Australian National University

EE468: Integrated Public Economics, Development and Political Economics

Lecture 8: Risk, Saving and Insurance

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Outline

- Household's decision with risk, how risk could reinforce poverty trap?
- What are (and limits to) mechanisms households use to manage risk and so smooth consumption?
- How to design and target intervention to help the poor manage risk?

Why development community cares so much about risk?

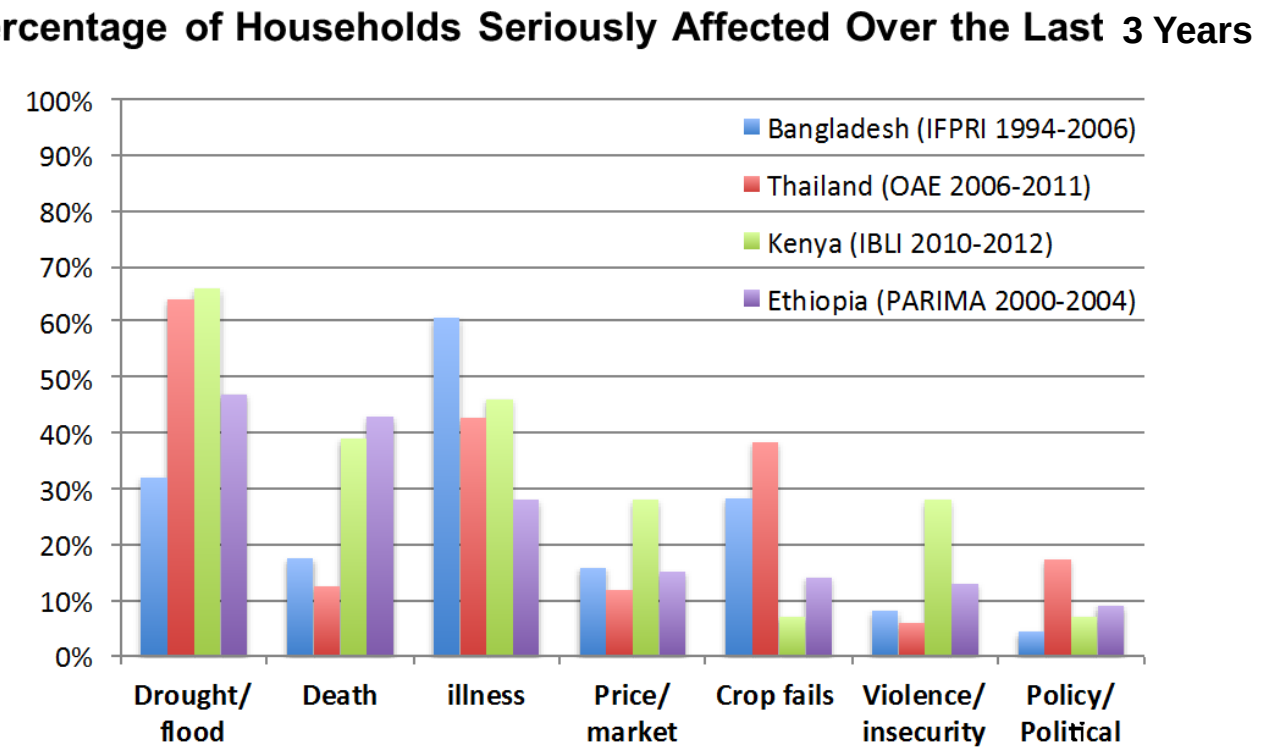
- **Risk is one of the key defining features of the low-income world!**
  - What are the big sources of risks the poor face? Price, illness, unemployment, weather, natural disasters, other crop production risks, etc.
- **Limited means to manage risk and cope with shock with missing market**
  - Poor rely on informal means, some of which carry large welfare costs!
  - Wealth-differential access to effective risk management strategies
- **Risk thus could reinforce poverty traps → risk very costly to the poor**
  - Costly risk avoidance *ex ante* → poor tend to adopt low (risk) return livelihood
  - Irreversible effects of shock *ex post* with threshold-based poverty trap
  - Costly smooth asset among the poor → risk causes long-term effect on HC
- **Formal market for saving and insurance ill-developed in poor regions**
  - Several market failures
  - Other demand side impediments

Key policy questions

- Why risk matters to households? How do households make decisions with risk?
- What are (and limits to) mechanisms households use to manage risk, to cope with shock and so to smooth consumption?
- How could uninsured risk reinforce poverty trap?
- Are there needs for intervention to help the poor manage risk and/or to keep household from falling into poverty traps? How might they look like and target?

The risky environment where the poor live

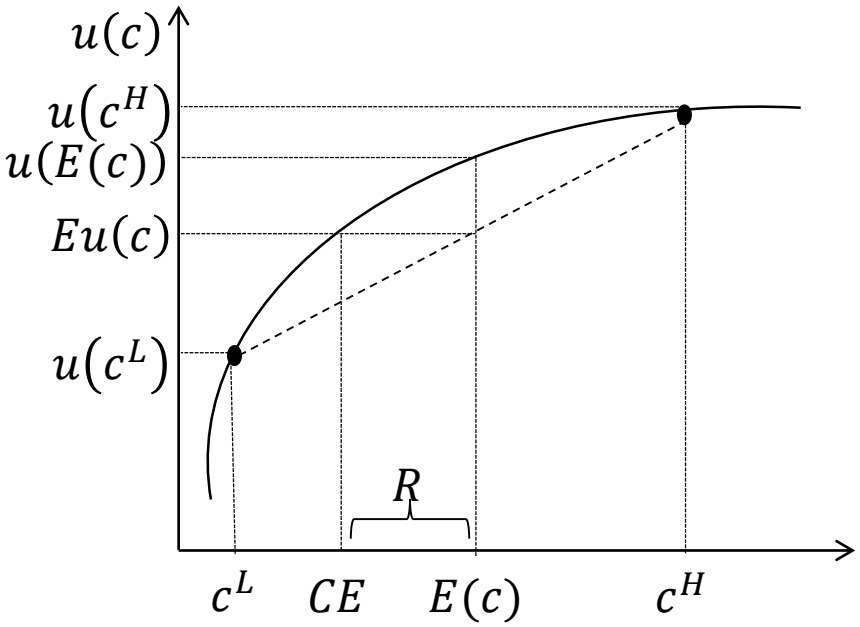
- More than 90% of sampled households in poor regions were affected by at least one serious shock over the last 3 years



- These shocks could result in large fluctuation in income, though direct observation of income risk could underestimate the actual risk exposure. Why? Think about the potential effect from *ex ante* risk avoidance behaviour!

Why risk matters to people?

- **Economic agents tend to be risk averse → welfare reduces with risk**
  - Typical utility function is concave → $u'(c) > 0, u''(c) < 0$
- Suppose HH faces stochastic consumption: c is either c^L or c^H with prob. 0.5
  - HH's expected consumption is $E(c) = 0.5c^L + 0.5c^H$
  - HH will maximise expected utility: $Eu(c) = 0.5u(c^L) + 0.5u(c^H)$



- Risk aversion from concave utility implies
  - ✓ Prefer certain outcome than uncertainly

    $u(E(c)) > Eu(c)$

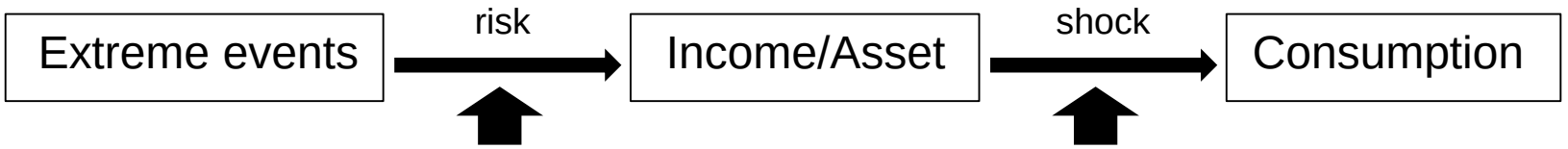
  - ✓ They are willing to pay risk premium up to R to reduce risk such that

    $u(E(c) - R) = Eu(c)$

Risk averse HH will be willing to smooth consumption at some cost!

How do the poor manage risk?

- Using sophisticated mechanisms to deal with risk, the poor are still largely uninsured in the absence of effective insurance/saving/credit markets
- Their risk management and coping strategies could further carry regressive long-term poverty costs (especially those in red)!



Risk management strategies

- Diversification (off farm, multiple crops, migration)
- Low risk (low return) portfolios

Risk coping strategies

- Saving/borrowing
- Informal mutual insurance
- Labor reallocation (incl. child labor)
- Asset smoothing (by sacrificing consumption, health, edu)

- Let's now explore opportunities and limitations of these strategies…

How do the poor manage risk? 1) Saving/Borrowing

HH's intertemporal decision without income risk

- Assuming that HH lives for 2 periods and earn income y_1, y_2
- They make decision to consume c_1 and save (or borrow) s_1 according to

$$\text{Max } u(c_1) + \frac{1}{1+\delta}u(c_2)$$

Subject to

$$c_1 + s_1 = y_1$$

$$c_2 = y_2 + (1 + \mathrm{r})s_1$$

- With complete market ($s_1 > 0$ reflects saving, $s_1 < 0$ reflects borrowing)
  - This separable problem can be solved by substituting s_1 into c_2 equation → HH's solution can be represented by

$$\frac{u'(c_1)}{u'(c_2)} = \frac{1+r}{1+\delta}$$ where r is saving return, δ discount rate

  - If $r = \delta$, then $c_1 = c_2$. With complete markets, consumption should be equalised across lifetime and saving/borrowing used to redistribute wealth across times!

How do the poor manage risk? 1) Saving/Borrowing

HH's intertemporal decision with income risk

- If y_1 is known but y_2 can be y^H (with prob. p) or y^L (with prob. $1-p$)
- Household makes expectation of what they should consume without knowing y_2

$$\text{Max } u(c_1) + \frac{1}{1+\delta} Eu(c_2)$$

Subject to

$$c_1 + s_1 = y_1$$

$$c_2 = y_2 + (1+\mathrm{r})s_1$$

- Solve this by substitute $Eu(c_2) = pu\left(y^H + (1+r)s_1\right) + (1-p)u\left(y^L + (1+r)s_1\right)$
  - Household's solution can be represented by

$$\frac{u'(c_1)}{Eu'(c_2)} = \frac{1+r}{1+\delta}$$

  - At $r = \delta$ and take a special quadratic form $u(c) = ac - 0.5bc^2$ → $u'(c) = a - bc$. This implies a solution: $c_1 = E(c_2)$

At equilibrium, risk averse HH will try to smooth consumption!

How do the poor manage risk? 1) Saving/Borrowing

What might be the role of saving/borrowing in consumption smoothing?

- We can derive c_1 from the budget constraint

$$c_2 = y_2 + (1 + \mathrm{r})(y_1 - c_1) \rightarrow E(c_2) = E(y_2) + (1 + \mathrm{r})(y_1 - c_1)$$

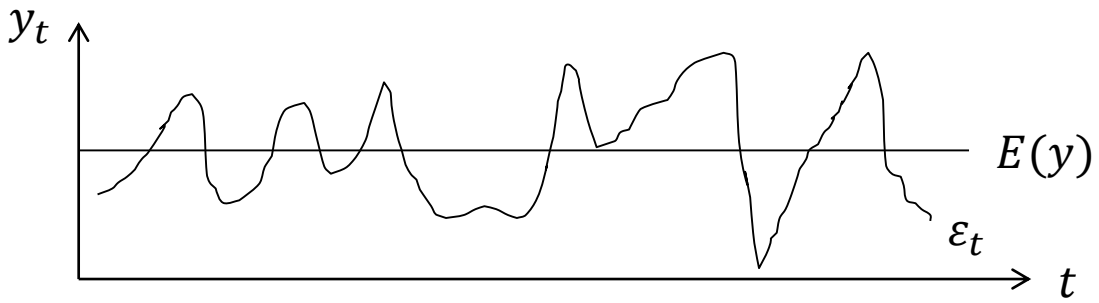
$$E(c_2) + (1 + r)c_1 = E(y_2) + (1 + \mathrm{r})(y_1)$$

$$c_1 = E(c_2) = \frac{E(y_2)}{2 + r} + \frac{1 + r}{2 + r}(y_1)$$

- In general, HH's stochastic income stream (y_1, y_2) include two components

$$y_t = E(y) + \varepsilon_t$$

where $E(y)$ reflects permanent component and ε_t is transitory component



How do the poor manage risk? 1) Saving/Borrowing

- We can thus show that HH consumption will response differently to these two different components of income, by first rewriting

$$c_1 = E(c_2) = \frac{E(y_2)}{2+r} + \frac{1+r}{2+r}(E(y_1) + \varepsilon_1)$$

  - HH's propensity to consume out of permanent income is 1, where as that out of transitory income change is very low (closed to 0 if the horizon is infinite)

$$\frac{\partial c_1}{\partial E(y)} = \frac{1}{2+r} + \frac{1+r}{2+r} = 1\ , \quad \frac{\partial c_1}{\partial \varepsilon_1} = \frac{1+r}{2+r}$$

- **This is a concept of permanent income hypothesis (PIH)**
  - If there exists complete market or frictionless saving and dissaving (credit) opportunities, then HH attempting to smooth consumption → consumption will be determined solely by permanent income and NOT by transitory income
  - Any shortfall (excess) in current income relative to permanent expected income will be dis (saved) so as to smooth consumption over the lifetime!

Testing PIH: Can HH smooth c using saving/borrowing?

- Generally, one can estimate the following equation using panel data:

  $$c_{it} = \alpha + \beta y_{it}^{P} + \gamma y_{it}^{T} + X_{it}' \delta + \varepsilon_{it}$$

  where y_{it}^{P} and y_{it}^{T} are permanent and transitory income respectively

- Strict test of PIH: $Ho: \beta = 1 \; and \; \gamma = 0$

- Weak test of PIH: $Ho: \beta = \gamma \; vs. \; Ha: \; \beta > \gamma$

- The key identification problems one will run into
  - Correlated measurement errors (common in $c_{it}, y_{it}^{P}, y_{it}^{T}$)
  - How to distinguish y_{it}^{P}, y_{it}^{T}?

- The key identification: instrument y_{it}^{P} (education, asset, time-invariant characteristics) and/or y_{it}^{T} (deviation of rainfall from normal)

- Evidence to date reject strict PIH, but in favor of weak PIH ($\beta > \gamma$) → HH appears to be able to smooth consumption to some extent!

Testing PIH: Can HH smooth c using saving/borrowing?

- Paxson (1992) estimates propensity to save out y_{irt}^{P} and y_{irt}^{T} among Thai farmers:

$$s_{irt} = \alpha + \beta \widehat{y_{irt}^{P}} + \gamma \widehat{y_{irt}^{T}} + X_{irt}' \delta + \varepsilon_{irt}$$

$\widehat{y_{irt}^{P}}$ $from$ $y_{irt} = aZ_{it}^{P} + a_t + a_r + e_{irt}^{P}$ with Z_{it}^{P} = land, HH composition, education

$\widehat{y_{irt}^{T}}$ $from$ $y_{irt} = bZ_{it}^{T} + b_t + e_{irt}^{T}$ with Z_{it}^{T} = deviation of rainfall from normal

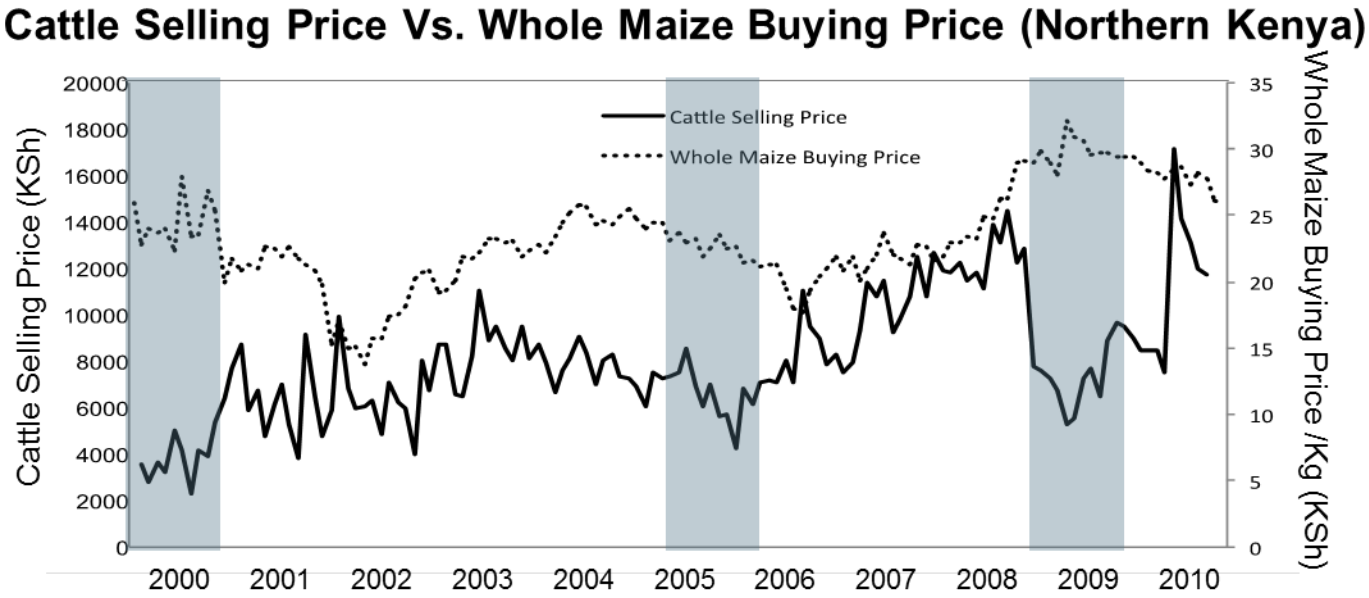
TABLE 4—TWO-STEP AND MAXIMUM-LIKELIHOOD ESTIMATES OF SAVINGS EQUATIONS

	Two-step			Maximum likelihood		
Variable	SAVE1	SAVE2	SAVE3	SAVE1	SAVE2	SAVE3
$\hat{Y}^{P}$ (α_1)	0.2773 (5.40)	0.4400 (8.94)	0.1824 (2.73)	0.2514 (4.86)	0.4210 (8.51)	0.1649 (2.45)
$\hat{Y}^{T}$ (α_2)	0.7362 (4.28)	0.8039 (4.87)	0.7340 (3.21)	0.7546 (4.32)	0.8015 (4.84)	0.8294 (3.50)

- Saving responses more significantly to y_{irt}^{T} (reject strong PIH but also reject $Ho: \gamma = \beta$ in favor of $\gamma > \beta$). Thai HHs use saving to smooth consumption to some extent!

Constraints to saving?

- Good saving products not available (no access to bank, risky institutions, etc.)
- Return to saving might be low (lower than discount rate)
- Efficient not to save: may not get money when you need if save in, e.g., Roscas
- If asset market is not well integrated, (saving) buffer asset could lose term of trade significantly during catastrophic shocks. Why?



- Self-control issues: time inconsistent preference?

Constraints to borrowing (liquidity constraints)?

- There are many reasons why poor HHs might face borrowing constraints (both from formal and informal credit) → we will explore more next week!

- Why do borrowing constraints limit consumption smoothing?

  - HH's new constrained problem:

$$\text{Max } u(c_1) + \frac{1}{1+\delta} Eu(c_2)$$

Subject to

$$c_1 + s_1 = y_1$$

$$c_2 = y_2 + (1 + \mathrm{r})s_1$$

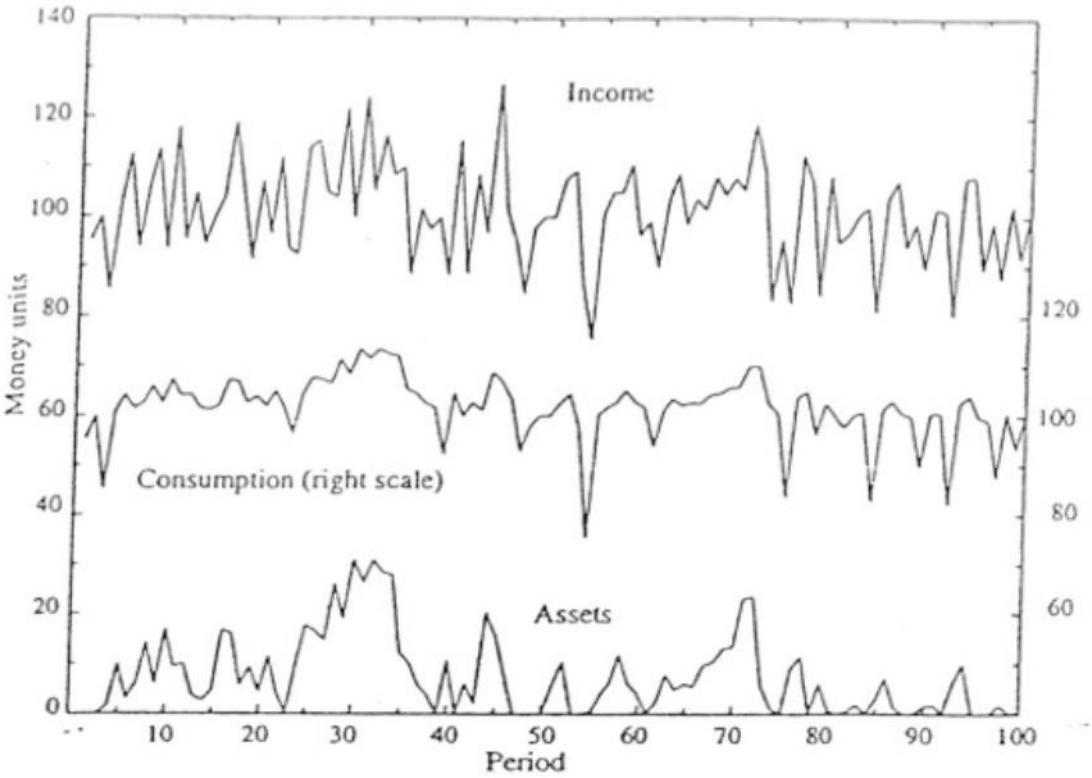
$$s_1 \geq 0 \rightarrow c_1 \leq y_1$$

- This implies that HH can still save in a good years to smooth consumption (and so the constraint does not bind)

- With big adverse shock to income, they will run down all their cash in hand (so constraint binds → $c_1 = y_1$ and $s_1 = 0$). So consumption will drop occasionally following big income shocks!

Constraints to borrowing (liquidity constraints)?

- Deaton (1997) simulates income, consumption and asset (saving) dynamics under liquidity constraint. We can see that



- There are times when assets ran out and so consumptions drop dramatically
- Consumption will fluctuate more but still smoother relative to income (as HH can still use saving to smooth consumption to some extent!)
- Who has higher tendency to be borrowing constrained? → the poorest

- **Can saving and borrowing always provide complete protection from risk?** What happen if HH experience many consecutive adverse shocks? Will their ability to borrow depend on the past repayment?

How do the poor manage risk? 2) Informal insurance

- Mutual insurance can be manifest in state-contingent transfers of credit, asset, etc. between individuals, HHs, communities using reciprocity system
- Suppose A and B's harvest income can be \$1,000 or \$2,000 with probability 0.5, Assuming that they both are risk averse and maximise expected utility:

$$Eu(y) = 0.5u(\$2000) + 0.5u(\$1000)$$

- Now if they agree to form mutual insurance where they both pool their income and share them equally in all possible events

Case 1: If income shocks are independent across A&B

$$Eu\left(y^{insured}\right) = 0.25u(\$2000) + 0.25u(\$1000) + 0.5u(\$1500)$$

Prob	A	B	Insured
0.25	\$2,000	\$2,000	\$2,000
0.25	\$1,000	\$1,000	\$1,000
0.25	\$2,000	\$1,000	\$1,500
0.25	\$1,000	\$2,000	\$1,500

$$Eu\left(y^{insured1}\right) = 0.5Eu(y) + 0.5u(E(y))$$
$$> Eu(y) \text{ as } u(E(y)) > Eu(y)$$

So both risk averse A&B will be better off in the mutual insurance when risk are independent across the two!

How do the poor manage risk? 2) Informal insurance

- **Case 2: If shocks are perfectly and negatively correlated**

Prob	A	B	Insured
0.5	$2,000	$1,000	$1,500
0.5	$1,000	$2,000	$1,500

$$Eu\left(y^{insured2}\right) = u(E(y)) > Eu\left(y^{insured2}\right) > Eu(y)$$

→ Mutual insurance results in full insurance (remove risk altogether), A&B will be better off comparing to case 1 and the case without mutual insurance

- **Case 3: If shocks, however, are perfectly and positively correlated**, e.g., if both A and B face the same weather or natural disaster shocks

Prob	A	B	Insured
0.5	$2,000	$2,000	$2,000
0.5	$1,000	$1,000	$1,000

$$Eu\left(y^{insured3}\right) = Eu(y)$$

→ Risk sharing cannot be achieved through mutual insurance → no welfare gain

Effectiveness of mutual insurance depends on spatial distribution of shocks!

How do the poor manage risk? 2) Informal insurance

- Let's generalise this mutual risk sharing insurance to a village populated by large number of HHs, where income of HH i, in village j and year t represented as

$$y_{ijt} = \bar{y}_{jt} + \theta_{jt} + \varepsilon_{ijt}$$

where $\bar{y}_{jt}$ is village *j*'s average income in period *t*, θ_{jt} is common village aggregate shock and ε_{ijt} is idiosyncratic shock across HHs

- When HHs in the village share risk in a simple mutual insurance:

$$y_{ijt}^{Insured} = \frac{1}{N}\sum y_{ijt} = \bar{y}_{jt} + \theta_{jt} + \frac{1}{N}\sum \varepsilon_{ijt}$$

- **Full risk sharing insurance** can be achieved when there are large number of HHs with iid ε_{ijt} such that $\frac{1}{N}\sum \varepsilon_{ijt} \to 0$. HHs' insured income (consumption) will closely track village average income and NOT their idiosyncratic component!

$$y_{ijt}^{FullInsured} = \frac{1}{N}\sum y_{ijt} = \bar{y}_{jt} + \theta_{jt}$$

- Even with full risk sharing, mutual insurance will not insure against aggregate shock θ_{jt} → useful if majority of shocks are idiosyncratic!

Mutual insurance through informal loans in Nigeria

- Udry (1994) spent a year in Nigeria recording the terms of the loans that villagers give to each others
- He found that when a borrower has an adverse shock, their loan repayment is less. And when a lender has an adverse shock, the borrowers repay more.

Table 5. *Realized Terms versus Borrower and Lender Shocks Received*

	Sample means		
Adverse shock to:[a]	*Monthly interest rate (percent)*	*Simple interest rate (percent)*	*Repayment period (days)*
Borrower			
No shock	0.5	20.4	67
Shock	−4.0	−0.6	72
Impact of shock on mean	Lower	Lower	Longer
t-statistic[b]	(1.58)	(2.20)	(1.03)
Lender			
No shock	−7.5	−5.0	89
Shock	2.6	11.8	80
Impact of shock on mean	Higher	Higher	Shorter
t-statistic[b]	(4.56)	(3.06)	(1.89)

a. The definition of adverse shock is that of table 4, broadened to include lenders.

b. The impact of the shocks is judged by a two-sided *t*-test of equal means ($\mu_{noshock} - \mu_{shock}$). The absolute value of the *t*-statistic is in parentheses.

Source: Survey data, available at a nominal reproduction charge upon written request to the author.

Test risk pooling in mutual insurance empirically

- If village risk sharing is effective → controlling for variations in aggregate village consumption, variations of HH consumption SHOULD NOT depend on variations in HH income. Using panel data, one can estimate:

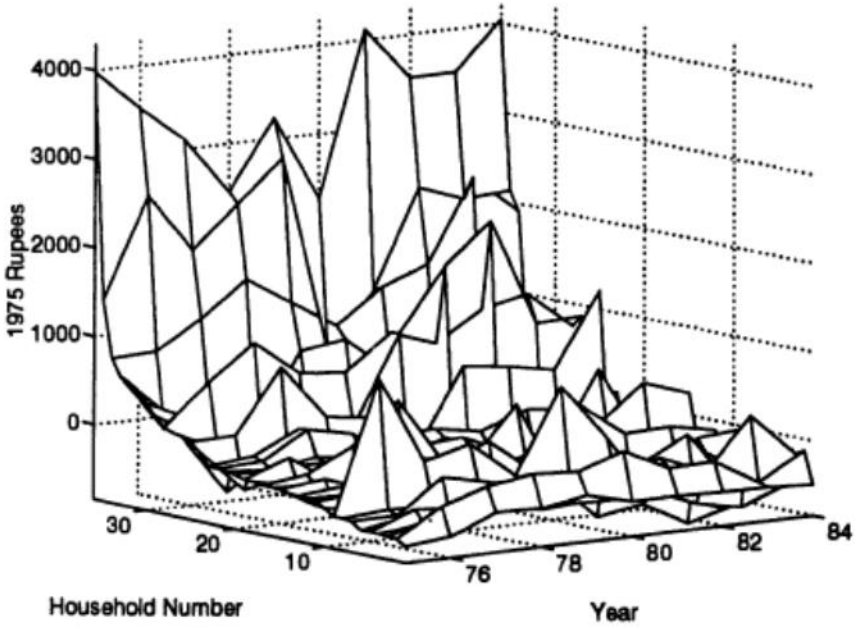
$$c_{ijt} = \alpha + \beta y_{ijt} + \gamma \bar{c}_{jt} + \varepsilon_{ijt}$$

- Strict test of full risk pooling: $Ho: \beta = 0 \; and \; \gamma = 1$
- Weak test of full risk pooling: $Ho: \gamma = 0 \;\; vs. \; Ha: \gamma > 0$
- The key identification problems one will run into
  - Correlated measurement errors → need instrument for y_{ijt}
- Existing studies (Townsend 1994, 1995, Deaton 1997, etc.) reject full risk pooling but also reject weak test pointing toward some degree of consumption smoothing within the village
- Ability to smooth consumption may vary significantly across HHs: Townsend 1994 and Morduch 1995 finds evidence of consumption smoothing among better-off farmers, but not so for small farmers and landless laborers in India!

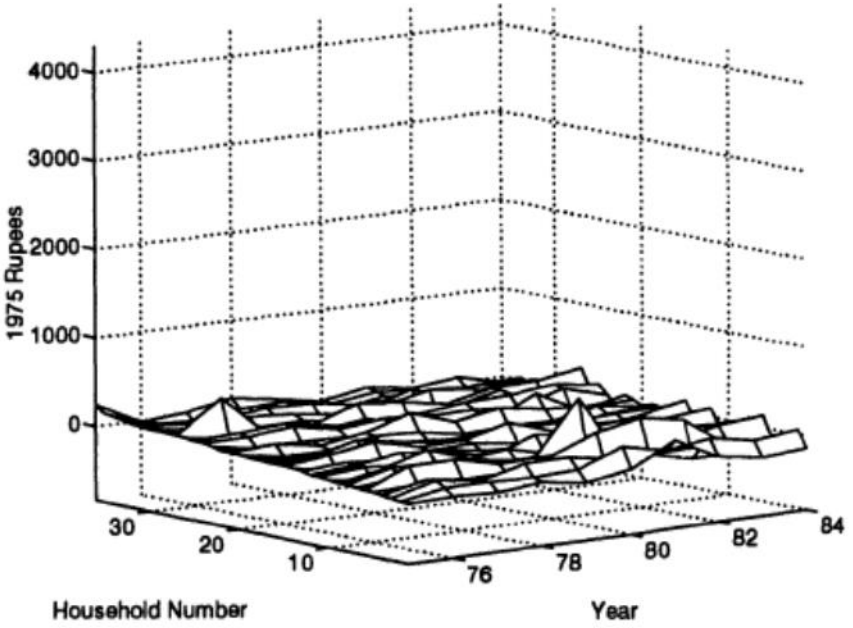
Test risk pooling in mutual insurance empirically?

- Townsend (1994) tests for risk pooling in villages in India
  - Household panel data (40 HH/village, 3 villages for 10 years, 1975-1984)
  - Despite the high degree of idiosyncratic shocks on household income, HH consumption seems to co-move well with village aggregate!

Co-movement of $y_{ijt} - \bar{y}_{jt} = \varepsilon_{ijt}$



Co-movement of $c_{ijt} - \bar{c}_{jt}$



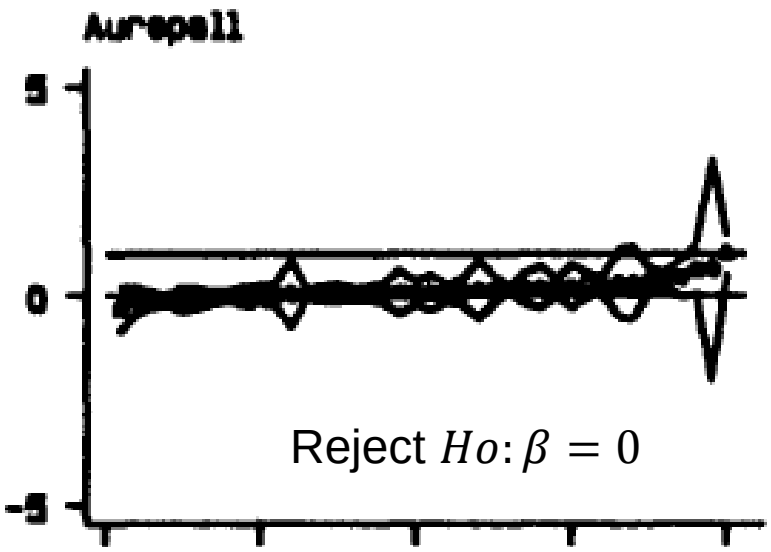
Test risk pooling in mutual insurance empirically?

- Townsend (1994) tests for risk pooling in villages in India
  - Running a small variant of the following with HH-specific coefficients

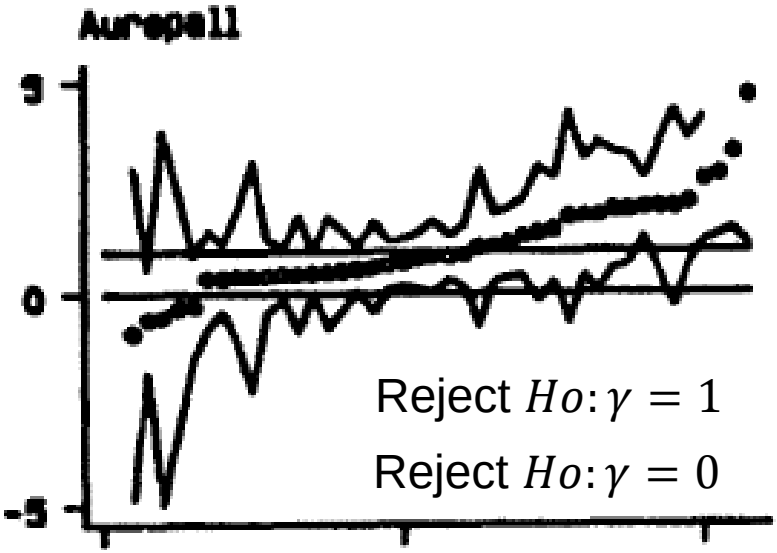
$$c_{ijt} = \alpha_i + \beta_i y_{ijt} + \gamma_i \bar{c}_{jt} + \varepsilon_{ijt}$$

  - He rejects full risk pooling hypothesis but also reject weak test implying that there are some degree of consumption smoothing within the villages!

Plot of β_i by wealth



Plot of γ_i by wealth



Constraints to informal mutual insurance?

- **Moral hazard**: Will insured HHs take excessive risk or put less effort on their farm knowing they will be covered in the case of bad outcome? Do this incentive problem observable by others ex ante? What might be the solution?
- **Limited commitment and imperfect enforcement**: HH who have had a good shock may conceal part of their income or refuse to contribute to the pool (they trade off short-term gain from defaulting today against long-term loss of being isolated from the insurance network). What might be the effect of banks? Of migration?
- **Covariate shock**: only idiosyncratic shocks can be insured. Uninsurable risk could still be large among communities exposed largely to covariate risk

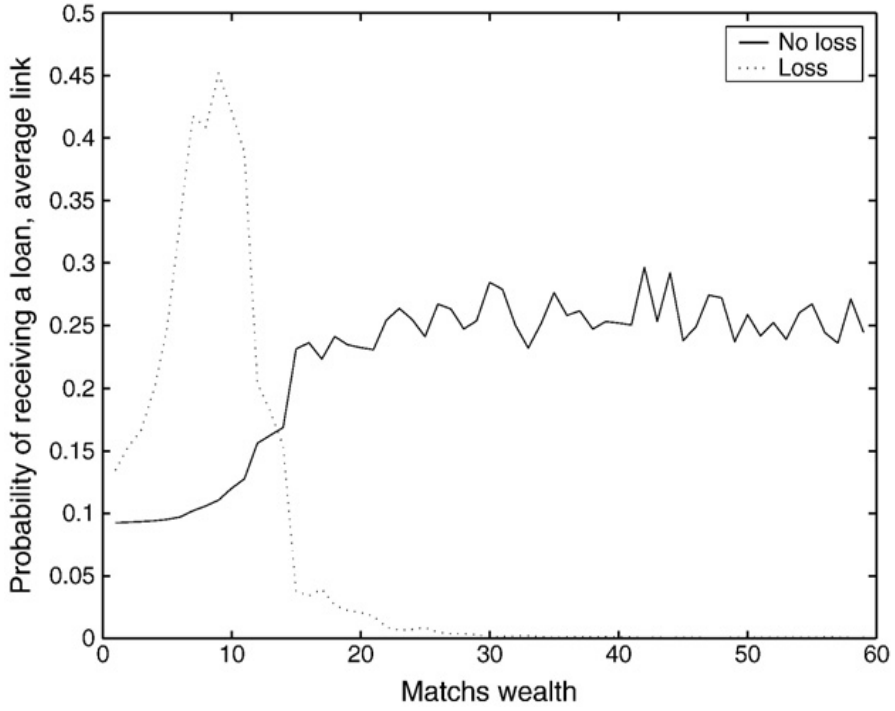
Overall, mutual insurance tend to be formed among those who know each others, so taking advantage in reducing information, monitoring and enforcement problem through social proximity, sanction and repeated interaction!

But this means that most mutual insurance is limited in size, which then limit capacity for the risk sharing of aggregate shocks, e.g., disasters → uninsurable risk remains!

Constraints to informal mutual insurance?

- **Is informal insurance accessible by everyone?**
  - Santos and Barrett (2011) show that the poorest often are excluded from the reciprocal risk-sharing insurance network. Why?

Probability of being accepted to establish a credit link



Source: Santos and Barrett (2011)

How do the poor manage risk? 3) *Ex ante* risk avoidance

- Uninsured risk induces (costly) behavior response of the relatively risk averse poor to try to trade off expected gain to avoid risk
  - Carter and Zimmerman 2003 → the poor (with small productive assets) who are closer to subsistence constraint will tend to choose (low-risk) low return portfolio

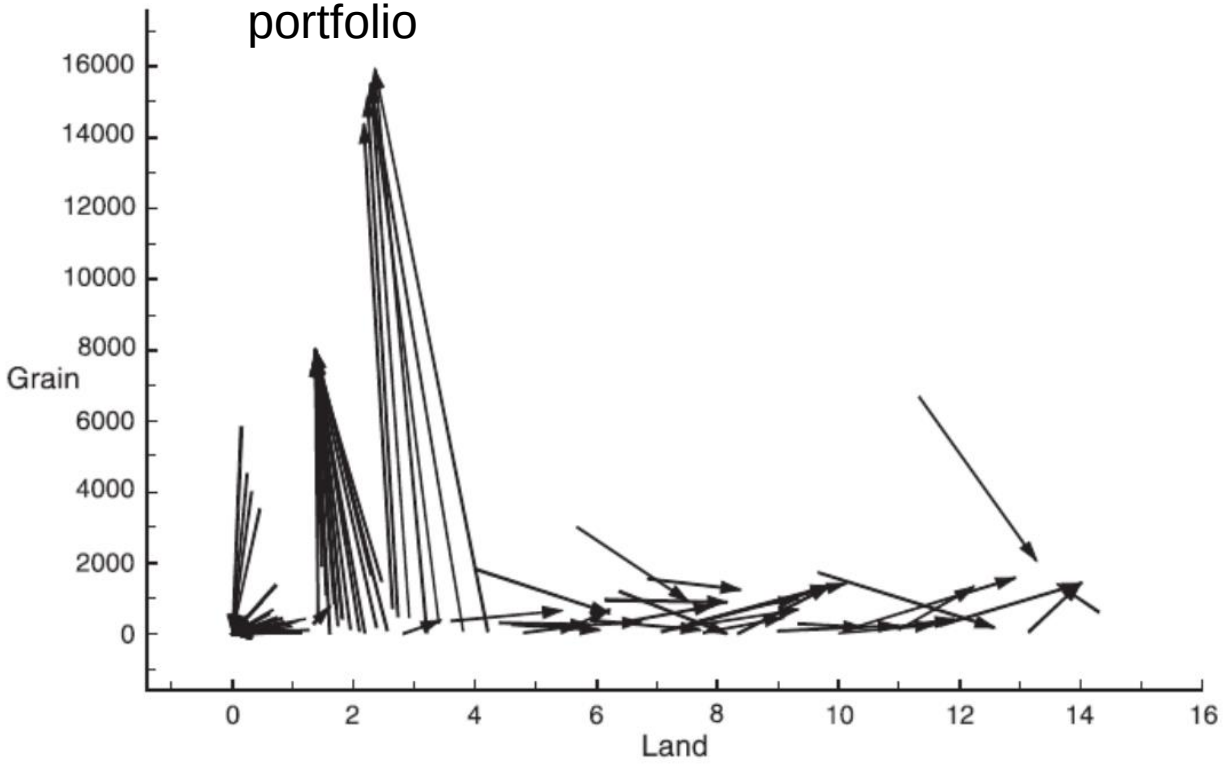


Fig. 3. Evolution of individual portfolios.

- Others found adoption of less productive livelihood diversifications among the vulnerable poor
- Risk also reduce the poor's incentive to invest, adopt new technology and use fertilizer

This automatically create bifurcation in expected return to asset → multiple equilibria poverty trap

How do the poor manage risk? 3) *Ex ante* risk avoidance

- Various evidence show 25-50% loss in mean return of the poor relative to the rich due to conservative risk avoidance assets/income portfolio choices
- Rosenzweig and Binswanger 1993 show that 1 stdev increase in variability of monsoon onset date lead to large decline in mean profit among the poorest

Determinants of Profit Levels: Six ICRISAT Villages

Variable/Estimation procedure	Random effects	Fixed effects	Random effects
Coefficient of variation in onset (*CV*)	−24·7 (1·33)*	—	−11·2 (1·06)
CV × total wealth ($\times 10^{-4}$)	2·91 (2·35)	3·28 (2·03)	—
CV × inherited wealth ($\times 10^{-4}$)	—	—	2·11 (2·89)
Total wealth ($\times 10^{-4}$)	440·8 (5·15)	308·2 (2·84)	—
Inherited wealth ($\times 10^{-4}$)	—	—	25·1 (0·44)
Onset date	−14·2 (2·11)	−13·2 (1·93)	−15·9 (1·17)
Mean onset date	247·8 (1·46)	—	−229·1 (2·46)
Age	24·4 (0·95)	40·1 (1·13)	394·6 (3·88)
Constant	194·0 (0·06)	—	1990 (0·54)

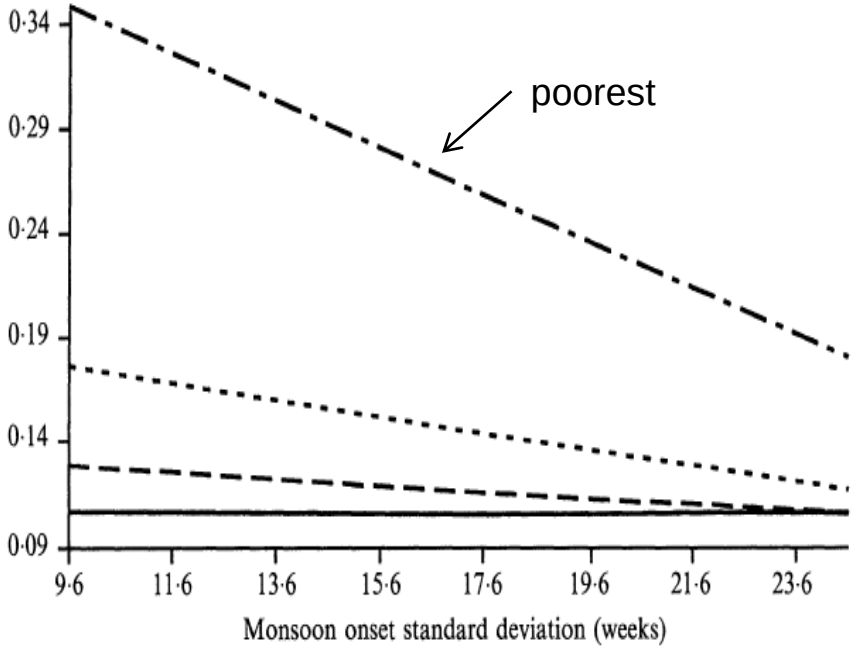


Fig. 3. Profit–wealth ratios and weather variability, by wealth class. Percentiles: ——, 20th ———, 40th; – – –, 60th; ——–, 80th.

How do the poor manage risk? 4) Other costly risk coping

- **Child labor are often used as coping strategies for uninsured HHs**
  - In Tanzania, Beegle and Gatti (2006) found that child labor were used as buffer against unexpected crop loss among agricultural households

$$y_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 shock_{ijt} + \beta_3 (shock_{ijt} \times assets_{ijt}) + \beta_4 assets_{ijt} + \varepsilon_{ijt}$$

Hours worked, income shocks, and assets

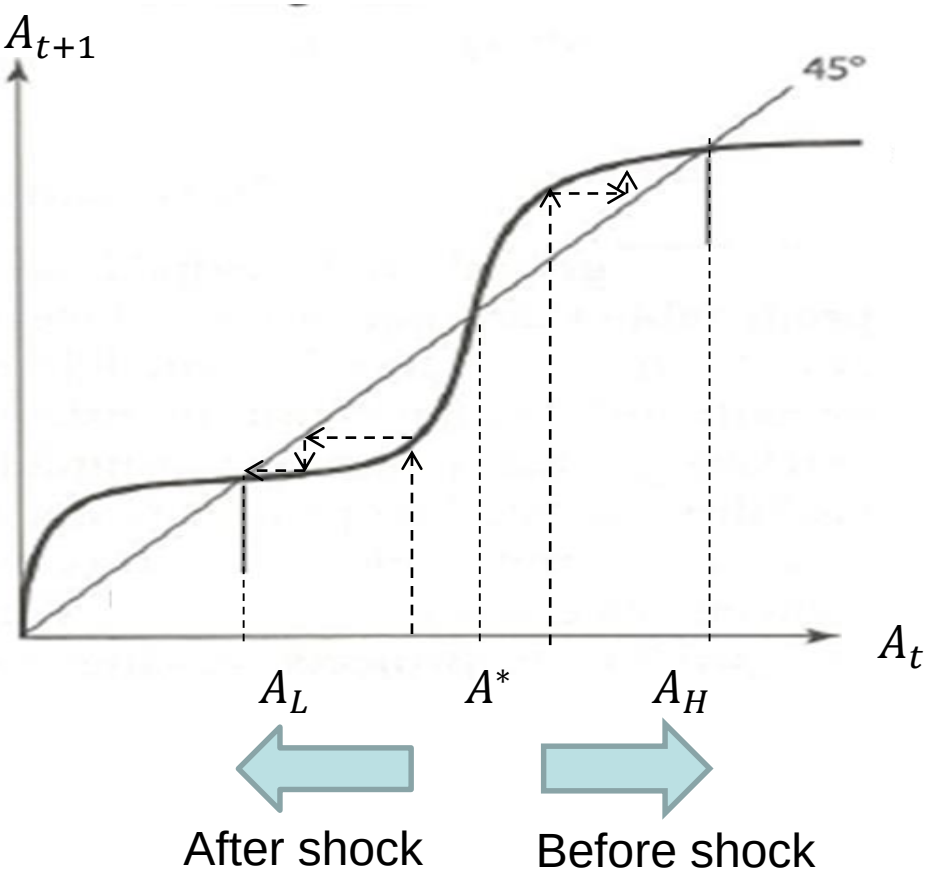
	(1)	(6)
Dependent variable	Hours worked	Hours worked
Specification	FE	FE with cluster-time dummies
Sample restriction: land acres		1–25.5
Shock: any crop loss	6.08** (2.87)	7.50** (3.56)
Log per capita land value	0.47* (0.27)	0.87** (0.35)
Shock *x* log per capita assets	−0.47* (0.28)	−0.61* (0.35)
Per capita land value		0.02*** (0.01)
Shock/10 *x* per capita land value		−0.06 (0.23)
Mother dead		−0.36 (0.86)
Father dead		0.63 (0.89)
Observations	5591	4706
R-squared	0.38	0.42

- Availability of asset helped decrease the impact on child labor. So the poor with less asset would tend to use more child labor as buffer to shock!

This easily leads to underinvestment in human capital!

How might uninsured risk reinforce stochastic poverty trap?

- *Ex post*: Uninsured shocks that destroy (physical, human) assets could cause irreversible consequence by trapping the initial non-poor into poverty in the setting with threshold-based poverty trap



- *Ex post* risk coping and asset smoothing that reduce investment in human capital
- *Ex ante* risk avoidance also help create bifurcation in returns to asset

Effective insurance/safety net could yield very high return

- Prevent vulnerable from collapsing into trap
- Stimulate investment incentives among the poor

How about formal insurance market?

- Microfinance community would like to see microinsurance as “the next revolution” → small insurable contracts but many of them!
- Yet, the current commercialised experience have been disappointing!
  - Very low demand among the poor at even at actuarial fair rate!
  - Insurers also needs premium marked up to keep up with increasing cost!
- **What are the key market failures?**
  - **Adverse selection**: HHs highly exposed to risk would tend to buy insurance, what happen the insurer does not observe this?
  - **Moral hazard**: insured HHs tend to take excessive risks, over claim, what happen if the insurer does not know this?
  - **Transaction costs** could be very high for claim loss verification, obtain information to control for incentive problems and for delivery mechanism
- **Key demand side impediments?**
  - **Trust, understanding, liquidity constraint, low client value?**

How about formal insurance market?

EX 1) Health insurance

- Moral hazard: We already see that the poor already spend a lot on curative care! What if HH had insurance?
- Adverse selection: People who know to be sick may sign up
- Fraud: How to prevent doctors for charging for services they do not?
- To avoid moral hazard and fraud → Offer only catastrophic health insurance (hospitalization insurance, usually in a networked hospital which has been vetted)
- To avoid adverse selection → Make the insurance compulsory for a pre-selected group of people (e.g. clients of a microcredit organization)

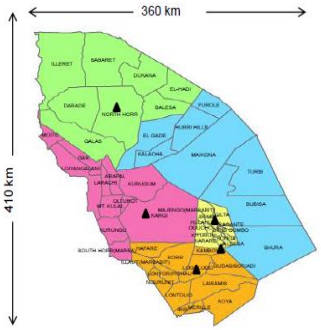
How about formal insurance market?

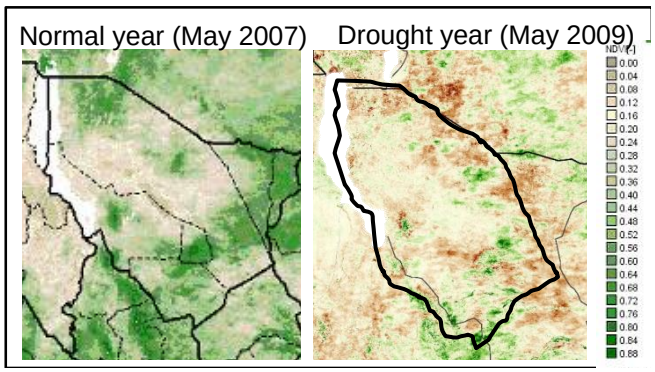
EX 2) Crop insurance

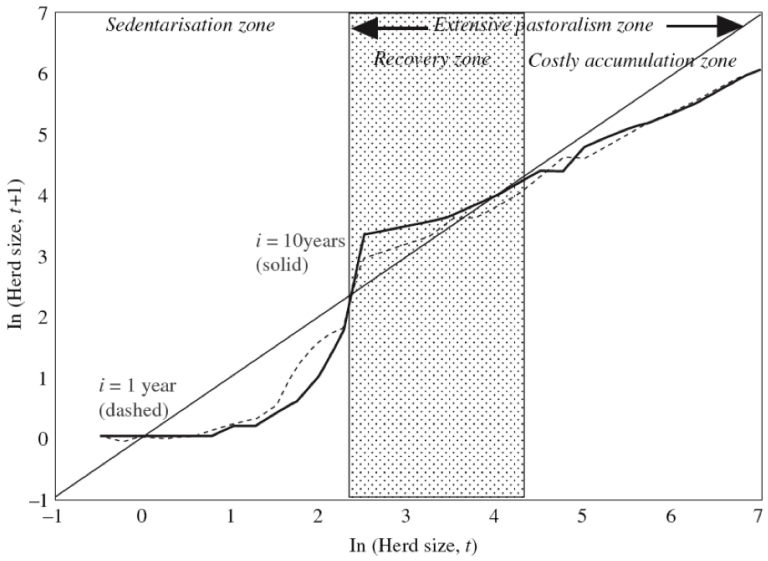
- Moral hazard: would insured farmers take care of their farm? Do insurers observe this?
- Adverse selection: farmers in risk prone areas will tend to buy insurance
- Transaction cost will be very high to verify claimed loss farm by farm in remote regions, costs will be overwhelming for small contract sizes of smallholders
- Offer weather insurance or index insurance instead → insurance payouts based on an index, e.g., rainfall at a nearby weather station, satellite data that are objectively measured at low cost, instead of actual farm loss
  - Low transaction cost as no need for loss verification by farm (just go online to get weather data)
  - No moral hazard as index cannot be manipulable by the insured: payout based on rainfall NOT action by the insured farmers
  - No adverse selection as long as insurer prices contract based on the fully observed risk based on rainfall … can charge more in risky areas

Satellite-based livestock insurance piloted in Kenya

- The setting: livestock as key asset, poverty trap/ drought prone/ the only form of safety net is food aid, limited risk strategies







Nadaraya-Watson estimates using Epanechnikov kernel with bandwidth ($h = 1.5$)

- Resolve insurance market failure

  → Using satellite images to trigger compensate for livestock loss from drought

- Cost effective delivery → local MFI, mobile technology

- Ensure informed demand → educational game, village insurance promoters

Satellite-based livestock insurance piloted in Kenya

Research questions	Testable hypotheses
In the short term:	
What might be the patterns and determinants of IBLI uptake? How elastic is IBLI demand with respect to price?	• Elastic demand among poor, budget constrained households • Varying patterns and determinants across groups
In the medium term:	
Could IBLI reduce costly risk coping? Could IBLI improve investment incentive and credit availability?	• Reduce the need for asset and sacrificing consumption to smooth asset • Increase incentive and D&S for credit • Varying results across groups
In the long term:	
Would IBLI resolve poverty trap?	• Help the poor get out of poverty trap • Prevent non-poor from falling into trap

Impact evaluation: The encouragement design

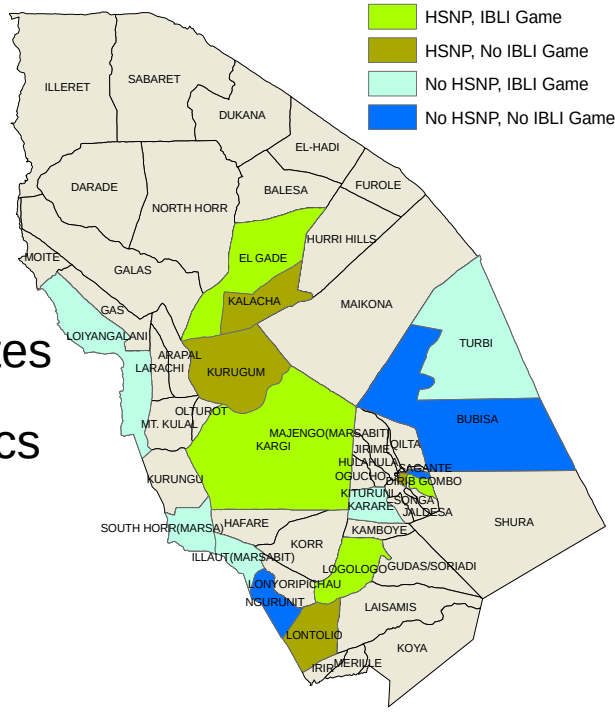
- **Ideally, we want to estimate unbiased impact (β) from**

$$Y_i = \alpha + \beta ins_i + \varepsilon_i \quad \text{where} \quad ins_i = \begin{cases} 1 \text{ if buy insurance (treatment)} \\ 0 \text{ if do not buy (control)} \end{cases}$$

- **Pure randomisation would be ideal but not possible!**
  - Can we force some sampled households to buy insurance?
  - So household self-select into the market → β biased estimate of impact (why?)
- **Randomisation to create instrument Z_i to solve self selection in 2SLS**
  - 2SLS: $Y_i = \alpha + \beta \widehat{ins}_i + X_i\delta + \varepsilon_i$ with $ins_i = a + bZ_i + X_ic + e_i$
  - With proper instrument(s), β will give unbiased estimate of impact
- **We create two Z_i by randomising "encouragement to buy insurance"**
  - Discount coupon (0-60%, household level)
  - Educational game (50% of sites, 50% households/site)

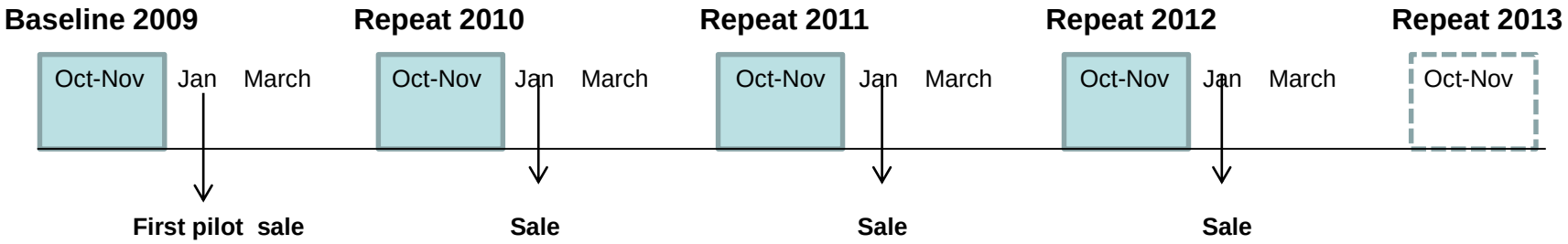
Impact evaluation: Implementation

- **Two randomised encouragement (Z_i)**
  - Discount coupon (household level)
  - Educational game (site and households levels)
- **Confounding factor:** HSNP at randomly selected sites
  - 16 sites; 8 matched paired with similar characteristics



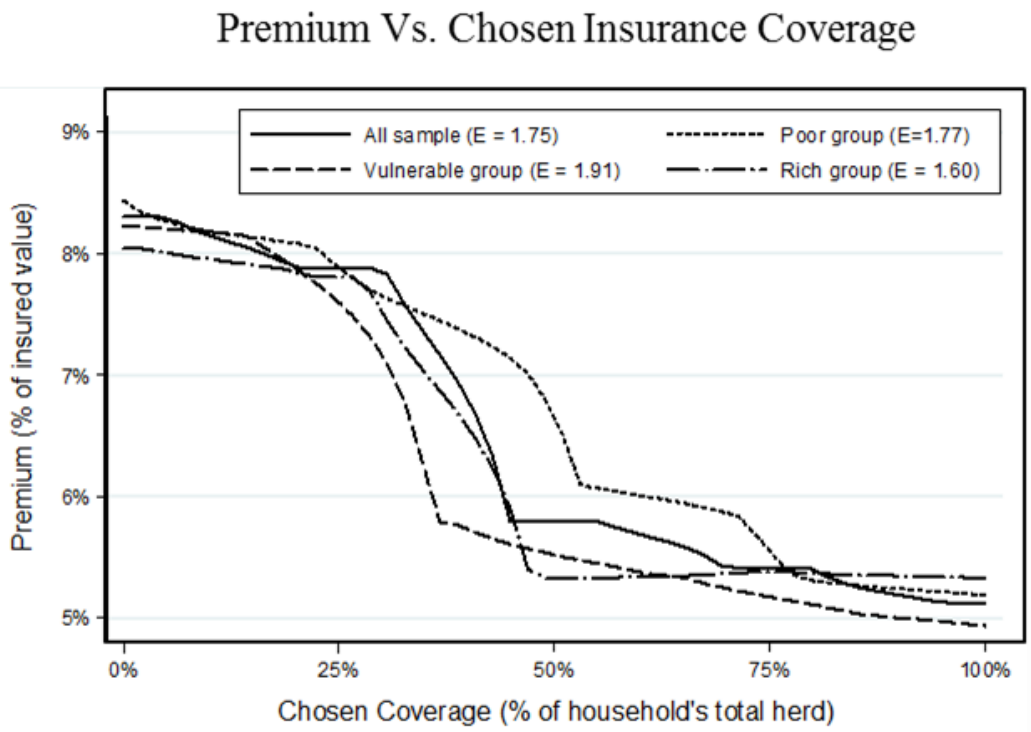
	HSNP	No HSNP
game	4 sites	4 sites
No game	4 sites	4 sites

- **Sample selection:** 924 households (stratified by wealth)

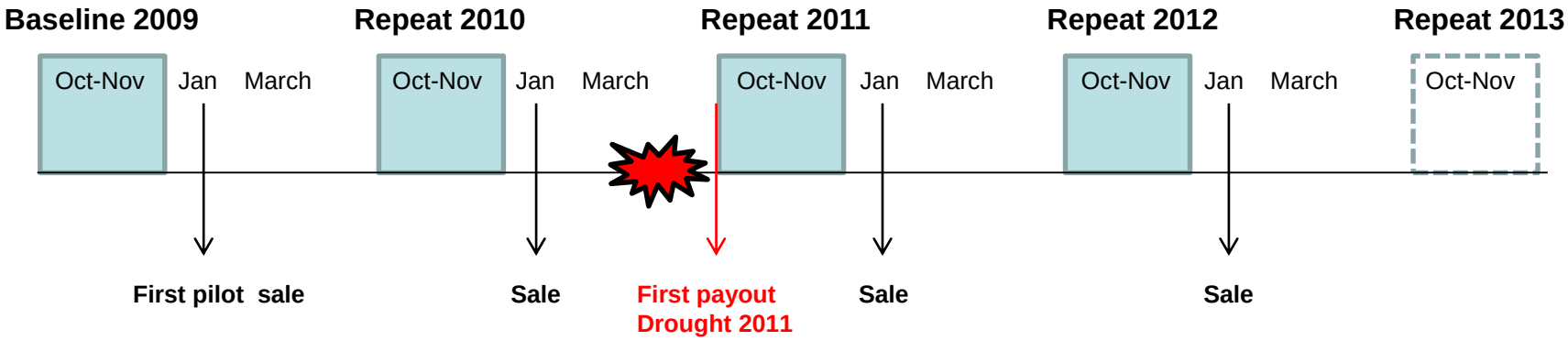


Pattern of insurance demand

- Price elasticities are high and vary across wealth group…with those vulnerable to falling into poverty having the highest elasticity (Chantarat and Mude 2012)
  - What does this imply about role of public policy in enhancing market and uptake of insurance?



Immediate insurance impacts following drought 2011



- **Can insurance payouts reduce the need to rely on coping strategies that could undermine asset and HC accumulation?**
  - Use only data from repeated survey in 2011 with 24% of insured
  - How insurance payouts affect household's "anticipated" livestock sale and reducing meals following drought 2011?
  - Empirical strategies: 2SLS with randomised encouragement instruments, robustness check with Heckman, DD, matching approaches

Coping strategies:

Action	Insured Qtr 3	Insured Qtr 4	Uninsured Qtr 3	Uninsured Qtr 4	Difference in Means Qtr 3	Difference in Means Qtr 4
Sell livestock	.33	.12	.28	.32	-.042	.208***
	(.04)	(.03)	(.02)	(.02)	(.04)	(.04)
Reduce the number of meals eaten each day	.64	.33	.74	.70	.102**	.374***
	(.04)	(.04)	(.02)	(.02)	(.04)	(.04)
Rely more on food aid	.92	.43	.92	.92	.005	.494***
	(.02)	(.04)	(.01)	(.01)	(.02)	(.03)
Rely on assistance from others	.35	.15	.44	.45	.096**	.305***
	(.04)	(.03)	(.02)	(.02)	(.05)	(.04)
Pull children otherwise in school, out of school	.11	.08	.11	09	.006	.006
	(.03)	(.02)	(.01)	(.01)	(.03)	(.03)
Increase non-livestock activities like petty trade	.26	.22	.20	.26	-.061	.041
	(.04)	(.03)	(.02)	(.02)	(.04)	(.04)
Send family members to look for work elsewhere	.04	.04	.05	.07	.010	.026***
	(.02)	(.02)	(.01)	(.01)	(.02)	(.02)

- Pre-payout differences in coping strategies (in Q3) → selection bias?

Summary of key characteristics

Variable	Insured Qtr 3	Uninsured Qtr 3	Difference in Means Qtr 3
Years of education, household head	.76 (.20)	1.18 (.15)	.416 (.294)
Risk-taking *(dummy=1 if risk-taking)*	.24 (.03)	.29 (.15)	.049 (.041)
Risk-moderate *(dummy=1 if risk-moderate)*	.50 (.04)	.45 (.02)	-.054 (.046)
Non-livestock asset index *(from factor analysis)*	.15 (.10)	.00 (.05)	-.150 (.098)
Number of TLU Owned	16.22 (1.40)	18.86 (1.29)	2.646 (2.423)
Number of TLU losses in past year	7.67 (.89)	7.53 (.49)	-.137 (1.001)
Number of Expected TLU losses in next year	6.98 (.62)	7.56 (.37)	.579 (.748)
Credit Constrained *(dummy=1 if say it's difficult to acquire a loan)*	.42 (.04)	.37 (.02)	-.043 (.045)

Summary of key characteristics

Variable	Insured Qtr 3	Uninsured Qtr 3	Difference in Means Qtr 3
Participated in IBLI game *(dummy=1 if true)*	.28 (.04)	.25 (.02)	-.030 (.040)
Received IBLI discount coupon *(dummy=1 if true)*	.87 (.03)	.55 (.02)	-.320*** (.043)
Value of IBLI discount coupon *(possibilities include 0, 10, 20, 30, 40, 50, 60)*	23.85 (1.85)	16.53 (.97)	-7.32*** (2.01)
Heard about IBLI from Village Insurance Promoter *(dummy=1 if true)*	.71 (.04)	.47 (.02)	-.238*** (.045)
Number of IBLI information sources	2.16 (.07)	1.89 (.05)	-.269 (.092)

- Surprisingly, the insured appears relatively similar to the uninsured households!
- The randomised discount coupons (not the game) appear to have been effective as instruments!

2SLS Results: Demand

- **The 2SLS specification used to estimate impact:**

1st stage: $ins_i = a + bZ_i + X_i c + e_i$

2nd stage: $Y_i = \alpha + \beta \widehat{ins}_i + X_i \delta + \varepsilon_i$

- Game appears weak as an instrument; hence dropped
- Both coupon instruments are jointly significant!

Demand for Insurance: First Stage Probit

	(1)
Received IBLI discount coupon *(instrument #1)*	1.476***
	(0.202)
Value of IBLI discount coupon *(instrument #2)*	-0.004
	(0.005)
Years of education (head)	-0.047
	(0.029)
Risk-taking	0.126
	(0.170)
Risk-moderate	0.148
	(0.114)
Non-livestock asset index	0.259***
	(0.091)
TLU Owned	-0.007***
	(0.002)
TLU losses in past year	0.012***
	(0.005)
Expected TLU losses	-0.010
	(0.008)
Credit Constrained	0.040
	(0.152)
Ethnicity fixed effects	yes
Location fixed effects	yes
Observations	634
Pseudo R^2	0.263
Wald test for joint significance of instruments	75.47

2SLS Results: Potential impacts of insurance payouts

- Insurance reduces a household's tendency to sell off livestock and reduce daily meal

	Impact of Insurance #1, Sell livestock			Impact of Insurance #2, Reduce daily meals		
	(1) *IV*	(2) *Heckman*	(3) *DD*	(1) *IV*	(2) *Heckman*	(3) *DD*
$\widehat{insured}$	-0.363*			-0.268**		
	(0.198)			(0.092)		
insured*post			-0.252***			-0.277***
			(0.059)			(0.062)
insured		-0.259***	-0.005		-0.359***	-0.080
		(0.076)	(0.044)		(0.056)	(0.057)
post (time dummy)			0.035			-0.046***
			(0.022)			(0.014)
Inverse Mills Ratio		0.255			-0.134	
		(0.356)			(0.154)	
Ethnicity fixed effects	yes	yes	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes	yes	yes
Observations	634	634	1,268	634	634	1,268
R^2	0.153	0.200	0.184	0.164	0.236	0.210

Threshold-based asset smoothing?

- Using Hansen's threshold estimation, we can confirm the literature on poverty trap → poor households near and below critical asset tend to smooth asset!

Table 8: Threshold-Disaggregated Summary of Quarter 3 Coping Behavior

Action	Asset Poor Households (Less than 11.75 TLU)	Asset Rich Households (Greater than 11.75 TLU)	Difference in Means
Sell livestock	.21 (.02)	.39 (.03)	-.17*** (.04)
Reduce the number of meals eaten each day	.79 (.02)	.64 (.03)	.15*** (.03)
Rely more on food aid	.92 (.01)	.92 (.02)	.00 (.02)
Rely on assistance from others	.40 (.03)	.44 (.03)	-.04 (.04)

Threshold-based impacts of insurance payout?

- Insurance payouts reduce the tendency to reduce meal (sell livestock) more significantly among the asset poor (asset rich), who are likely to use this action to cope with droughts

  → This insurance seems valuable as effective drought coping strategies!

Table 9: Threshold-Disaggregated Impact of Insurance Using IV

	Impact #1 Sell Livestock		Impact #2 Reduce Meals	
	(1) Asset Poor < 10.5 TLU	(2) Asset Rich > 10.5 TLU	(3) Asset Poor < 9.3 TLU	(4) Asset Rich < 9.35 TLU
$\widehat{insured}$	-0.143	-0.616***	-0.393***	-0.137
	(0.142)	(.188)	(0.161)	(0.184)
Ethnicity fixed effects	yes	yes	yes	yes
Location fixed effects	yes	yes	yes	yes
Observations	323	311	304	330
R^2	0.165	0.219	0.198	0.233

Might there be space for public intervention?

- **Strengthen the poor's ability to manage and cope with risk themselves**
  - Improve access to diversification (e.g., R&D, microcredit)
  - Improve saving products (commitment saving?)
  - Insure the "uninsured covariate risk" of group-based risk sharing
- **Public intervention to complement the market**
  - (Targeted) subsidized insurance offered by the market
  - Public provided insurance program, e.g., for expensive product which market tends to fail, e.g., natural disasters
  - Social protection programs, cash transfers, food aid, credit schemes
- **Support sustainable market** → investment in public goods, risk market infrastructure, etc.
- **Provision of financial education, awareness and trust**
- **Support and investment in effective risk reduction strategies**