Formal Insurance, Informal Risk Sharing, and Risk-Taking

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Background

• Formal insurance markets largely absent where they are needed
  – 75% of the world’s poor engaged in agriculture
  – 90% of variation in Indian agricultural production caused by variation in rainfall
  – 90% of Indians not covered by formal insurance

• Informal risk sharing networks are important
  – Protects against idiosyncratic risk 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 Insurance

• Under-developed Formal Insurance Market
  – Income/liquidity constraints, Trust/fraud issues,
  – High overhead costs (moral hazard, adverse selection)

• Index-based insurance
  – Payment schemes based on an *exogenous* publically observable index, such as local rainfall
  – Mitigates moral hazard and adverse selection
  – Eliminates the need for in-field assessments
  – **Basis risk** (Clarke 2011)
  – Low Demand (Cole et al 2009, Gine and Yang 2009)
Setting and Approach

• We design a simple index insurance contract for AICI
  – Based on monsoon onset date
• We randomize insurance offers to 5100 cultivators and wage laborers across three states in India

• The sub-caste (*jati*) is the identifiable risk-sharing network
  – *Jatis* can span districts or even states (permits aggregate risk sharing of village rainfall shocks)
• We make offers to *jatis* for whom we have rich, detailed histories of both aggregate and idiosyncratic shocks and responsiveness to shocks.
• We randomly allocate rainfall stations to some villages.
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

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

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

1. Demand for Insurance
   – How does the presence of risk-sharing networks affect the demand for index insurance?
   – Interactions with Basis Risk
2. Risk-Taking
   – Does informal risk sharing allow farmers to take more risk?
   – Does index insurance allow farmers to take more risk?
3. Spillover Effects – Cultivators and Landless Laborers
   – Do insurance sales affect labor market relationships?
   – Should the Indian government continue targeting insurance marketing to only cultivators?
Empirical Approach

• Sources of variation in the data:
  – Designed random variation in index insurance offers from the RCT (3 states)
  – Designed random variation in extent of basis risk (1 state)
  – Natural variation in informal risk-sharing stemming from birth in certain sub-castes (data from 17 states)

• People are born into the risk sharing network (exogenous)
• Cannot exit
• Can measure nature and extent of risk sharing for each caste using census data
Informal Risk Sharing

• Historical data on
  – Aggregate shocks (village-level rainfall)
  – Idiosyncratic shocks (e.g. illness, theft)
  – Gifts and transfer given and received

• Some castes indemnify aggregate shocks well
  – e.g. castes with occupational diversification

• Some castes indemnify idiosyncratic shocks well
  – e.g. caste members in village, to control moral hazard

• Create index of “aggregate risk sharing” and “idiosyncratic risk sharing” for each caste
Jatis can insure aggregate risk

Lowess-Smoothed Relationship between Inter-Village Distance (Km) and June-August Rainfall Correlation, Andhra Pradesh and Uttar Pradesh 1999-2006
Figure 1: Mean Rainfall (mm) Across the Sample Villages, by Crop Year
(Source: REDS 2007)
Rain per Day in 2011 *Kharif* Crop Season in Andhra Pradesh, by Rainfall Station

Insurance Payout Stations in Red (with Rupee Amount)
Theory

• Aggregate (informal) risk sharing and index insurance are substitutes, but not idiosyncratic risk sharing

• Basis risk lowers the demand for index insurance
• With basis risk, idiosyncratic (informal) risk sharing and index insurance can become complements!
• Why?
  – Basis risk creates a state where farmer suffers from drought on farm, pays insurance premium, and does not get a payout
  – Especially valuable to have informal help from friends during such bad states
Basis Risk Exists

Lowess-Smoothed Relationship Between Log Output Value per Acre and Log Rain per Day in the *Kharif* Season, by Placement of Rain Station

- **AWS Outside Village**
- **AWS in Village**
Price Effects on Demand

Insurance Take-up by Subsidy: Cultivator vs Agr Laborer

**ANDHRA PRADESH**
- Agr labor (pure)
- Cultivator

**TAMIL NADU**
- Agr labor (pure)
- Cultivator

**UTTAR PRADESH**
- Agr labor (pure)
- Cultivator

Subsidy levels:
- 0
- 0.1
- 0.5
- 0.75
Relationship Between Distance to the Nearest AWS and Index Insurance Take-up, by Level of Informal ‘Idiosyncratic’ Risk-Sharing
Informal Risk Sharing and Demand for
Index Insurance

Effect of ‘idiosyncratic’ informal risk sharing on insurance demand

Effect of ‘aggregate’ informal risk sharing on insurance demand
Risk-Taking

• Insurance would ideally allow farmers to pursue riskier, high-return technologies
  – Risk-taking promotes growth

• Informal Risk Sharing can lower risk-taking
  – Arnott-Stiglitz (1991): the network needs to control moral hazard

• Index insurance allows farmers to take more risk even in the presence of informal risk sharing
Empirical Test

• ‘Risk Taking’ can take many different forms…
  – Changes in crops, or in seed varieties, or changes in input use (fertilizer, irrigation)
  – …each of which is difficult to measure directly

• **Summary measure**: Output should be *more sensitive* to rainfall if farmers are taking more risk

• We will also study seed variety choice directly
• Every result heretofore is ‘intent to treat’ (pure experimental estimate)
Figure 6: Lowess-Smoothed Relationship Between Log Per-Acre Output Value and Log Rain per Day in the *Kharif* Season, by Insurance Type and Level

- **High Informal Indemnification, No Rainfall Insurance**
- **Low Informal Indemnification, No Rainfall Insurance**
- **Offered Rainfall Insurance**
Figure 7: Effects of Insurance Offers on Rice Varieties Planted: Farmers in Tamil Nadu

- Crops Characterized as having Good Yield
- Crops with Good Drought Tolerance

Offered insurance
Not offered insurance
Weather Insurance and the Landless

• Weather insurance programs exclusively targeted to (landed) cultivators who have an “insurable interest”

• Insurance induces farmers to take more risk =>
  – increased wage risk for agricultural laborers.

• Landless are the least able to handle risk, and are worse off

• We study the general equilibrium effects of insurance on labor supply, labor demand and insurance demand.
General Equilibrium Theory

• Effect of offering rainfall insurance to cultivating households:
  – A ‘high return’ effect, a ‘high risk’ effect
  – Increase the amount of labor hired
  – Increase the sensitivity of labor demand to rainfall
    (cultivators pass on risk to landless)

• Effect of offering insurance to wage workers:
  – Reduces wage volatility (via labor supply, migration)
  – Increases profit volatility
    • (insured laborers supply less labor than uninsured in bad rainfall states)
Figure 10: Lowess-Smoothed Relationship Between Hired Male Harvest Labor Use and Rain per Day in the *Kharif* Season among Farmers, by Insurance Offer
Insurance Demand Spillover

• Offering weather insurance to cultivators should increase the demand for insurance by the landless

• Regression estimate:
  – At sample mean, landless households are 12 percentage points (31.5%) more likely to purchase insurance if all cultivating households are offered the insurance product than if none are.
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.
• Landless likely to be worse off (in terms of risk management) if only cultivators are offered insurance.
EXTRA SLIDES
Labor Supply of Landless Farmers

• Non-linear effects of rainfall on days worked:
  – At low levels, labor supply increases with rainfall
  – At high levels, income effect may dominate

• Effect of Rainfall Index Insurance on landless:
  – Makes labor supply less responsive to rainfall variation
  – Lowers the level of labor supply

• GE cross labor-supply effect:
  – Insuring the landless raises cost of cultivation and increases wage volatility - makes cultivators worse off
  – Regression estimate of effect of index insurance offer: 12.7 (28.3%) fewer days worked
Figure 8: Lowess-Smoothed Relationship Between Days Worked for Agricultural Wages and Rain per Day in the *Kharif* Season Among the Landless, by Insurance Offer
Migration during Kharif season

• Non-linear rainfall effect on migration propensity
  – Lots of rainfall => don’t need to migrate
  – Drought=> difficult to take risk or finance migration
    (Bryan, Chowdhury, Mobarak 2012)

• Offering weather insurance to landless should lower out-migration and lower sensitivity of out-migration to local weather

• Lowers average wages in bad times, which makes cultivators better off

• Estimated effect of offering rainfall insurance:
  – Lowers migration 2-3 percentage points during droughts
  – Flattens the rainfall-migration relationship
Is there basis risk in this sample?

<table>
<thead>
<tr>
<th>Variable</th>
<th>Uttar Pradesh</th>
<th>UP+AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain per day</td>
<td>0.16516</td>
<td>0.13937</td>
</tr>
<tr>
<td></td>
<td>[1.32]</td>
<td>[1.4]</td>
</tr>
<tr>
<td>Distance to aws (km)</td>
<td>0.12483</td>
<td>0.08460</td>
</tr>
<tr>
<td></td>
<td>[2.4]</td>
<td>[1.92]</td>
</tr>
<tr>
<td>Rain per day x Distance to aws</td>
<td>-0.02231</td>
<td>-0.01673</td>
</tr>
<tr>
<td></td>
<td>[3.53]</td>
<td>[2.81]</td>
</tr>
<tr>
<td>N</td>
<td>945</td>
<td>1,459</td>
</tr>
</tbody>
</table>

Absolute values of t-ratios in brackets, clustered at the village level. Two state regressions include state fixed effects.
### Fixed-Effect Estimates: Determinants of Formal Insurance Take-up

<table>
<thead>
<tr>
<th>Variable/Est. Method</th>
<th>Three States</th>
<th>FE-State</th>
<th>Two States (AP and UP)</th>
<th>FE-Caste</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \eta_j ) [Informal Idiosyncratic coverage]</td>
<td>0.125</td>
<td>0.151</td>
<td>0.142</td>
<td>0.0228</td>
</tr>
<tr>
<td>[0.56]</td>
<td>[0.61]</td>
<td>[0.00]</td>
<td>[0.07]</td>
<td></td>
</tr>
<tr>
<td>( \eta_j \times \text{Distance to aws} )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.151</td>
</tr>
<tr>
<td>[3.42]</td>
<td>[2.55]</td>
<td>[2.31]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \iota_j ) [Informal aggregate coverage]</td>
<td>-198</td>
<td>-209.6</td>
<td>-213.6</td>
<td>-209.7</td>
</tr>
<tr>
<td>[1.71]</td>
<td>[1.28]</td>
<td>[1.29]</td>
<td>[0.94]</td>
<td></td>
</tr>
<tr>
<td>( \iota_j \times \text{Distance to aws} ) [Basis Risk interaction]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[-0.528]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to aws (km) [Basis Risk]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.00101</td>
</tr>
<tr>
<td>[0.41]</td>
<td>[3.50]</td>
<td>[2.63]</td>
<td>[1.50]</td>
<td></td>
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<tr>
<td>Agricultural laborer</td>
<td>-0.0343</td>
<td>-0.0341</td>
<td>-0.0357</td>
<td>-0.028</td>
</tr>
<tr>
<td>[2.19]</td>
<td>[2.13]</td>
<td>[2.17]</td>
<td>[1.58]</td>
<td>[1.49]</td>
</tr>
<tr>
<td>Agricultural laborer ( \times ) Distance to aws</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[0.797]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actuarial price</td>
<td>-0.00143</td>
<td>-0.00159</td>
<td>-0.00162</td>
<td>-0.00167</td>
</tr>
<tr>
<td>[2.07]</td>
<td>[2.07]</td>
<td>[2.04]</td>
<td>[2.40]</td>
<td>[2.14]</td>
</tr>
<tr>
<td>Subsidy</td>
<td>0.389</td>
<td>0.355</td>
<td>0.351</td>
<td>0.35</td>
</tr>
<tr>
<td>[3.38]</td>
<td>[2.86]</td>
<td>[2.75]</td>
<td>[3.10]</td>
<td>[3.26]</td>
</tr>
<tr>
<td>Owned land holdings</td>
<td>0.000405</td>
<td>0.000445</td>
<td>0.00045</td>
<td>0.000648</td>
</tr>
<tr>
<td>[0.14]</td>
<td>[0.14]</td>
<td>[0.14]</td>
<td>[0.20]</td>
<td>[1.42]</td>
</tr>
<tr>
<td>Village coefficient of variation, rainfall</td>
<td>0.523</td>
<td>0.751</td>
<td>0.781</td>
<td>0.747</td>
</tr>
<tr>
<td>[2.16]</td>
<td>[2.89]</td>
<td>[2.92]</td>
<td>[2.77]</td>
<td>[2.92]</td>
</tr>
</tbody>
</table>
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
## Properties of Rice Varieties Planted by Tamil Nadu Rice Farmers

<table>
<thead>
<tr>
<th>Property</th>
<th>Yield</th>
<th>Drought Resistant</th>
<th>Disease Resistant</th>
<th>Insect Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>61.0</td>
<td>58.9</td>
<td>40.3</td>
<td>34.7</td>
</tr>
<tr>
<td>Neither good nor poor</td>
<td>30.7</td>
<td>30.9</td>
<td>46.2</td>
<td>50.6</td>
</tr>
<tr>
<td>Poor</td>
<td>8.3</td>
<td>10.2</td>
<td>13.5</td>
<td>14.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Number of varieties: 94
Number of farmers: 364
## 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

<table>
<thead>
<tr>
<th>Crop Characteristic:</th>
<th>Good Drought Tolerance</th>
<th>Good Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Offered insurance</td>
<td>-0.0593</td>
<td>0.376</td>
</tr>
<tr>
<td>× η&lt;sub&gt;j&lt;/sub&gt;</td>
<td>[2.67]</td>
<td>[1.74]</td>
</tr>
<tr>
<td>× ι&lt;sub&gt;j&lt;/sub&gt;</td>
<td>-</td>
<td>-1.64</td>
</tr>
<tr>
<td>× η&lt;sub&gt;j&lt;/sub&gt;</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Owned land holdings</td>
<td>0.0000934</td>
<td>0.0000468</td>
</tr>
<tr>
<td></td>
<td>[0.02]</td>
<td>[0.02]</td>
</tr>
<tr>
<td>Village coefficient of variation, rainfall</td>
<td>0.351</td>
<td>0.398</td>
</tr>
<tr>
<td></td>
<td>[0.88]</td>
<td>[1.08]</td>
</tr>
<tr>
<td>N</td>
<td>325</td>
<td>325</td>
</tr>
</tbody>
</table>

Absolute values of t-ratios in brackets, clustered at the caste/village level.
Figure 9: Lowess-Smoothed Relationship Between the Probability of Temporary Out-Migration and Rain per Day in the *Kharif* Season, by Insurance Offer (Males Aged 15-49)