Selling Formal Insurance to the Informally Insured

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Background

- Informal risk sharing networks are important
  - Protects against idiosyncratic, and perhaps aggregate risk
  - But risk-sharing is incomplete (Townsend 1994). Lower risk-taking by farmers than we would want
  - Informal risk-sharing can drive out formal insurance, given moral hazard (Arnott and Stiglitz, 1991)
- Index-based insurance
  - Mitigates moral hazard (Arnott and Stiglitz 1991 not directly relevant
  - Basis risk (Clarke 2011)
  - Low Demand (Cole et al 2009, Gine and Yang 2009, many others)

Setting and Approach

- We design a simple index insurance contract for the Agricultural Insurance Company of India
- The sub-caste (*jati*) is the readily identifiable risk-sharing network

- We make randomized insurance offers to *jatis* for whom we have rich, detailed histories of both aggregate and idiosyncratic shocks and responsiveness to shocks.
  - 5100 cultivators and wage laborers across three states in India
  - Wage laborers face less basis risk than cultivators
- We randomly allocate rainfall stations to some villages.

Research Questions

1. **Demand for Insurance:**
   – How does the presence of risk-sharing networks affect the demand for *index* insurance?
2. **Interaction between Index Insurance with Basis Risk and Informal Risk Sharing:**
   – How important is basis risk in affecting index insurance take-up?
3. **Risk Taking:**
   – How does informal risk-sharing and formal index insurance affect risk-taking?

Research Questions (cont.)

- Using three types of variation:
  - Natural variation in informal risk-sharing stemming from birth in certain sub-castes (data from 17 states)
    - Using census of villages (i.e. large sample for each caste)
  - Designed variation in index insurance offers (3 states)
  - Designed variation in extent of basis risk (1 state)

Outline

- Theory
  - Index insurance with basis risk embedded in a model of cooperative risk sharing (Arnott-Stiglitz 1991 and Clarke 2011)
  - Yields optimal risk sharing in network and risk-taking
  - Demand for index insurance (with basis risk) by individuals in network and effects on subsequent risk taking
- (Historical) Survey Data
  - Characterize *jatis* in terms of indemnification of idiosyncratic and aggregate losses
  - Effect of informal insurance on risk-taking
- Field Experiment
  - Demand for formal insurance by different *jatis*
  - Effect of formal insurance on risk-taking

Model of Informal Risk Sharing

- Game with two identical partners who behave cooperatively and possess full information
- Each member faces an independent adverse event with probability *P* drawn from a common distribution
- *P* can be lowered by investing in a risk-mitigating technology *e*
- If a farmer incurs a loss he receives a payment *d* from his partner if the partner does not incur a loss.
- **Result 1:** $\mathrm{d}e/\mathrm{d}\delta$ can be either positive or negative: *Informal insurance can increase or decrease risk-taking*
  - The risk reduction, by itself encourages a reduction in effort. However, as *d* increases, individuals become less selfish in their choice of effort.

Informal and Formal insurance without basis risk

- Now introduce aggregate risk and index insurance (No basis risk)
- Probability that an adverse event causes losses for all participants = q
- Assume q and P are independent. P is now idiosyncratic risk

Proposition 2:

If there is no basis risk and index insurance is actuarially fair, the partners will choose full index insurance and variation in δ will have no effect on the demand for index insurance.

- Aggregate risk or index insurance does not affect optimal informal payout
- **Result 2:** *Informal individual insurance does not crowd out index insurance – in the absence of basis risk*

Introducing Basis Risk

- r = probability a payout is made by insurance company
- q and r correlated imperfectly
- Basis Risk parameter ρ :
  - ρ = the joint probability that there is no payout from index insurance but each community member experiences the loss L
- **Result 3:** Basis risk reduces the demand for index insurance

Basis Risk, Index and Informal Insurance

Result 4:

- If index insurance is actuarially fair but there is basis risk, the index is informative, and some index insurance is purchased, then

an increase in the ability of the group to indemnify idiosyncratic losses may increase the demand for index insurance .

(i.e. index insurance and informal risk sharing will generally not be independent)

Intuition

- Consider two communities:
  - 'A' has an informal risk sharing network, 'B' does not
  - The absolute worst state (incur loss d , loss L, pay the insurance premium but receive no compensation from the contract) is worse for community B
  - But, greater indemnification of the idiosyncratic loss when the aggregate loss is partially indemnified by the contract lowers the utility gain from the contract
- **Result 5**: Furthermore, the first term is larger and the second term is smaller the larger the basis risk ρ
  - With larger basis risk, the probability of the absolute worst state gets larger.

Implications to be Tested

- When there is no basis risk, informal idiosyncratic coverage should not affect demand for formal index insurance.
- If the informal network already provides index coverage, that can crowd out formal index insurance.
- With basis risk, indemnification against idiosyncratic risk and index insurance are complements.
- Index insurance can allow more risk-taking even in the presence of informal insurance
- As wage workers face less basis risk than cultivators, a reduction in basis risk will affect wage workers less than cultivators

Setting

- Advantages of data on sub-castes:
  - The risk sharing network is well defined (*jati*)
  - Exogenous (by birth, with strong penalties on inter-marriage (<5% marry outside *jati* in rural India)
  - *Jati*, not village (or geography) is the relevant risk-sharing group. Majority (61%) of informal loans and transfers originate outside the village.
  - Depending on *jati* characteristics, both idiosyncratic and aggregate risk may get indemnified to different extents.
  - We have historical (REDS) data on *jati* identity and transfers for a large sample (17 states, N=119,709 for census, and N=7342 for detailed sample survey) in response to idiosyncratic and aggregate risks

Key information from 2007/8 sample

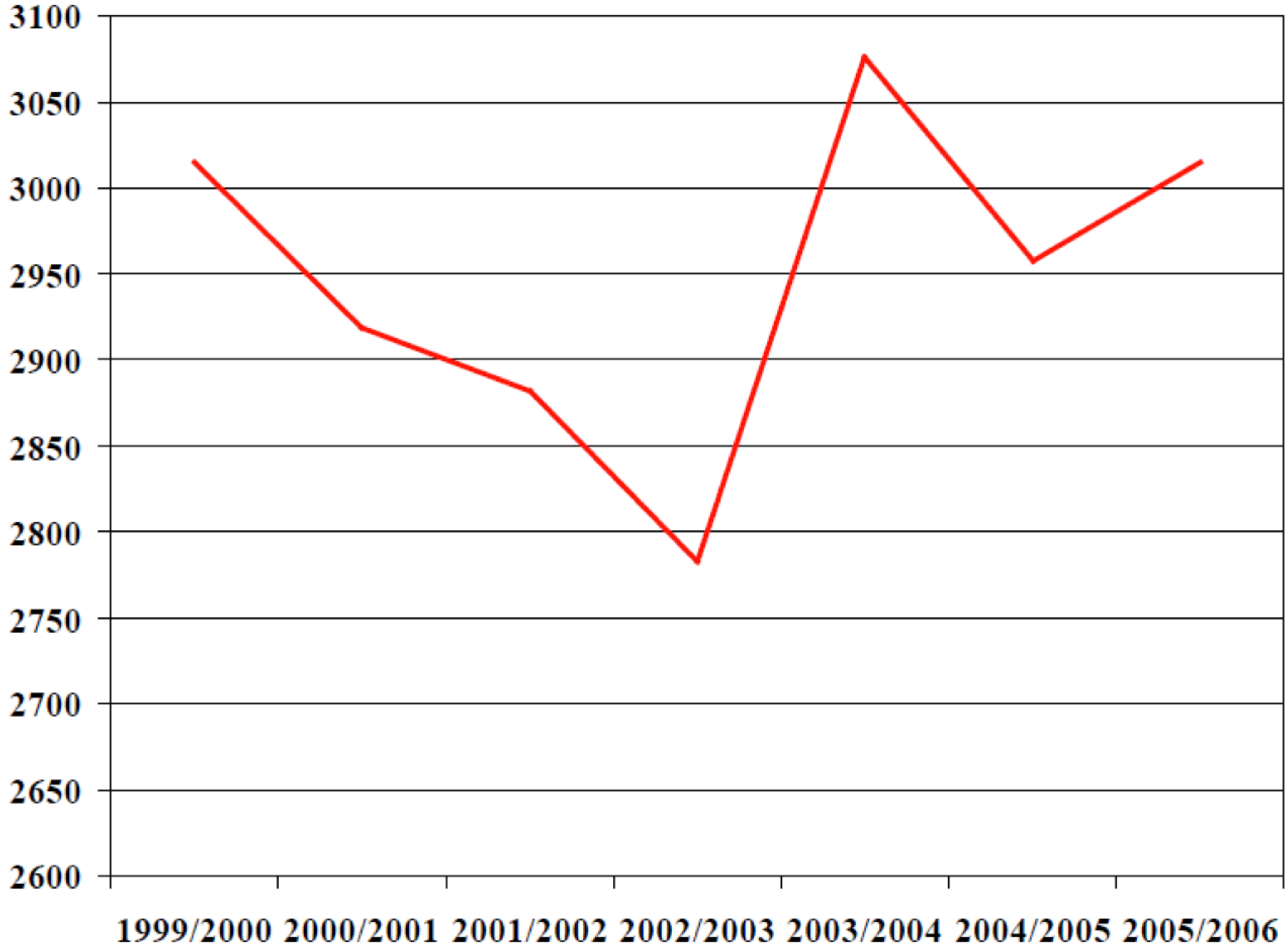
1. Amounts of "assistance received at time of difficulty"+ loans from relatives/friends within and outside the village in 2005/6
2. Monthly rainfall in each village from 1999/2000 through 2005/6
3. History of *Village-level* distress events (crop loss, pest attack, drought, cyclone/floods/hailstrorm, livestock epidemic) 1999/2000 - 2007/8
4. History of *Household-specific d*istress events (fire, deaths of immediate family, health problems/accidents, crop failure, theft/robbery, dry wells) 1999/2000 - 2007/8
5. Amounts of losses from each event
6. Measures taken by household to reduce impact of events after they occurred (crop choice, improved technology, livestock immunization)
7. Caste, land holdings, education, occupation, detail for computing farm profits (Foster and Rosenzweig, 2011).

=> *Can estimate jati responsiveness to idiosyncratic and aggregate shocks*

Table 1. Distribution of Distress Event Types, 1999-2006

Distress Type	Percent
Village level	
Crop loss	15.9
Drought	18.2
Floods/hailstorm	12.9
Pest attack	8.9
Livestock epidemic	3.1
Dry wells	3.1
Water-borne diseases	2.1
Epidemic	2.2
Household level	
Price increase	12.4
Crop failure	7.8
Sudden health problem	5.5
Death of immediate family member	5.1
Fire, theft, loss/damage of assets, job loss, theft/robbery, dry well	2.7

Figure 1: Mean Rainfall (mm) Across the Sample Villages, by Crop Year (Source: REDS 2007)



Randomized Field Experiment

- Sample drawn from 2006 REDS census data in Andhra Pradesh, Tamil Nadu and Uttar Pradesh (63 villages, of which 21 were controls)
- Households belonging to large castes (>50 households in census) so that *jati*- indemnification against idiosyncratic risk and aggregate risk can be precisely characterized
- Experiment:
  - Insurance offer randomized at caste/village level (spillovers)
  - Price randomized at the individual level (N=4667): 0, 10, 50 or 75% subsidy
  - Basis risk: 12 of 19 randomly chosen UP villages received rainfall gauge in the village itself.

Delayed Monsoon Onset Insurance Product

Agricultural Insurance Company of India (AICI)

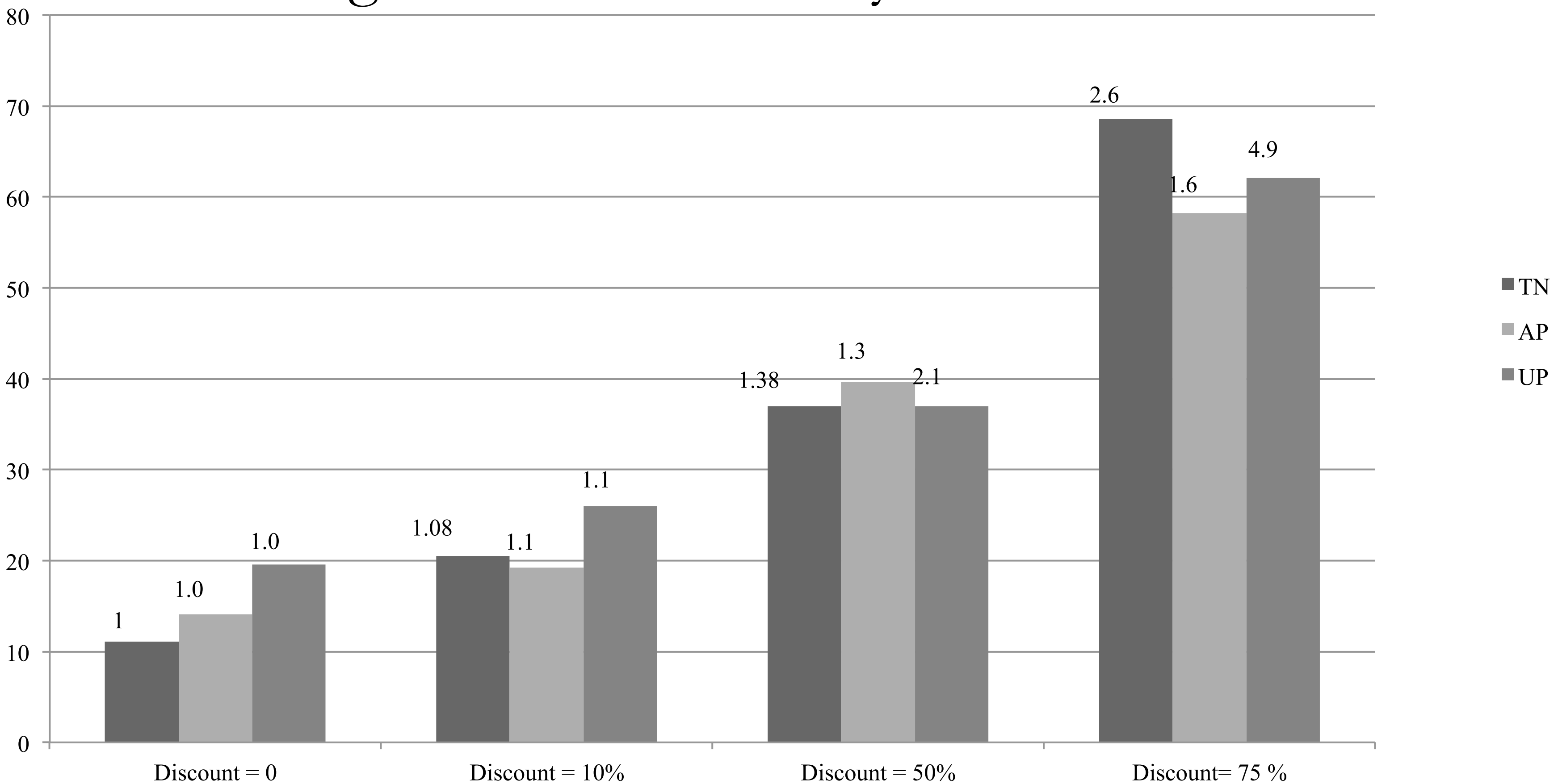
AICI offers area based and weather based crop insurance programs in almost 500 districts of India, covering almost 20 million farmers, making it one of the biggest crop insurers in the world.

Timing and Payout Function

Trigger Number	**Range of Days Post Onset** (varied across states and villages)	**Payout** (made if less than 30-40mm (depending on state) is received at each trigger point)
1	15-20	Rs. 300
2	20-30	Rs. 750
3	25-40	Rs. 1,200

Rainfall measured at the block level from AWS (Automatic weather stations)

Rainfall Insurance Take-up Rates and Average Number of Policy Units Purchased



Identifying the strength of informal, group-based idiosyncratic and index insurance

- Need to estimate the determinants of informal indemnification δ
- Payment δ_{ijk} made to household i in caste group j in village k in the event of a household-specific loss d_{ijk} or an aggregate village production shock ξ_k

$$\delta_{ijk} = \eta_{ij} d_{ijk} + \iota_{ij} \xi_k + \mu_j \quad \text{where } \eta_{ij} = \eta(X_j, X_{ij}), \ \iota_{ij} = \iota(X_j, X_{ij})$$

- Indemnification of shocks depends on caste and household characteristics.
- What are the relevant caste-level variables that affect the ability to pool risk?
  - Group's ability to indemnify risk and avoid moral hazard depends on the group's level of resources, its ability to agree on common actions, its ability todiversify risk, and its ability to monitor.

- Problem: the model indicates that risk-taking is endogenous at the sub-caste level
- Other unobserved caste-level characteristics might also matter.

Can estimate the interaction parameters η^{j}_{n} and i^{j}_{m} using caste-fixed effects to eliminate μ_{j} (and any unmeasured differences across Indian states)

Cannot identify the effect of caste variables on the level of transfers, but they are not of direct interest here

Response to Aggregate Risk

ML Conditional Logit Estimates of the Determinants of Receiving Financial Assistance (Informal Loans + Non-regular Transfers in Crop Year 2005/6)

Variable/Coefficient type	Log-Odds	Log-Odds	P
Adverse village rain deviation in 05/06	-0.00183	-0.00179	0.00045
	(2.96)	(2.91)	(2.90)
×Caste's mean land holdings	0.000256	0.000274	0.00007
	(1.90)	(1.95)	(1.95)
×Caste's proportion landless	0.00139	0.00165	0.00041
	(1.09)	(1.47)	(1.46)
×Caste's proportion hh's with in non-ag. occupations	0.0206	0.0207	0.0052
	(4.31)	(4.60)	(4.60)
×Caste's standard deviation of land holdings ($x10^{-3}$)	-0.00232	-0.00426	0.0011
	(0.22)	(0.39)	(0.39)
×Number of same-caste households in village ($x10^{-3}$)	0.00109	0.00114	0.00028
	(1.22)	(1.22)	(1.22)

Response to Idiosyncratic Risk

Variable/Coefficient type	Log-Odds	Log-Odds	P
Any individual household loss from distress event in 05/06	-0.833	-0.794	-0.195
	(2.09)	(2.09)	(2.17)
×Caste's mean land holdings	0.144	0.165	0.0412
	(1.69)	(2.01)	(2.01)
×Caste's proportion landless	1.37	1.22	0.305
	(1.89)	(1.91)	(1.92)
×Caste's proportion hh's with in non-ag. occupations	3.05	3.25	0.81
	(1.61)	(1.76)	(1.76)
×Caste's standard deviation of land holdings ($x10^{-3}$)	-16.5	-18.8	-4.69
	(2.09)	(2.43)	(2.43)
×Number of same-caste households in village ($x10^{-3}$)	1.77	1.73	0.00043
	(1.92)	(1.90)	(1.91)

Estimate the effect of informal insurance on formal index insurance demand

- Compute from the estimates caste-specific (and household-specific) abilities to indemnify against

  actual individual losses: $\eta_j = \Sigma \eta^j_n X_{jn}$

  aggregate shocks (index) $\iota_{ij} = \Sigma \iota^j_n X_{jn}$

- Use as determinants of formal insurance take-up

Table 6

Fixed-Effect Estimates: Determinants of Formal Insurance Take-up

	Three States	Two States	Two States			
Variable/Est. Method	FE-State		FE-State		FE-Caste	
η_j [Informal Idiosyncratic coverage]	0.125	0.151	0.142	0.0228	-	-
	[0.77]	[0.82]	[0.15]	[0.15]		
η_j × Distance to aws	-	-	-	0.151	0.139	0.157
				[2.48]	[2.09]	[2.30]
ι_j [Informal aggregate coverage]	-198	-209.6	-213.6	-209.7	-	-
	[1.95]	[1.49]	[1.51]	[1.53]		
ι_j × Distance to aws	-	-	-	-	-	-18.6
						[0.85]
Distance to aws (km) [Basis Risk]	-	-	-0.00101	-0.0254	-0.0246	-0.019
			[0.48]	[2.56]	[2.66]	[1.96]
Agricultural laborer	-0.0343	-0.0341	-0.0357	-0.028	-0.0238	-0.0379
	[1.70]	[1.52]	[1.65]	[1.23]	[1.10]	[1.39]
Agricultural laborer × Distance to aws	-	-	-	-	-	0.00333
						[1.03]
Actuarial price	-0.00143	-0.00159	-0.00162	-0.00167	-0.00154	-0.00157
	[1.77]	[1.71]	[1.71]	[2.58]	[2.56]	[2.55]
Subsidy	0.389	0.355	0.351	0.35	0.376	0.372
	[2.68]	[2.10]	[2.05]	[2.71]	[3.14]	[3.07]
Owned land holdings	0.000405	0.000445	0.00045	0.000648	0.00353	0.0035
	[0.16]	[0.17]	[0.17]	[0.26]	[1.75]	[1.75]
Village coefficient of variation, rainfall	0.523	0.751	0.781	0.747	0.874	0.908
	[1.56]	[2.02]	[2.04]	[1.91]	[2.53]	[2.43]
N	4,260	3,338	3,338	3,338	3,338	3,338

Absolute values of t-ratios in brackets, clustered at the village level. Specifications also include scheduled tribe or caste indicator and whether non-Hindu

Test of Result 1: Are higher levels of *ex post protection* against idiosyncratic losses in cooperative risk-sharing schemes associated with more conservative investments and thus lower average incomes?

Caste Fixed-Effects Estimates: Effect of an Adverse Event on Subsequent Action to Reduce Risk by Farmers

Variable	(1)	(2)
Experience adverse event (village or household)	0.237	0.229
	[3.22]	[2.95]
$\times\eta_j$	1.21	1.23
	[2.76]	[2.75]
$\times\iota_j$	-238	-249
	[1.78]	[1.82]
×Head's years of schooling	-	0.00306
		[1.09]
×Owned land holdings	-	-0.00133
		[0.56]
Head's years of schooling	0.00178	0.000348
	[1.39]	[0.33]
Owned land holdings	-0.00026	-0.00133
	[0.22]	[0.56]
N	3,600	3,600

Absolute values of t-ratios in brackets, clustered at the village level.

Risk-taking effects of formal index insurance (ITT estimates for Tamil Nadu)

- Compare treated sample to control sample
- Control sample: in villages and *jatis* not receiving offer *(N=648)*
  - No possibility of spillovers
- Measures of risk-taking: crop choice
  - Average return and resistance to drought of planted rice varieties
  - Based on perceived qualities of 94 different rice varieties planted in prior seasons rated on three-category ordinal scale

Table 8
Properties of Rice Varieties Planted by Tamil Nadu Rice Farmers

Property	Yield	Drought Resistant	Disease Resistant	Insect Resistant
Good	61.0	58.9	40.3	34.7
Neither good nor poor	30.7	30.9	46.2	50.6
Poor	8.3	10.2	13.5	14.7
Total	100.0	100.0	100.0	100.0
Number of varieties		94		
Number of farmers		364		

Table 9

Intent-to-Treat Fixed-Effects Caste Estimates of Index Insurance on Risk and Yield:

Proportion of Planted Crop Varieties Rated "Good" for Drought Tolerance and Yield, Tamil Nadu *Kharif* Rice Farmers

Crop Characteristic:	Good Drought Tolerance		Good Yield	
Variable	(1)	(2)	(1)	(2)
Offered insurance	-0.0593	0.376	0.0519	-0.517
	[2.67]	[1.74]	[1.93]	[1.54]
$\times\eta_j$	-	-1.64	-	2.13
		[1.32]		[1.47]
$\times\iota_j$	-	181.5	-	-232.9
		[0.63]		[0.75]
Owned land holdings	0.0000934	0.0000468	0.00056	0.00131
	[0.02]	[0.02]	[0.12]	[0.26]
Village coefficient of variation, rainfall	0.351	0.398	-0.516	-0.567
	[0.88]	[1.08]	[0.81]	[0.95]
N	325	325	325	325

Absolute values of t-ratios in brackets, clustered at the caste/village level.

Conclusions

- Informal networks lower the demand for formal insurance *only if* the network covers aggregate risk.
- When formal insurance carries basis risk, informal risk sharing can be a complement to formal insurance
- Formal insurance enables households to take more risk, and assists in income growth.
- Landless laborers' livelihoods are weather dependent, and they also demonstrate a strong demand for insurance, especially relative to cultivators living farther away from rainfall stations.