The Effects of Rainfall Insurance on the Agricultural Labor Market

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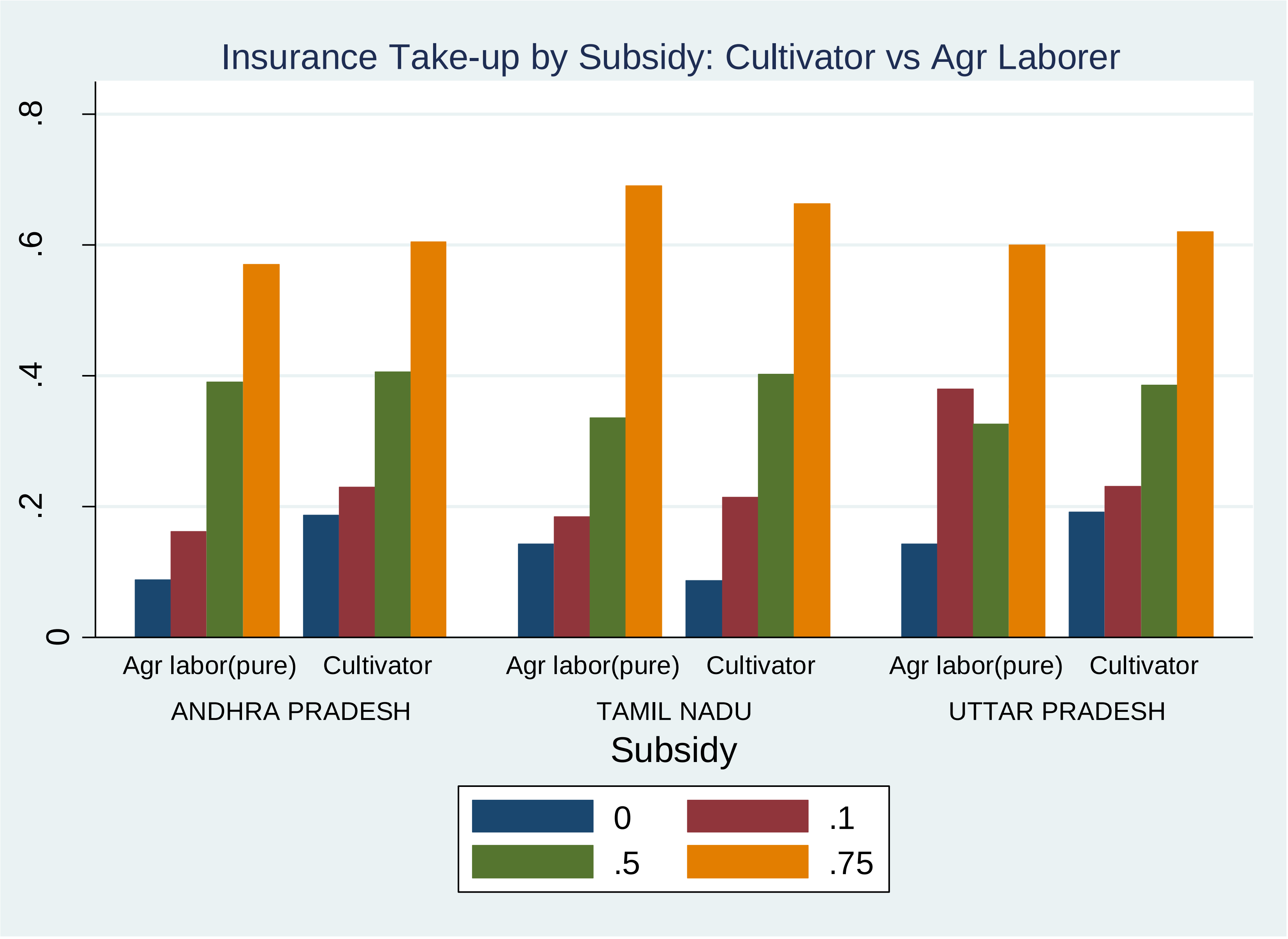
Background on the project and the grant

- In the IGC-funded precursors to this paper, we study:
  - **Demand for Insurance:** How do caste-based informal risk sharing networks mediate the demand for formal index insurance with basis risk?
  - **Effects of Insurance**: Do informal risk sharing and index insurance allow farmers to take more risk?
- The BASIS grant was awarded to study spillover effects of insurance
- We study a specific type of spillover which has a clear theoretical basis, and is policy-relevant:
  - General equilibrium labor market effects of selling insurance to the landed and the landless

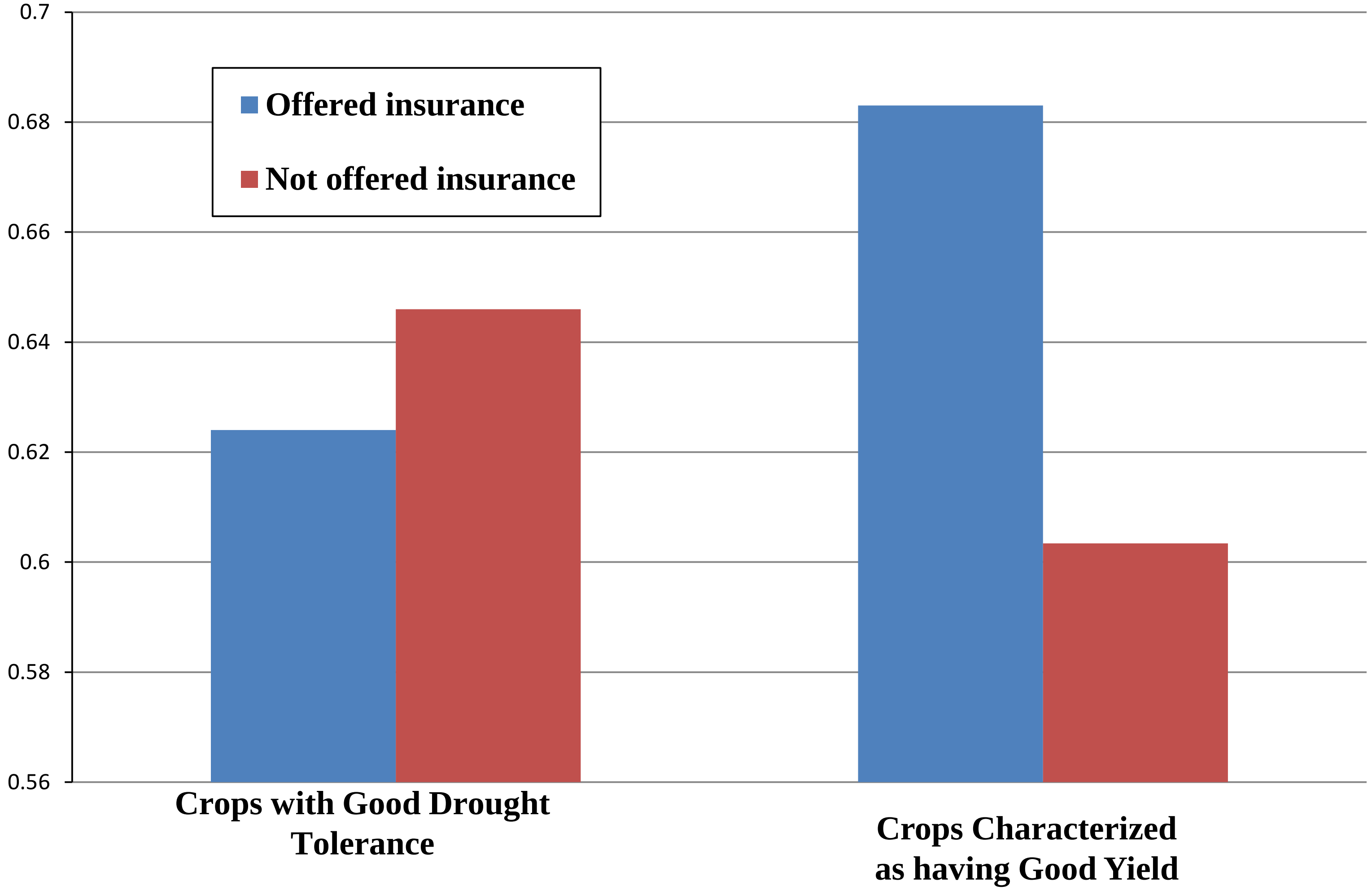
Policy Setting

- In India agricultural insurance is marketed exclusively to those who have an "insurable interest"
  - Landed, cultivator households
- Majority of rural Indians engaged in agriculture are landless or near-landless
- Raises two issues:
  - Labor demand varies with rainfall, and the landless therefore need insurance
  - If insurance allows cultivators to take more risk, then selling insurance only to cultivators may make the landless worse off than if insurance did not exist!

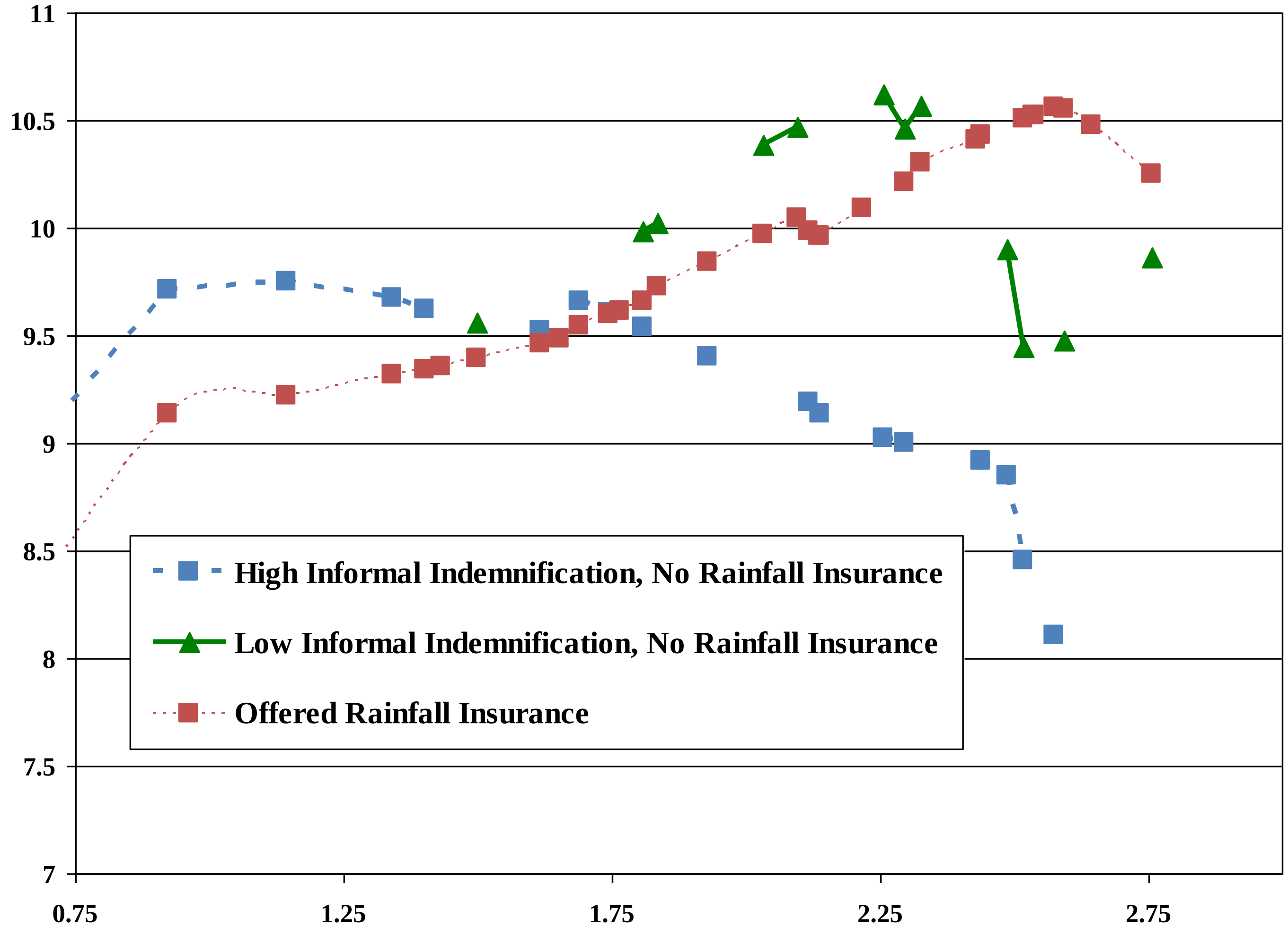
Demand for Insurance in Experiment



When offered Insurance (ITT from RCT experiment), farmers in Tamil Nadu switch to high-risk, high-return varieties of rice



With Insurance, Cultivator Output becomes more responsive to rainfall variation



Lowess-Smoothed Relationship Between Log Per-Acre Output Value and Log Rain per Day in the *Kharif* Season, by Insurance Type and Level

Research Needs for Devising Policy

- Same results from other insurance RCTs:
  - Karlan et al 2013 in Ghana
  - Cole et al 2012 in India
- Landless (wage workers) income arguably even more directly tied to rainfall:
  - heterogeneity in farmer characteristics and land induce idiosyncratic components of risk;
  - all agricultural wage workers of the same gender receive the same wage for any given operation/crop
- Important to study the details to evaluate and devise proper insurance marketing policy
  - e.g. does labor demand become more volatile?
  - Can the landless self-insure through labor supply changes?

Outline 1: Theory

- General-equilibrium model in which both landless (supplying labor), and cultivators (hiring labor) face risk but no borrowing constraints.
- Theory: Labor Demand Effect
  - subsidizing rainfall insurance for cultivators results in more risk for wage workers:
  - wages higher but more volatile across weather states
- Theory: Labor Supply
  - Subsidizing rainfall insurance to wage workers reduces wage volatility (via labor supply: uninsured work more than insured in the bad state)
  - Increases profit volatility for farmers

Outline - Empirics

- RCT offering rainfall (monsoon onset) index insurance to 5000+ cultivators and landless agricultural workers in three states in India (UP, AP, TN)
- Individual-level random variation in insurance offers and weather-based payouts
  - Effects on labor supply and seasonal migration for the landless, and labor demand by cultivators
- Village-level random variation in *proportions* of cultivators and wage workers offered insurance
  - Effects on demand for insurance by landless, on labor supply and demand (through equilibrium wage effects)

Landless Labor Households, Labor Supply and Rainfall Insurance

$$U = h^{\gamma}c^{(1-\gamma)}$$

There are two states of nature, L and H

The L-state occurs with probability q

Insurance costs p per unit and pays out L

$$c^L = w^L(1-h) + m - pI + I$$

$$c^H = w^H(1-h) + m - pI,$$

where m = non-earnings income, 1-h = l^s(labor supply)

$$\max_{I,h} E(U) = qU^L + (1-q)U^H$$

FONC: $q(1-p)U_c^L = p(1-q)U_c^H$ ($U_c^L = U_c^H$ if actuarially fair)

Key Results

- **Proposition 1**: Increase in $(w^H - w^L)$ will increase demand for insurance among landless
- **Proposition 2**: Labor supply of insured and uninsured varies across weather states:
  - In the bad state, insured labor supply is lower (they get payouts, and have less need for income)
  - In the good state, insured labor supply is higher (they have paid the premium)
- Empirics: we will have variation in both insurance offers and payouts

Cultivator Households, the Demand for Labor and Insurance

Production takes place in stages:

In stage 1, cultivators decide on the stage-1 input x and whether to take insurance

In stage 2, the state of nature θ^j is realized, labor is hired and profits are maximized

$$\text{Stage-2 profits} = \theta^j l^{\beta} x^{(1-\beta)} - w^j l$$

where l = hired labor (labor demand)

Thus, in any state j, labor demand is

$$l = x(\beta\theta^j/w^j)^{1/(1-\beta)}$$

The stage-1 program:

$$\max_{x,\, I} E(U) = U(c_1) + b[qU(c_2^L) + (1-q)U(c_2^H)]$$

$$c_1 = m - x - s - pI$$

$$c_2^j = rs + \theta^j l^{\beta} x^{(1-\beta)} - w^j l + \iota^j I$$

where $\iota^j = 1$ if $j=H$

$\iota^j = 0$ if $j=L$

S= savings, r=savings return

There are no credit constraints

x is below the profit-maximizing level because of uncertainty

*Proposition 3: x is higher the lower the cost of insurance (lower for the uninsured)

Labor Market Equilibrium in any state j

$$1 - \gamma - \gamma y^j/w^j \quad = \quad x(\beta\theta^j/w^j)^{1/(1-\beta)}$$

<u>Proposition 4</u>: Offering insurance to landless laborers dampens wage volatility (Δw).

Proof: The effect of an increase in y on the equilibrium wage is

$$dw/dy = \gamma(\beta-1)w/[(\gamma y(\beta-1) - \ell w] > 0$$

In state L, y is higher for the insured (ℓ lower), w^L increases.

In state H, y is lower for the insured (ℓ higher), w^H decreases.

Offering insurance to some landless smooths income for the uninsured landless.

<u>Proposition 5</u>: Offering insurance to cultivators increases average wages.

Proof: Insured cultivators use more x (Proposition 3). The effect of an increase in x on the equilibrium wage in any state is positive

$$dw^j/dx = (\beta\theta^j/w^j)^{1/(1-\beta)}(\beta-1)(w^j)^2/[\gamma y^j(\beta-1) - xw(\beta\theta^j/w^j)^{1/(1-\beta)}] > 0$$

<u>Proposition 6</u>: Offering insurance to cultivators increases wage volatility (Δw).

Proof: The effect of an increase in x on wages in the H state is higher than in the L state, so $d\Delta w/dx > 0$.

$$d(dw^j/d\theta^j)/dx = d(dw^j/dx)/d\theta^j = -w\gamma y(\beta-1)\beta(\beta\theta^j/w^j)^{\beta/(1-\beta)}/[wx(\beta\theta^j/w^j)^{1/(1-\beta)} - \gamma y(\beta-1)] > 0$$

Offering insurance to cultivators only may worsen the welfare of the (uninsured) landless.

*Lemma 1: The more insured cultivators there are the greater is the demand for insurance by the landless. See Proposition 1.

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)

Key Outcome Variables in Follow-Up Surveys

- Cultivators: Detailed information on agricultural inputs by stage of production.
  - Key for identifying *ex ante* and *ex post* investments.
  - Focus on use of harvest-stage labor, which is surely dependent on rainfall realizations and *ex ante* (planting-stage) investments.
- Information for landless households:
  - Days worked in agriculture for wages
  - Days spent working for wages outside the village (temporary out-migration)

Rain per Day in 2011 *Kharif* Crop Season in Andhra Pradesh, by Rainfall Station
Insurance Payout Stations in Red (with Rupee Amount)

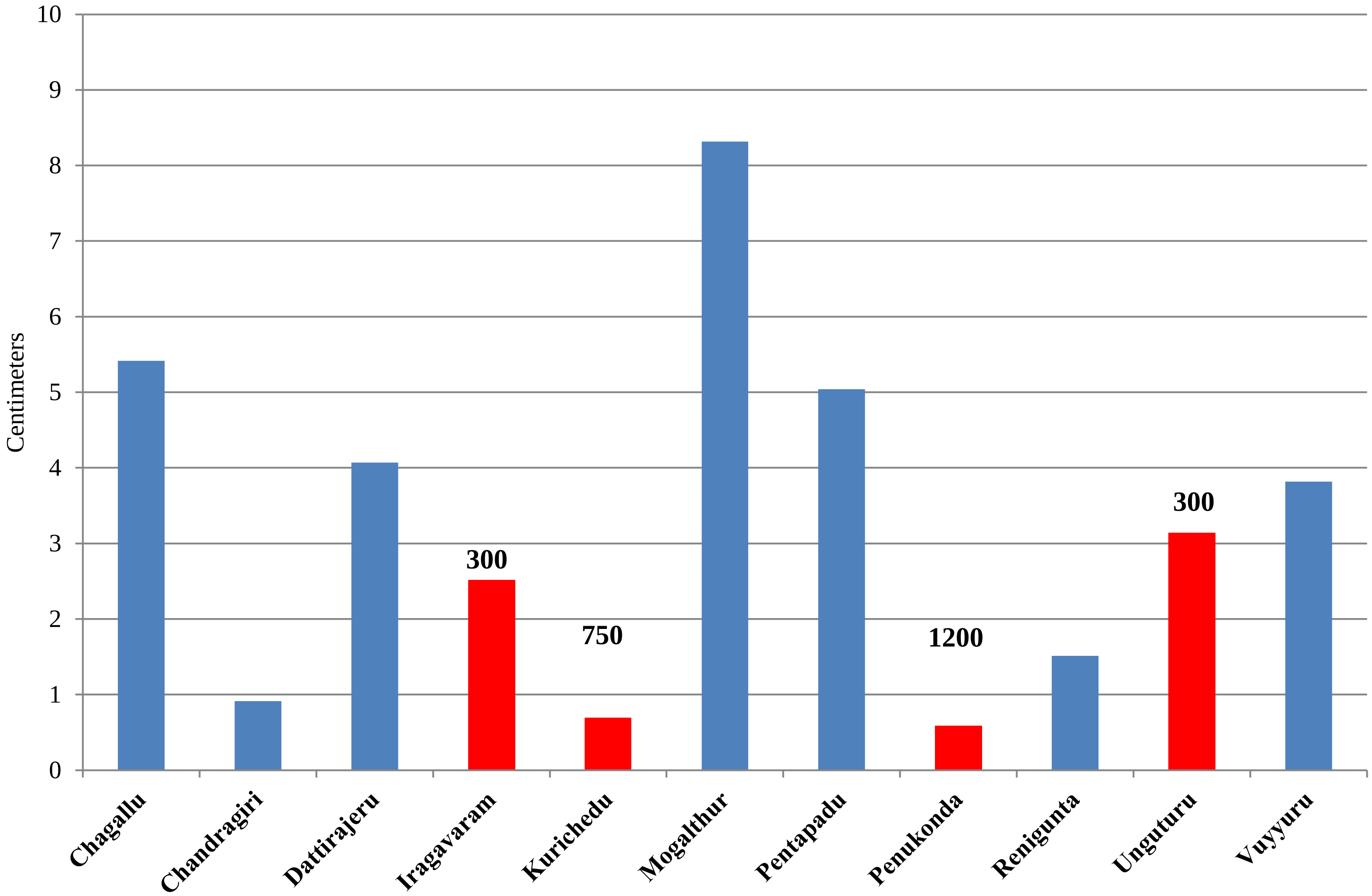


Figure 10: Lowess-Smoothed Relationship Between Hired Male Harvest Labor Use and Rain per Day in the *Kharif* Season among Farmers, by Insurance Offer

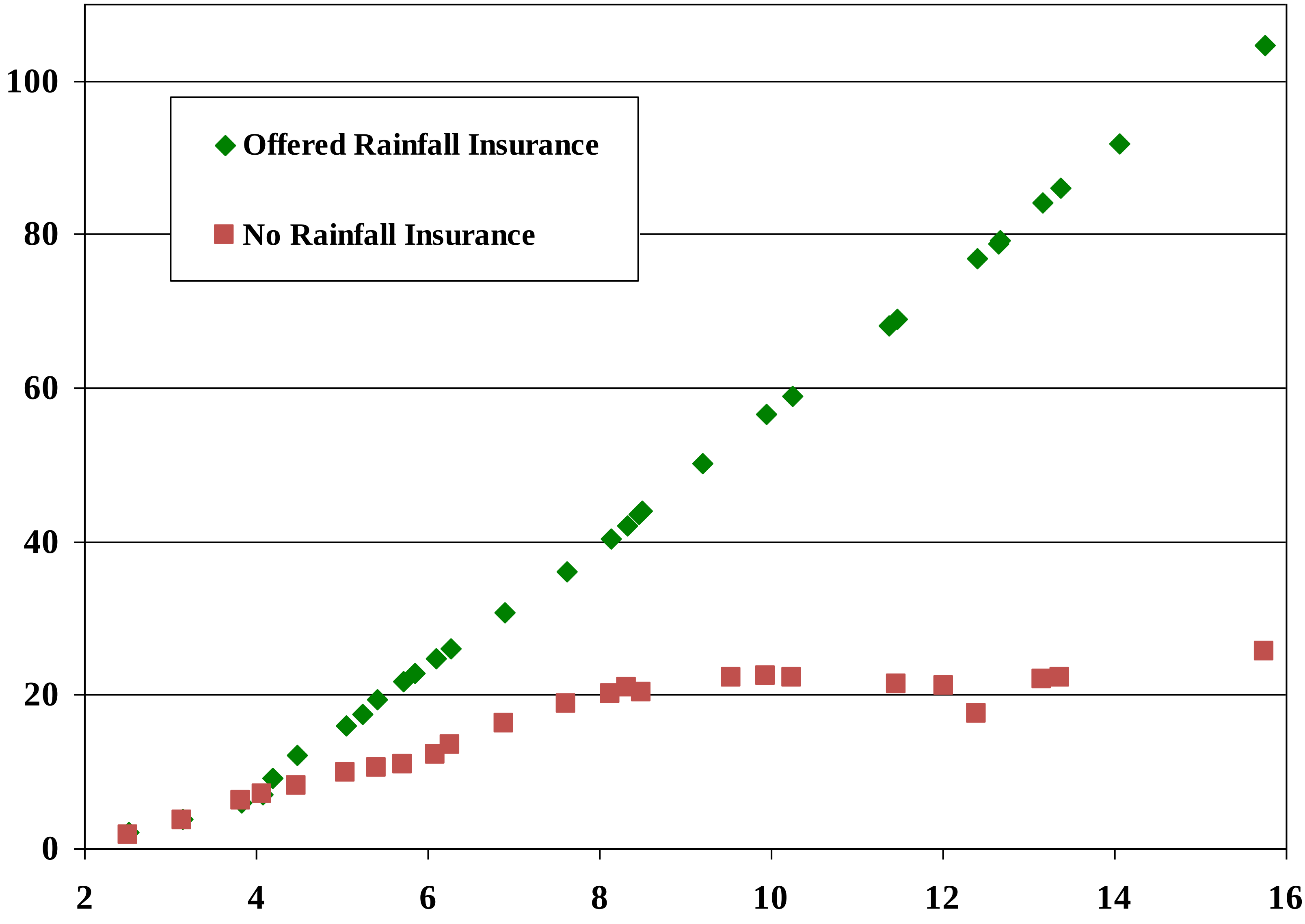


Table 5
Demand for *Kharif* Season Male Harvest Labor (Days) by Cultivators, by Sample

States	Andhra Pradesh		Tamil Nadu + Uttar Pradesh	
Fixed effects	Village	State	Village	None
Offered insurance	-6.76 (2.05)	-9.61 (2.90)	-1.70 (1.27)	-1.86 (0.56)
Offered insurance x mean rain per day	1.29 (2.77)	1.65 (3.26)	.324 (2.35)	.630 (1.99)
Offered insurance in payout village	4.02 (1.44)	7.22 (2.74)	-	-
Acreage cultivated	1.49 (2.84)	1.57 (2.91)	1.73 (2.57)	1.73 (2.57)
Proportion ag laborers in village offered insurance	-	95.6 (2.80)	--	22.5 (1.86)
Proportion ag laborers in village offered insurance in payout village	-	-85.4 (3.66)	-	-
Proportion ag laborers in village	-	.690 (0.05)	-	11.9 (1.17)
Mean rain per day	-	3.94 (3.01)	-	1.25 (1.26)
Mean rain per day squared	-	-.463 (2.93)	-	-.0741 (1.69)
N	833	833	734	734

Asymptotic *t*-ratios in parentheses clustered at the sub-caste level.

Table 6
Conditional (State) Logit Estimates, Whole Sample:
Take-up of Insurance Product Before the *Kharif* Season in Landless Agricultural Labor Households

Actuarial price	-.00965	-.0129
	(3.39)	(4.23)
Subsidy	1.62	1.20
	(3.64)	(2.62)
Distance to rainfall station	-.0641	-.0595
	(1.078)	(1.03)
Caste indemnity coefficient	.0663	.444
	(0.14)	(0.88)
Caste indemnity coefficient x distance	.349	.234
	(1.78)	(1.27)
Fraction of cultivators in village offered insurance	-	6.32
		(4.43)
Fraction of ag laborer households offered insurance	-	-1.19
		(1.14)
N	1,789	1,789

Bootstrapped *t*-ratios in parentheses clustered at the sub-caste level.

Ex-post Labor Supply Response: Temporary Migration

Conditional (Village) Logit Estimates, Whole Sample:
Kharif -Season Work as Migrant Laborer - Males Aged 25-44 in Landless Labor Households

Offered insurance	.651	3.87
	(1.86)	(3.46)
Offered insurance x mean rain per day in village	-	-.487
		(3.32)
Offered insurance in payout village	-	-2.15
		(1.74)
Age	.458	.453
	(1.57)	(1.53)
Age squared	-.00713	-.00709
	(1.63)	[1.60]
N	1,444	1,444

Asymptotic *t*-ratios in parentheses clustered at the sub-caste level.

- The landless migrate if buy insurance, but no payout
- This labor supply effect mitigated with more rainfall
- Migration effect smaller in villages where payouts are made

Concluding Comments

- Landless laborer households benefit from insurance and recognize the benefits -
  - Experimental evidence: their take-up of rainfall insurance was insignificantly different from that of cultivators (Mobarak & Rosenzweig, 2012).
- General-equilibrium effects enhance the benefits, raising wages in bad times
- Benefits to landless also larger when cultivators are insured; they pass on risk in the form of greater disparities in wages between low and high-rainfall states.
- Symmetrically, cultivators incur lower profits in bad times when the landless are insured.
- Political Economy? The absence of large-scale schemes providing weather insurance to labor households may not be due entirely to oversight.