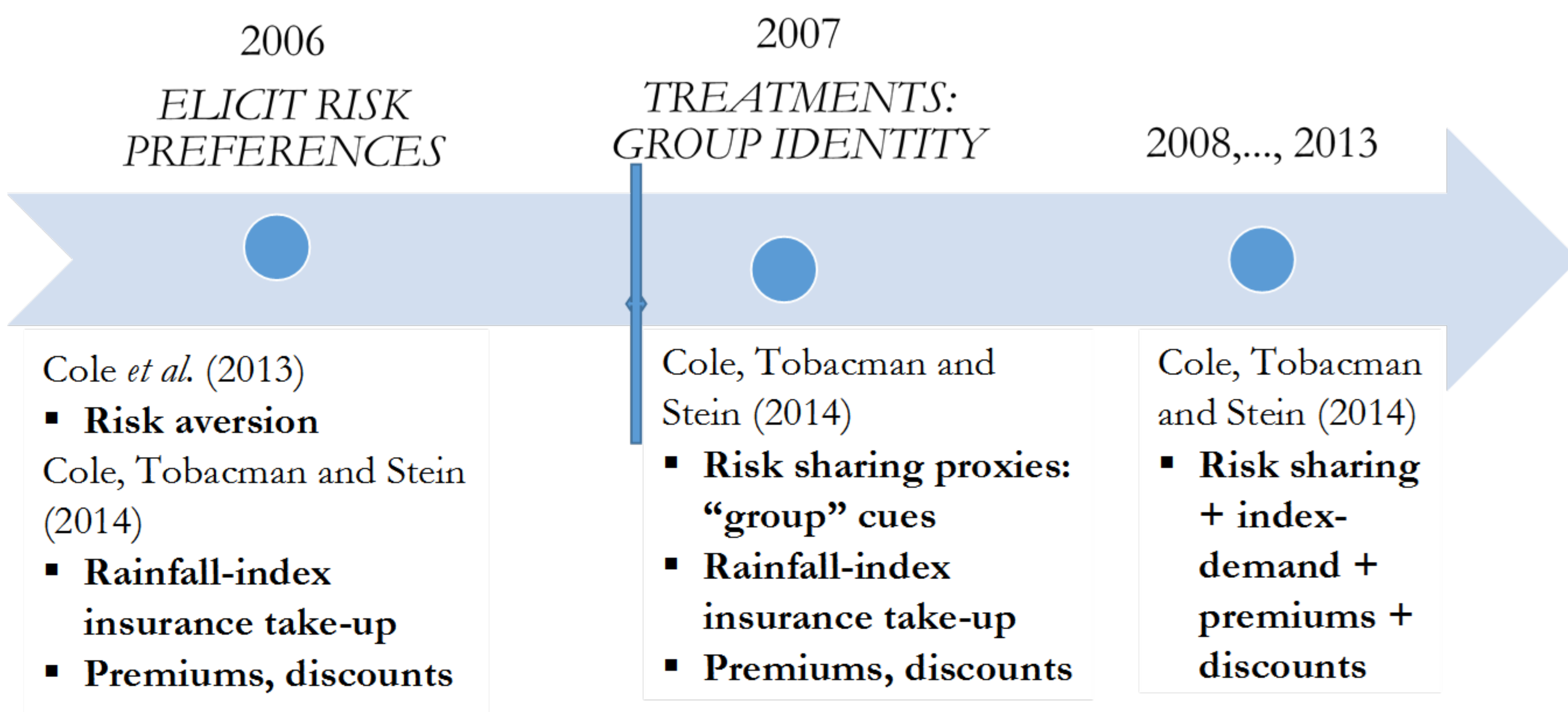
Notes: Table reports the results from regressions of take-up for rainfall-index insurance on group size, along with controls for basis risk, exogenous changes in premium and potential *nonlinear* wealth effects (i.e., include wealth quintile dummies: Q1-Q5 with Q1 being omitted category). The coefficient on Q3 is not estimable, since there are no households in the third quintile of the distribution. $\mathbf{1}(.)$ is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Columns (1)-(3) differ based on how group size is defined. In column (1), group size refers to the number of households that received "Group" cues. In column (2), group size refers to the number of households that received "Hindu" cues. In column (3), group size refers to the number of households that received "Muslim" cues. Errors are clustered at the village level. Stars indicate significance: $***$, $**$, and $*$ stand for significance at the 1%, 5%, and 10% level, respectively.

Figure 1: INDEX TAKE-UP UNDER LARGE LOSSES



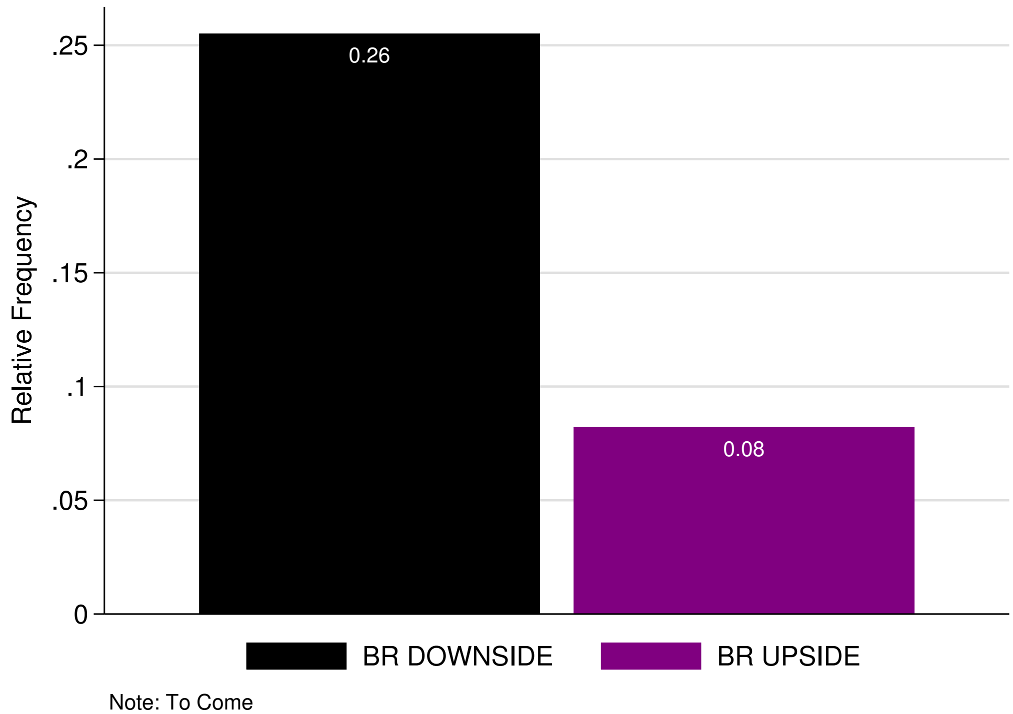
Notes: Assumptions underlying Figure 1 are as follows: $p = q = \frac{1}{3}$, $L = 1$, $r = \frac{1}{9}$, $\beta = 0.5$, $m = 1.15$. The vertical black lines correspond to $\gamma = 0.8$ and $\gamma = 4.7$.

Figure 2: **Timelines of data and experimental treatments**

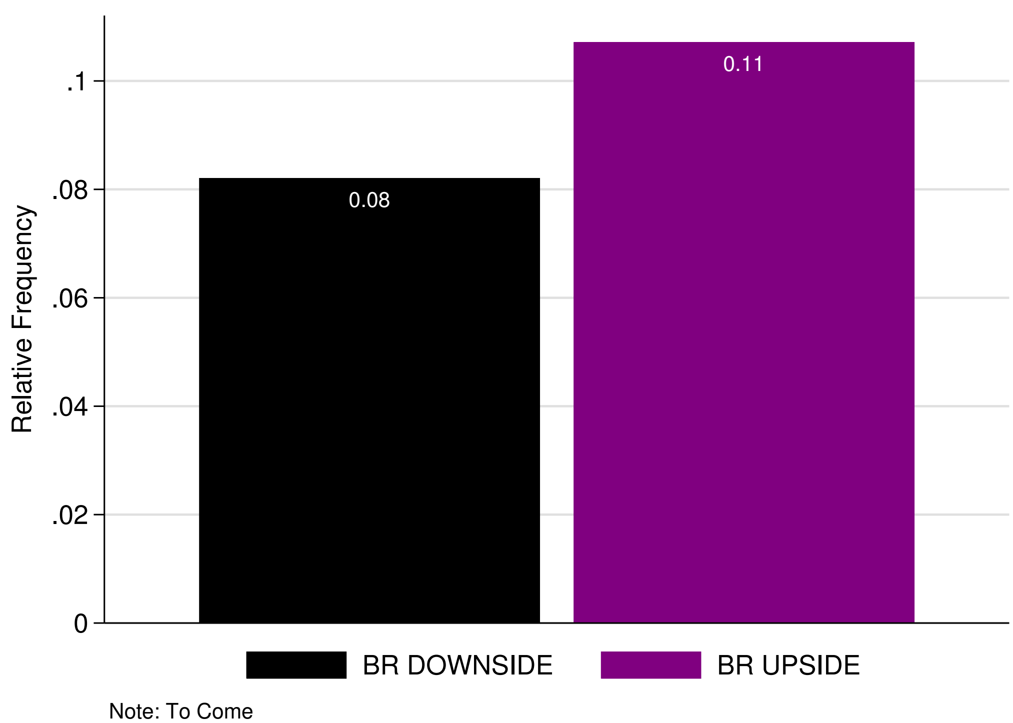


Notes: Figure shows the timeline of the data sets and experimental treatments that we combined for our empirical analysis. The two primary sources of our data are Cole et al (2013) and Cole, Tobacman and Stein (2014). Major parts of our data come from the latter source.

Figure 3: **Distribution of basis risk**



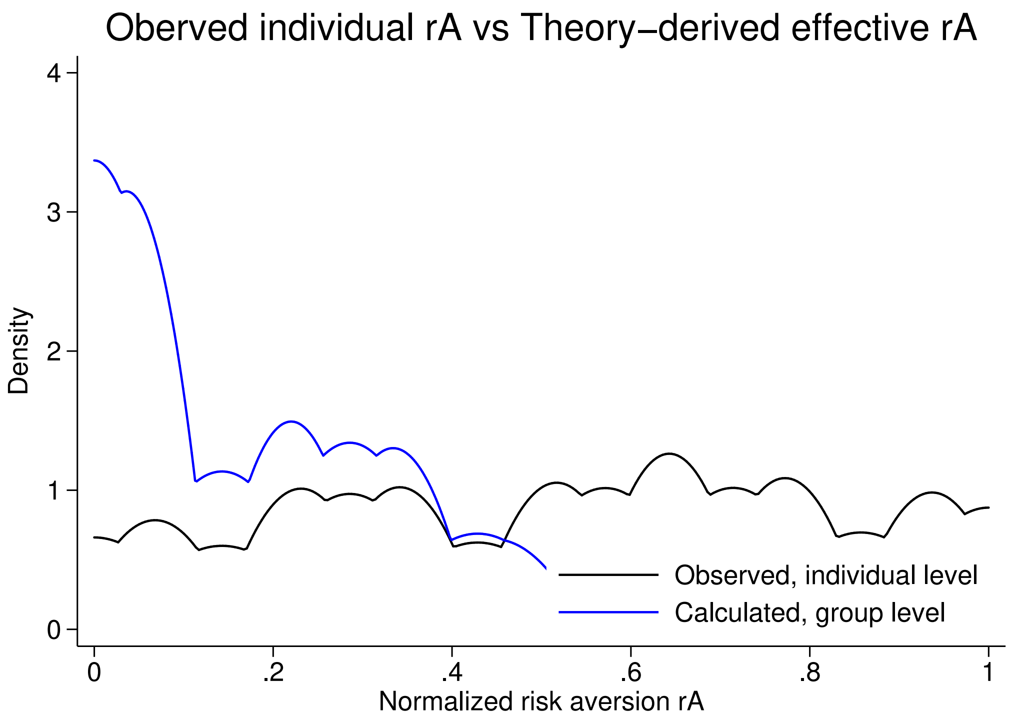
(a) **crop loss: downside vs upside basis risk**



(b) **revenue loss: downside vs upside basis risk**

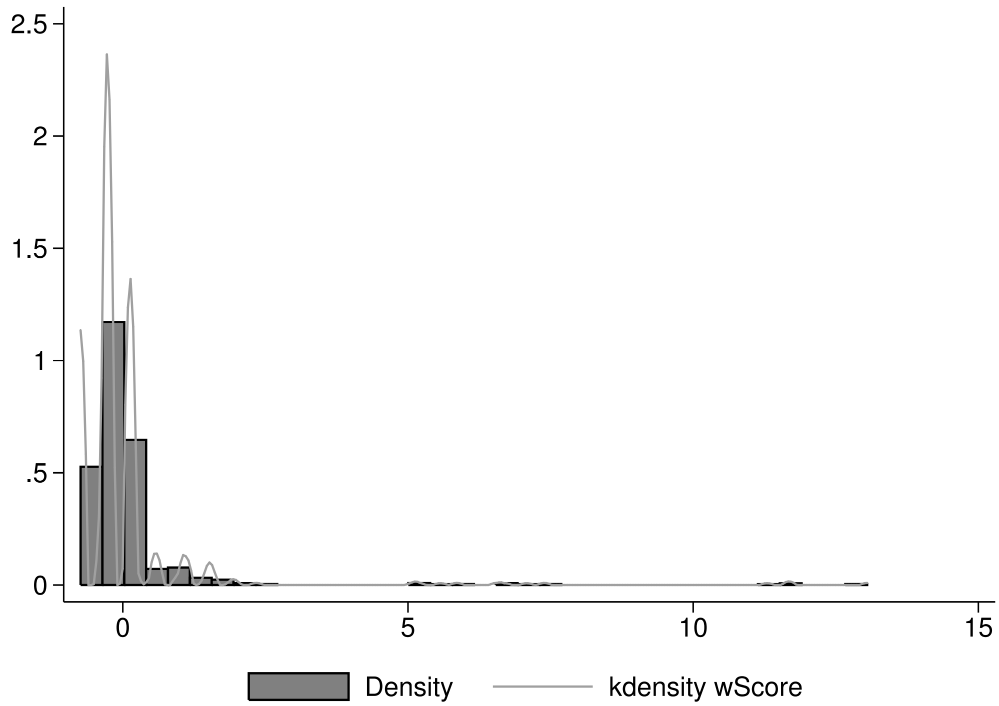
Notes: Figures display the distribution of basis risk measured as the mismatch between households experience of pre-insurance loss in crops or revenue and receiving an index payout, respectively. This shown for both downside and upside basis risks. Revenue is measured for market years in which a crop loss is reported, and captures the "amount" of crop loss: calculated as the difference between that market year's agricultural output and the mean value of output in all previous years where crop loss was not reported.

Figure 4: **Observed versus theory-derived effective risk aversion**

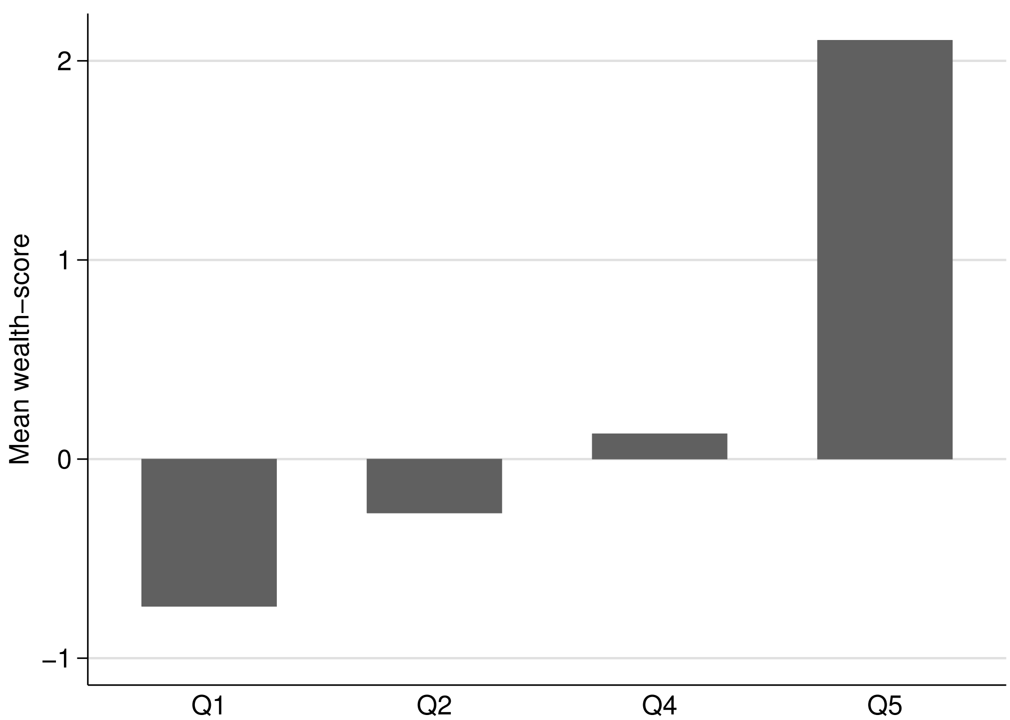


Notes: Figure shows the distribution of risk aversion elicited (i.e., observed) in the 2006/2007 baseline household surveys. For each village group level v, we apply our theoretical rule that says that the effective risk aversion $\gamma_{i=v*}$ is less than the minimum of all members risk aversion in that village to derived the distribution of effective risk aversion. This is jointly displayed with observed values of risk aversion.

Figure 5: **Distribution of household wealth**



(a) **wealth scores**



(b) **wealth quintiles**

Notes: Figures display the distribution of household wealth. Wealth is estimated using Factor analysis and based on eight (8) household asset holdings: **1**(Electricity=Yes), **1**(Mobile Phone=Yes), **1**(Sew Machine=Yes), **1**(Tractor=Yes), **1**(Thresher=Yes), **1**(Bull cart=Yes), **1**(Bicycle=Yes), and **1**(Motorcycle=Yes). **1**(.) is a logical indicator that equals 1 whenever the argument in the bracket is true, and 0 otherwise. Q3 is missing, as there are few to no households in this bracket.