Risk and Insurance Market Failures

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Role of Uncertainty in Rural Areas

- Households in rural areas of LDCs are subject to significant risks in many dimensions
- Production risks:
  - drought, temperature
  - natural disasters (earthquakes, volcanic eruptions, floods, fires)
  - crop yield (pest attacks)
  - cattle disease
  - price risk
- Consumption/need shocks:
  - health (sickness, medical emergencies)
  - prices of essential goods
- Some risks are idiosyncratic (sickness, unemployment), others are covariate (rainfall, natural disasters, price shocks)

Role of Insurance

- In developed societies, insurance provided either by private companies or government (in the form of drought relief, loan waivers, public health services)
- Insurance against idiosyncratic risks, also some covariate risks (e.g., national/global insurance companies can insure regional risks)
- For sufficiently large/national risks, the government (and international aid) is the sole source of relief

Insurance Failures in LDC Rural Areas

- Missing markets in LDCs for formal insurance against idiosyncratic or local covariate risks (such as rainfall)
- Why insurance companies do not provide services: high transaction costs (basis risk, moral hazard, costs of marketing and ex post state verification), limited willingness to pay (and understanding of insurance) of rural households
- Compounded by problems of low trust on both sides
- Active area of recent research: scope for provision of rainfall insurance (two empirical papers next week)

Consequences of Lack of (Formal) Insurance

- Gaps in formal insurance may be filled by informal insurance arrangements
- Extent to which this happens has been researched intensively, will review some of the relevant theoretical literature in these two lectures
- Scope for informal insurance is limited to local networks, which applies only to idiosyncratic risks

Consequences of Lack of Insurance, contd.

- *Poverty:* Panel studies of poverty dynamics of households in various developing countries (e.g., Krishna (Journal of Policy Analysis and Management, March 2010)):
  - role of sickness or death of household members, drought, land exhaustion, crop disease as factors precipitating movement into poverty
  - income diversification as main factor assisting escape from poverty
- *Growth:* To cope with risk, rural households (Karlan et al (2014)):
  - under-invest in high return activities (cash crop cultivation, non-farm business, migration)
  - over-invest in low return 'self-insurance' activities (grow subsistence crops, store grains, fragment landholdings, buy livestock)
- Policy Question: can the government or NGOs design and implement insurance to cope with these market failures?

To What Extent does Private Informal Insurance Substitute for Missing Formal Insurance?

- Large literature in 1980s and 1990s on insurance motive for various observed behaviors of rural poor (grain storage, land fragmentation, investments in livestock, marriage patterns, ROSCAs) — see Bardhan and Udry (1999)
- Townsend (Econometrica, 1994) took a different approach: to estimate the end-result of informal insurance arrangements by examining co-movement of household consumption within Indian villages
- Tested the hypothesis that actual risk-sharing was first-best, in 3 Indian ICRISAT villages using panel consumption data

Townsend (1994) Methodology

- Households $i = 1, \ldots, N$; dates $t = 1, .., T$, states $s = 1, \ldots, S$
- One consumption good, no savings, common vNM utility $U(c)$ strictly increasing, strictly concave, common discount factor δ
- Exogenous endowment/income realizations y_{ist}
- Common, exogenous beliefs π_s (no adverse selection or moral hazard)
- Ex ante Pareto optimal insurance: select allocation c_{ist} to maximize $\sum_i \lambda_i U_i$ subject to $\sum_i c_{ist} = \sum_i y_{ist}$ for some Pareto weights $\lambda_i > 0$, where

$$U_i \equiv \sum_t \delta^t \sum_{s=1}^{S} \pi_s U(c_{ist})$$

Townsend (1994) Methodology, contd.

- Arrow-Borch FOCs: for all s, t:

$$\frac{U'(c_{ist})}{U'(c_{jst})} = \frac{\lambda_j}{\lambda_i}$$

- If $U(c) = 1 - \exp(-ac)$, this requires $\exp[a(c_{ist} - c_{jst})] = \frac{\lambda_i}{\lambda_j}$, or $a(c_{ist} - c_{jst}) = \log \lambda_i - \log \lambda_j$
- Letting bars denote village averages:

$$c_{ist} = \bar{c}_{st} + \frac{1}{a}[\log \lambda_i - \log \bar{\lambda}]$$

- Test this prediction by regressing household consumption on village consumption, household income realization, and household fixed effects
- First-best risk sharing requires coefficient of village consumption to be 1, household income shocks: 0

First-Best Insurance Test Results

- Townsend uses 10 year panel for 10 households per village, in 8 villages in semi-arid area of India (Maharashtra, AP)
- Null hypothesis of first-best insurance is rejected, but narrowly (coefficient of village average consumption is around .9, household sickness and unemployment shocks close to 0
- Similar results of Paxson (JPE 1992) for Thailand, using rainfall shocks as an instrument for transitory income fluctuations, which have near zero effect on household consumption

First-Best Insurance Test Results, contd.

- Subsequent econometric critiques of Townsend such as Chaudhuri and Ravallion (1998)
- Udry (RES 1994) study of Nigerian villages rejected hypotheses of first-best insurance using different methods
- Even in Indian ICRISAT data, role of social networks (stronger mutual insurance within castes; low caste households less able to insure than other groups)
- Resulting consensus: there is a lot of informal insurance against idiosyncratic shocks, but it is not perfect

Models of Less than Perfect Informal Insurance

- Permanent Income Hypothesis (PIH): assumes perfect credit, no insurance
- Moral Hazard:
  - Ex ante: Rogerson (1985)
  - Ex post: Coate and Ravallion (1993), Ligon, Thomas and Worrall (RES 2000)

Permanent Income Hypothesis (Hall 1978)

- Hall 1978: households can borrow and lend without limit at interest rate $r = \frac{1}{\delta} - 1$, but cannot purchase insurance
- Credit allows some insurance: borrow in bad times, repay in good times
- DP problem (y_t is stochastic income at date t):

$$V_t(y_t, W_t) \equiv \max_{W_{t+1}} [U(W_t + y_t - \frac{W_{t+1}}{1+r}) + \delta E V_{t+1}(y_{t+1}, W_{t+1})]$$

- FOC (Euler equation): marginal utility of consumption follows a martingale:

$$U'(c_t) = (1+r)\delta \frac{\partial E V_{t+1}}{\partial W_{t+1}} = E U'(c_{t+1})$$

- Implies increasing variance of consumption over time (random walk with quadratic utility function): consumption diverges between string of successive successes/failures

Permanent Income Hypothesis with Borrowing Constraint (Deaton 1991)

- Deaton adds borrowing constraint $W_{t+1} \geq 0$ to the DP problem
- Corresponding inequality version of FOC: $U'(c_t) \geq EU'(c_{t+1})$, super-martingale condition (also generates increasing variance)
- Limits scope for borrowing to smooth consumption, for poor households (for whom borrowing constraint binds)
- Deaton tests this using consumption data, using structural estimation methods

Problems with PIH

- Why insurance markets are missing, is not explained
- Why are credit markets functioning at the same time?
- Ad hoc formulation of financing constraints; we have seen evidence that insurance is imperfect, not missing
- Underlying moral hazard or adverse selection problems need to be explicitly incorporated

Ex ante Moral Hazard (Rogerson (1985))

- Rogerson extends the Grossman Hart (1983) model to a two period $t = 1, 2$ setting (results extend to arbitrary number of periods)
- Ex ante moral hazard: at each date agent (costly, unobservable) action a affects probability $\pi_s(a)$ of state $s = 1, \ldots, S$ (agent's output y_s)
- Optimal contract between a risk neutral Principal P (insurance company, social planner, rest of the village) and a risk averse agent A
- A's utility $U(c) - g(a)$, P's utility $y - c$, common discount factor δ
- A cannot/not allowed to save, P can save at interest rate $r = \frac{1}{\delta} - 1$,
- A has PV outside option $\underline{U}$, cannot quit interim

EA Moral Hazard Consumption Dynamics: Rogerson FOC

- Optimal contract satisfies the ‘inverse Euler’ equation:

$$\frac{1}{U'(c_t)} = E_{a_t}[\frac{1}{U'(c_{t+1})}]$$

- Outline of Proof:
  - P can vary c_t by ϵ; $c_{s,t+1}$ by $\eta_s(\epsilon)$ satisfying $U(c_{s,t+1} + \eta_s) - U(c_{s,t+1}) = v = -\frac{1}{\delta}[U(c_t + \epsilon) - U(c_t)]$
  - Preserves incentive and participation constraints; a_t unaffected
  - Effect on P’s PV profit: $-[\epsilon + \delta E_{a_t}[\eta_s(\epsilon)]$ should vanish at the optimum for ϵ small

EA Moral Hazard Consumption Dynamics, contd.

- EA Moral Hazard generates a FOC of a form similar in some ways to the PIH, $\frac{1}{U'}$ follows a martingale, so consumption variance increases over time
- Yet, specific form of FOC is different: hard to empirically distinguish
- Ligon (RES 1998) uses structural methods to test empirically between perfect insurance, PIH and EAMH using Indian ICRISAT data, no clear results

Ex Post Moral Hazard

- Now switch to models based on ex post moral hazard, or frictions on *enforcement*
- An insurance arrangement is essentially an exchange of state contingent promises
- It may not be viable or credible, if there are states of the world where (when the system gets there) some agents have incentives to renege on their promises to help others or make transfers
- I shall review mainly the model of Coate and Ravallion (JDE, 1993) which makes a key simplifying assumption of *stationarity* or history independence of the insurance arrangement
- It conveys the key ideas transparently, though the standard model in the literature is Ligon, Thomas and Worrall (RES 2000) which drops the stationarity assumption

Coate and Ravallion Model

- Two agents A, B, ex ante symmetric; single consumption good; dates $t = 1, \ldots, \infty$
- Exogenous endowment shocks: at each date t, each agent's endowment can take possible values $\{y_1, \ldots, y_n\}$
- Shocks (independent across dates) can be correlated across the agents: π_{ij} denotes probability of $y^A = y_i, y^B = y_j$
- Both agents have ex post utility function $U(c)$, strictly increasing and strictly concave
- Neither can save, common interest rate $r > 0$

Stationary Insurance Allocation

- A *stationary insurance allocation* is a plan for transfers $\theta \equiv \{\theta_{ij}\}$ from A to B in state (i, j) (positive: $A \rightarrow B$, negative: $B \rightarrow A$)
- Results in state-contingent consumption allocation $c^A_{ij} \equiv y_i - \theta_{ij}, c^B_{ij} \equiv y_j + \theta_{ij}$
- Resulting (stationary) ex ante utility $v^A(\theta) \equiv \sum_i \sum_j \pi_{ij} U(y_i - \theta_{ij})$, $v^B(\theta) \equiv \sum_i \sum_j \pi_{ij} U(y_j + \theta_{ij})$

Incentive Problem

- Suppose $\theta_{ij} > 0$, then A may be tempted to renege on the promise to transfer this
- What would the consequences of default be: B will not transfer to A at future contingencies where $\theta_{ij} < 0$
- Worst possible punishment would be a switch to autarky forever thereafter (which is a subgame perfect equilibrium)
- Necessary and sufficient condition for incentive compatibility (IC):

$$U(y_i) - U(y_i - \theta_{ij}) \leq \frac{1}{r}[v^A(\theta) - \bar{v}] \quad \text{if} \quad \theta_{ij} > 0 \tag{1}$$

$$U(y_j) - U(y_j + \theta_{ij}) \leq \frac{1}{r}[v^B(\theta) - \bar{v}] \quad \text{if} \quad \theta_{ij} < 0 \tag{2}$$

(where autarky payoff $\bar{v} \equiv \sum_{i,j} \pi_{ij} U(y_i)$)

Constrained Optimal Insurance

- A stationary insurance allocation θ is constrained (ex ante) Pareto optimal if for some set of welfare weights $\lambda, 1-\lambda$ with $\lambda \in (0,1)$: it maximizes $\lambda v^A(\theta) + (1-\lambda) v^B(\theta)$ subject to IC constraints (1, 2) (U Inada: ignore nonnegative consumption restriction)
- First-best insurance (with equal Pareto weights): $\hat{\theta} = \frac{y_i - y_j}{2}$ (pooling of idiosyncratic risk)
- First-best insurance is implementable (ie is IC) if and and only if $r < r^*$ for some threshold $r^* > 0$
- Interesting case: $r > r^*$, when first best is not implementable; assume this from now on

Second Best Insurance

Lemma *The set of feasible allocations is convex.*

Proposition 1 *Suppose $y_i > y_j$. If second-best transfer $\theta^*_{ij} \neq \hat{\theta}$, IC in state (i,j) must bind:*

$$U(y_i) - U(y_i - \theta^*_{ij}) = \frac{1}{r}[v^A(\theta^*) - \bar{v}] \tag{3}$$

Proof: The objective function is concave, while the feasible set is convex. If the first-best transfer is infeasible in some state, the optimal transfer in that state must be on the boundary of the feasible set.

If $y_i > y_j$:

$$\theta^*_{ij} = \min\{\hat{\theta}_{ij}, y_i - U^{-1}\left(U(y_i) - \frac{1}{r}[v^A(\theta^*) - \bar{v}]\right)\} \tag{4}$$

Some Features of Second-Best Insurance: Collective Risk

- *First-best insurance can be sustained only in (collectively) 'good times', and breaks down progressively when bad times get worse:*
  - Fix $m \equiv y_i - y_j > 0$, so first-best transfer $\hat{\theta}_{ij}$ is fixed
  - Then vary y_i, a measure of 'collective' risk
  - IC (1) will be violated for low y_i
  - The smaller y_i is, the lower is the transfer θ^*_{ij}

Some Features of Second-Best Insurance: Idiosyncratic Risk

- *First-best insurance can be sustained only for low idiosyncratic risk, is capped beyond:*
    - Within states where $y_i > y_j$, fix y_i and vary y_j
    - For y_j close to y_i, first best transfer is small and satisfies IC (1)
    - As y_j falls, the required transfer $\hat{\theta}_{ij}$ grows
    - At some threshold $\hat{y}_j$ IC will bind
    - Over the range $y_j < \hat{y}_j$ the second best transfer is constant

Some Features of Second-Best Insurance: 'Bootstrapping' Discontinuities

- Coate-Ravallion compute second-best insurance for numerical examples, then explore the effect of changing some parameters
- Small changes in risk-aversion or interest rates can suddenly cause insurance to disappear completely
- Intuition: Owes to a 'bootstrapping' characteristic of the second-best:
  - rise in r or risk-aversion requires reducing the transfer in some states
  - lowers the future value of insurance
  - need to lower transfers in other states
  - the process keeps iterating with shrinking transfers, until it disappears

Implications of Dropping Stationarity Restriction

- Ligon.Thomas and Worrall (LTW) (RES 2000) extend the Coate Ravallion analysis, by dropping the stationarity restriction
- In stationary allocations, transfers depend only on current shocks and do not depend on history of past shocks or transfers
- Allow history dependent transfers: θ depends on current state $s_t = \{i, j\}$, and also past history $h_t = (s_{t-1}, s_{t-2}, \ldots)$
- A feature of *quasi-credit:* 'borrow in bad times, repay in good times'; repayments depend on carried over debt (summarizing past history) and current state

LTW Characterization of Optimal Non-stationary Insurance

- IC constraints extend in the expected manner:

$$U(y_i) - U(y_i - \theta(s_t, h_t)) \leq \frac{1}{r}[Ev^A(\theta(.,.)|s_t, h_t) - \bar{v}] \qquad (5)$$

- Feasible set of allocations is again convex, so we get a similar characterization of second-best insurance:
- Co-insure perfectly with respect to 'small shocks, until shocks (and transfers) get large enough that IC binds, beyond which transfers do not vary
- *'Stationary' Characterization:* For each s_t, there is a maximum $\bar{\gamma}(s_t)$ and minimum $\underline{\gamma}(s_t)$ for MRS γ ($\equiv \frac{U'(y_i - \theta_{ij})}{U'(y_j + \theta_{ij})}$) such that MRS $\gamma_t = \gamma_{t-1}$ if $\gamma_{t-1} \in (\underline{\gamma}(s_t), \bar{\gamma}(s_t))$, otherwise set at the nearest boundary

LTW Empirical Analysis and Results

- LTW test First-best insurance (Arrow-Debreu), versus 'Static' optimal insurance (a la Coate-Ravallion), versus 'Dynamic' optimal insurance (a la LTW), using Indian ICRISAT data
- Use structural estimation methods: find ranges of required risk aversion parameters to 'fit' the data, while assuming CRRA preferences and calibrating other parameters
- Arrow Debreu model requires very wide range of relative risk aversion across 30 households in three villages, from .01 to 26.5
- 'Static' model narrows the range considerably to more reasonable levels: 1.4-1.6 for explaining consumption levels, .84 to .95 for explaining consumption changes (across dates)
- Fit of static and dynamic model very close for predicting 'levels', the dynamic model does somewhat better for predicting changes