Distinguishing barriers to insurance in Thai villages

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Introduction

Consumption smoothing is present but incomplete

- Consumption is significantly smoother than income.
- But, there is a significant tendency for consumption and income to co-move:
  - For households from rural Thailand over 1999-2005, this correlation is .17 ($t = 3.9$).
  - Figure for the US: $\sim .06 - .08$.
- Thai households are neither fully insured, nor living hand to mouth.
- Could be due to self-insurance with borrowing and saving, or incomplete insurance.

Introduction

Informal insurance is important

- Borrowing and saving is not the whole story
  - Informal credit often has a significant insurance element (Platteau and Abraham 1987, Udry 1994, Fafchamps and Lund 2003)
- Interpersonal transfers are widespread
  - In Thai data, households were asked "What did your household do to get by in the worst year of the past five?"
    - 21% reported receiving transfers from other households that did not need to be repaid
    - 17% reported receiving transfers from other households that could be repaid when they were able
  - Many (22%-93%) households in developing countries report receiving private transfers (Cox and Jimenez 1990)

Introduction

Models of incomplete insurance

- Why might insurance be incomplete? Contracts are incomplete:
  1. Limited commitment: cannot commit to remain in insurance agreement ($\Rightarrow$no long-term contracts)
  2. Moral hazard: effort is not observable ($\Rightarrow$no contracts on effort)
  3. Hidden income: income is not observable ($\Rightarrow$no contracts on income)
- Informal insurance often fits data better than borrowing-savings: Ligon (1998), Lim and Townsend (1998), Paulson, Townsend and Karaivanov (2006), Dubois, Julien and Magnac (2008)
- Few attempts to empirically distinguish *among* models of incomplete insurance
  - Exceptions: Kaplan (2006), Ai and Yang (2007), Karaivanov and Townsend (2009)

Introduction

The barrier to insurance matters

- Asset pricing implications
- Network formation implications
- Policy impact implications
  - Employment guarantee programs
  - Conditional cash transfers
  - Banking design (group vs. individual savings/credit)
  - Aid allocation
  - Price information systems
  - Market integration

Introduction

The barrier to insurance matters

Example: Rainfall insurance: known payment if rainfall is too low

- moral hazard
  - rainfall outside households' control$\Rightarrow$no effect on moral hazard problem
  - $\uparrow$ consumption smoothing one-for-one
- limited commitment
  - autarky is better$\Rightarrow$worsens limited commitment problem
  - $\uparrow$ consumption smoothing less than one-for-one; possibly $\downarrow$consumption smoothing (Attanasio and Rios-Rull 2000)
- hidden income
  - reduced likelihood of low income, when temptation to misreport is highest$\Rightarrow$lessens hidden income problem
  - may $\uparrow$ consumption smoothing *more* than one-for-one

Introduction

This paper's contribution

1. Derive testable implication of hidden income that can be compared to implications of moral hazard, limited commitment
   - Limited commitment or moral hazard: **lagged inverse marginal utility ("LIMU") is a sufficient statistic** for history in forecasting current inverse marginal utility
   - Hidden income: **LIMU is not a sufficient statistic: lagged income has additional predictive power**
2. Empirically test across barriers to insurance

Introduction

Why does history matter differently?

- Under limited commitment and moral hazard, income is observed⇒consumption/inverse marginal utility (IMU) is controlled by the community
  - Efficiency⇒equate value of marginal dollar in current period with expected value of marginal dollar in the future
  - ⇒lagged IMU encodes all past information relevant to predict current IMU
- Under hidden income, ability to misreport income⇒consumption/IMU is not a control variable
  - Lagged income contains additional information about how binding truth-telling constraints were
    - Truth-telling constraints (temptation to claim a lower income) bind more at low income levels
    - Low-income households receive more consumption in the present, when it is more valuable to truthful than misreporting households
    - High-income households receive more promised consumption in the future
  - Conditional on lagged IMU, current IMU will be positively correlated with lagged income

Introduction

Preview of results

- Implications of limited commitment, moral hazard are rejected for households in rural Thailand
  - robust to correcting for measurement error in consumption
  - robust to nonparametrically estimating utility function
- Data is consistent with hidden income
  - LIMU is not a sufficient statistic in forecasting current IMU
  - HHs with "less observable" income display greater insufficiency of LIMU
  - Insurance of "less-observable" income is distorted most

Outline

- Optimal insurance
- Implications of 3 barriers to insurance
    - Limited commitment
    - Moral hazard
    - Hidden income
- Data
- Results
    - Test moral hazard/limited commitment
    - Test hidden income model
    - Measurement error
    - Specification of utility function

Villages as insurance networks

- N risk-averse households evaluate consumption and effort plans according to:

$$U(\mathbf{c}_i, \mathbf{e}_i) = \mathbb{E} \sum_{t=0}^{\infty} \delta^t \left[v(c_{it}) - z(e_{it}) \right]$$

  - Common discount factor δ, utility of consumption c_{it}, disutility of effort e_{it}
  - Infinite time horizon
- Income is risky:

$$y_1 < y_2 < ... < y_{S-1} < y_S$$

- Incomes may be correlated across households and over time
- Income risk isn't perfectly correlated across households⇒scope for insurance

Intertemporal technology

Allow for intertemporal as well as interpersonal smoothing.

- Community-controlled borrowing-saving technology with gross return R
- Define $\tau_{irt} \equiv c_{irt} - y_r$, household i's net transfer when income is y_r
- Village assets a_t evolve according to

$$a_{t+1} = R\left[a_t - \sum_{i=1}^{N} \tau_{it}\right] \qquad (\eta_t)$$

- $\eta_t \equiv$ multiplier on village's budget constraint
- Borrowing-savings decisions are contractible while a household is within the network
  - HH who contemplates leaving the network has no private savings and may save/borrow thereafter

Production technology

- Effort takes two values, $e_t \in \{0, 1\}$
- Technological linkages between periods do not undo sufficiency of LIMU under limited commitment/moral hazard
- The distribution of income is affected by household's effort in the current and the previous period (durable investment, multi-period production):

$$\Pr(y_t = y_r) = \Pr(y_r | e_t, e_{t-1})$$
$$\Pr(y_r | e_t, e_{t-1}) \in (0, 1), \forall e_t, e_{t-1}, r$$

- Define

$$\begin{aligned} p_{ree'} &\equiv \Pr(y_r | e_t = e, e_{t-1} = e') \\ \text{e.g., } p_{r11} &= \Pr(y_r | e_t = 1, e_{t-1} = 1) \\ & \quad etc. \end{aligned}$$

- Effort $(e = 1)$ raises expected surplus

Full insurance

Planner's problem

- Find Pareto-efficient allocations as if a planner solves the recursive problem of maximizing the utility of household N:

$$u_N(\mathbf{u}_t, a_t, \mathbf{e}') \equiv \max_{\mathbf{e}, \{\boldsymbol{\tau}_{rt}\}, \{\mathbf{u}_{r,t+1}\}}$$

$$\sum_{r=1}^{S} p_{ree'} v(y_r + \tau_{Nrt}) - z(e_N) + \delta \mathbb{E} u_N(\mathbf{u}_{t+1}, a_{t+1}, \mathbf{e})$$

- subject to the promise-keeping constraints that each household 1 to $N-1$ must (in expectation) get their promised utility u_{it}:

$$\sum_{r=1}^{S} p_{ree'} [v(y_r + \tau_{irt}) - z(e_i) + \delta u_{ir,t+1}] = u_{it}, \forall i < N \quad (\lambda_{it})$$

- and the law of motion for assets:

$$a_{t+1} = R \left[a_t - \sum_{i=1}^{N} \tau_{it} \right] \qquad (\eta_t)$$

Full insurance

Implications

- Household consumption doesn't depend on household income, given aggregate community resources and the household's Pareto weight
  - changes in income don't predict changes in consumption, given aggregate consumption
  - aggregate consumption may move with aggregate income
- Village expected consumption evolves over time depending on $R\delta \gtreqless 1$

Barriers to insurance

- **Limited commitment**
- Moral hazard
- Hidden income

Limited commitment

- Workhorse model of village insurance (Coate and Ravallion 1993, Kocherlakota 1996, Ligon et al. 2002, Dubois et al. 2008)
- After seeing income, household can walk away from the insurance network if it can do better in autarky
  - No formal contracts
- Imposes the participation constraints

$$v(y_r + \tau_{irt}) + \delta u_{ir,t+1} \geq u_{aut}(y_r, e), \forall i, r$$

- If the household can choose saving (+ or -) s,

$$\begin{aligned} u_{aut}(y_r, e) \quad \equiv \quad & \max_{s_t, e_{t+1}} v(y_r - s_t) - \delta z(e_{t+1}) \\ & + \delta \mathbb{E}\left[u_{aut}(y_{t+1} + R s_t) | e_{t+1}, e\right] \end{aligned}$$

Limited commitment

This paper's contribution

- Kocherlakota (1996): vector of lagged marginal utility ratios for every member of the insurance group,

$$\left\{ \frac{v'(c_{N,t-1})}{v'(c_{i,t-1})} \right\}_{i=1}^{N-1}$$

  is a sufficient statistic for history in forecasting any household's consumption at t
  - Specifies a unique point on the Pareto frontier
  - Not directly testable without information on all the members of the insurance group
- My contribution: the shadow price of village resources η_t captures how much consumption must be given to other households in the village

Limited commitment

Sufficiency of lagged inverse marginal utility

Claim: *Under limited commitment, the inverse of lagged marginal utility* $\left(\frac{1}{v'(c_{i,t-1})}\right)$ *is a sufficient statistic for past information in forecasting household i's time t consumption, given the time t shadow price of assets* η_t.

- When a household is tempted to leave the network, its current consumption and future promise are chosen to make it exactly indifferent between leaving and staying.
- When a household's participation constraint is not binding, its marginal utility (scaled by the shadow price of assets) does not change.
  - Consumption of other village members only matters via shadow price of resources η_t
- LIMU encodes all information about past income realizations necessary to predict current consumption.
- Show FOC

Barriers to insurance

- Limited commitment
- **Moral hazard**
- Hidden income

Moral hazard

- Common model of incomplete insurance (Rogerson 1985, Phelan and Townsend 1991, Phelan 1998, Ligon 1998)
- Household effort is not observable
  - The planner wants to implement effort $(e = 1)$ each period
  - An incentive-compatibility constraint is added to the planner's problem
- Separability between consumption and effort $\Rightarrow$ incentive-compatibility constraint will be binding at the optimum (Grossman and Hart 1983)

Moral hazard

This paper's contribution

- Technological linkages between periods (durable investment, multi-period production, etc.) $\Rightarrow$ another control variable is added to the planner's problem: "threatened utility" $\hat{u}_{it}$ (Fernandes and Phelan 2000)
  - $\hat{u}_{it}$ = upper bound on a household's expected utility from today on if the household disobeys today's effort recommendation
- "Threat-keeping" constraints are added
  - a household who disobeyed the effort recommendation last period must on average do no better than $\hat{u}_{it}$, whether they obey or disobey today
- My contribution: linkages between periods do not overturn sufficiency of a single lag of IMU

Moral hazard

Sufficiency of lagged inverse marginal utility

Claim: *Under moral hazard, LIMU* $\left(\frac{1}{v'(c_{i,t-1})}\right)$ *is a sufficient statistic for past information in forecasting household* i*'s time* t *consumption, given the time* t shadow price of resources η_t.

- The planner observes income and controls consumption.
- Punishments and rewards for income realizations more likely under high/low effort are encoded in consumption.
- The household's LIMU summarizes the extent to which no-shirking constraints has affected what the household is promised in the current period.
  - Linkages between periods do not require controlling for additional lags of IMU
  - Similar intuition as Golosov et al. (2003)'s result for adverse selection
- Show FOC

Barriers to insurance

- Limited commitment
- Moral hazard
- **Hidden income**

Hidden income

- Household incomes are not observable
- Truth-telling constraints may rule out full insurance (Townsend 1982, Green 1987, Thomas and Worrall 1990, Wang 1994)
- $S\left(S-1\right)$ truth-telling constraints are added to the planner's problem
- Only $S-1$ local downward constraints will be binding at the optimum (Thomas and Worrall 1990):

$$v(y_r+\tau_{irt})+\delta u_{ir,t+1}=v(y_r+\tau_{i,r-1,t})+\delta u_{i,r-1,t+1},$$
$$r=2,...,S$$

- My contribution: characterize how history matters in an economy with hidden income

Hidden income

Insufficiency of lagged inverse marginal utility

Claim: *Under hidden income, LIMU conditional on η_t is not a sufficient statistic for past information in forecasting household i's time t consumption: conditional on lagged IMU, current IMU will be positively correlated with lagged income*

- The planner doesn't directly observe income⇒consumption is not a control variable
  - Truth-telling constraints bind more at low income levels, when marginal utility is highest
    - Low-income households receive more consumption in the present, when it is more valuable to truthful than misreporting households
    - High-income households receive more promised consumption in the future
  - Lagged income contains additional information about how binding truth-telling constraints were

Hidden income

Insurance when income is more predictable

- Better-predictable income $\Rightarrow$ truth-telling constraints are less binding $\Rightarrow$ reduced wedge between LIMU and expected promised utility
- More predictable income reduces the insufficiency of LIMU
- Skip ahead

Hidden income

Planner's problem

$$u_N(\mathbf{u}_t, a_t, \mathbf{e}') \equiv \max_{\mathbf{e}, \{\boldsymbol{\tau}_{rt}\}, \{\mathbf{u}_{r,t+1}\}}$$
$$\sum_{r=1}^{S} p_{ree'} v(y_r + \tau_{Nrt}) - z(e) + \delta \mathbb{E} u_N(\mathbf{u}_{t+1}, a_{t+1}, \mathbf{e})$$

subject to the promise-keeping constraints:

$$\sum_{r=1}^{S} p_{ree'} [v(y_r + \tau_{irt}) - z(e) + \delta u_{ir,t+1}] \geq u_{it}, i = 1, ..., N-1 \quad (\lambda_{it})$$

the law of motion for assets,

- and the truth-telling constraints:

$$v(y_r + \tau_{irt}) + \delta u_{ir,t+1} = \qquad (\xi_{irt})$$
$$v(y_r + \tau_{i,r-1,t}) + \delta u_{i,r-1,t+1}, r = 2, ..., S$$

Hidden income

Proof

Three steps:

1. The multiplier on last period's promise-keeping constraint ($\lambda_{i,t-1}$) plus today's shadow price of resources (η_t) is a sufficient statistic for past information in forecasting current consumption.
2. But, there's not a one-to-one relationship between the lagged multiplier ($\lambda_{i,t-1}$) and LIMU $\left(\frac{1}{v'(c_{i,t-1})}\right)$.
3. Current IMU is postively correlated with past income ($y_{i,t-1}$), given LIMU.

- Skip ahead

Hidden income

FOCs

τ_{irt} :

$$\Big(\underbrace{p_{ree'}\lambda_{it}}_{\text{Contrib. to PK}} + \underbrace{\xi_{irt}}_{\text{Contrib. to TT}_r} \Big) \underbrace{v'(y_r + \tau_{rt})}_{\text{MU in state } r \text{ if truthful}} =$$

$$\underbrace{\eta_t}_{\text{Price of resources}} + \underbrace{\xi_{i,r+1,t}}_{\text{Cost to TT}_{r+1}} \underbrace{v'(y_{r+1} + \tau_{rt})}_{\text{MU in state } r+1 \text{ if untruthful}}$$

Hidden income

FOCs

$u_{ir,t+1}$:

$$\underbrace{p_{ree'}\mathbb{E}\frac{-\partial u_N(\mathbf{u}_{t+1}, a_{t+1}, \mathbf{e})}{\partial u_{ir,t+1}}}_{\text{Exp. cost of } \uparrow \text{ promised utility after } r} = \underbrace{p_{ree'}\lambda_{it}}_{\text{Contrib. to PK}} + \underbrace{\xi_{irt}}_{\text{Contrib. to TT}_r} - \underbrace{\xi_{i,r+1,t}}_{\text{Cost to TT}_{r+1}}$$

Hidden income

FOCs

a_{t+1} :

$$\underbrace{\mathbb{E}\frac{\partial u_N(\mathbf{u}_{t+1}, a_{t+1}, \mathbf{e})}{\partial a_{t+1}}}_{\text{Exp value of resources tomorrow}} = \eta_t$$

Hidden income

FOCs

Envelope conditions:

u_{it} :

$$\underbrace{-\frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e}')}{\partial u_{it}}}_{\text{Cost of promised utility today}} = \underbrace{\lambda_{it}}_{\text{Multiplier on PK}}$$

Hidden income

FOCs

Envelope conditions:

a_t :

$$\underbrace{\frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e}')}{\partial a_t}}_{\text{Benefit of resources today}} = \underbrace{\eta_t}_{\text{Multiplier on BC}}$$

Hidden income

Step 1: Lagged promise-keeping multiplier is a sufficient statistic

- $\lambda_{i,t-1}$ is a sufficient statistic for history: the FOC for $u_{ir,t+1}$ and the envelope condition for u_{it} imply:

$$\underbrace{\mathbb{E}\left(\lambda_{i,t+1}|\eta_{t+1}\right)}_{=\text{Exp. cost of utility at } t+1} = \lambda_{it} + \frac{\xi_{irt} - \xi_{i,r+1,t}}{p_{ree'}}$$

- lagging one period ($q \equiv$state at $t-1$):

$$\mathbb{E}\left(\lambda_{it}|\eta_t\right) = \lambda_{i,t-1} + \underbrace{\frac{\xi_{iq,t-1} - \xi_{i,q+1,t-1}}{p_{qee'}}}_{=0 \text{ in exp'n}}$$

Hidden income

Step 2: Insufficiency of lagged inverse marginal utility

- $\frac{1}{v'(c_{i,t-1})}$ does not capture all information to forecast λ_{it}
- The FOC for transfers at $t-1$ implies that

$$\mathbb{E}(\lambda_{it}|\eta_t) =$$

$$\lambda_{i,t-1} = \frac{1}{v'(y_q + \tau_{iqt-1})} \times$$

$$\left(1 - \frac{\xi_{iqt-1} v'(y_q + \tau_{iqt-1}) - \xi_{iq+1t-1} v'(y_{q+1} + \tau_{iqt+1})}{\eta_{t-1} p_{qee'}}\right)$$

Hidden income

Step 3: Overprediction at the bottom

- Using the envelope condition for u_{it}, the time $t-1$ FOC for u_{it} can be written

$$\underbrace{\frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it}}}_{\lambda_{it}} - \underbrace{\frac{\partial u_N(\mathbf{u}_{t-1}, a_{t-1}, \mathbf{e})}{\partial u_{i,t-1}}}_{\lambda_{i,t-1}} = \frac{\xi_{ir,t-1} - \xi_{i,r+1,t-1}}{p_{ree'}}$$

- Assume no aggregate uncertainty: $a_t = a_{t-1}$
- Since $u_N(\mathbf{u}_t, a_t, \mathbf{e})$ is concave in each u_{it}, when a household's promise decreases $(u_{it} < u_{i,t-1})$,

$$\frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it}} > \frac{\partial u_N(\mathbf{u}_{t-1}, a_t, \mathbf{e})}{\partial u_{i,t-1}}$$

- so $\xi_{ir,t-1} > \xi_{i,r+1,t-1}$: truth-telling constraints at low incomes bind more when promises decrease.

Hidden income

Step 3: Overprediction at the bottom

- Since $v'(y_r + \tau_{rt}) > v'(y_{r+1} + \tau_{rt})$,

$$\xi_{ir,t-1} v'(y_{ir} + \tau_{ir,t-1}) > \xi_{i,r+1,t-1} v'(y_{ir+1} + \tau_{ir,t-1})$$

- so when promises decrease

$$\xi_{ir,t-1} v'(y_{ir} + \tau_{ir,t-1}) - \xi_{i,r+1,t-1} v'(y_{ir+1} + \tau_{ir,t-1}) > 0$$

- so

$$\mathbb{E}(\lambda_{it} | \eta_t) = \frac{1}{v'(y_q + \tau_{iq,t-1})} \times \underbrace{\left(1 - \frac{\xi_{iqt-1} v'(y_q + \tau_{iqt-1}) - \xi_{iq+1t-1} v'(y_{q+1} + \tau_{iqt+1})}{\eta_{t-1} p_{qee'}}\right)}_{<1 \text{ when } u_{it} < u_{i,t-1}} \tag{1}$$

Hidden income

Step 3: Overprediction at the bottom

- When promised utility decreases

$$\mathbb{E}(\lambda_{it}|\eta_t) < \underbrace{\frac{1}{v'(y_{ir} + \tau_{ir,t-1})}}_{\text{LIMU}}$$

- LIMU over-predicts λ_{it} when the household's promise decreased between $t-1$ and t.
- Truth-telling $\Rightarrow$ promises are an increasing function of income.
- Low-y_{t-1} households will get less consumption at t than predicted using lagged inverse marginal utility.■
- Aggregate uncertainty $\Rightarrow$ control for interaction of aggregate shock and quadratic in lagged income $\left[\begin{array}{cc} y_{i,t-1} \times \Delta\eta_t & y^2_{i,t-1} \times \Delta\eta_t \end{array}\right]$ because extent of overprediction may vary non-monotonically with $\Delta\eta_t$.
- Details

Theoretical implications

Summary

- **Limited commitment or moral hazard $\Rightarrow$LIMU is a sufficient statistic** for history in forecasting current inverse marginal utility
  - controlling for LIMU $\left(\frac{1}{v'(c_{it})}\right)$ and a measure of village resources (η_t), no other information dated $t-1$ or before will predict current IMU
- **Hidden income $\Rightarrow$ LIMU is not a sufficient statistic**
  - controlling for LIMU and η_t, current IMU is positively correlated with past income $y_{i,t-1}$
  - Comparing two households with the same c_{t-1}, the household with higher y_{t-1} has higher expected c_t

Empirical implications

Distinguishing barriers to insurance

- With CRRA utility

$$
\begin{aligned}
v(c_{it}) &= \frac{c_{it}^{1-\rho}}{1-\rho} \\
\frac{1}{v'(c_{it})} &= c_{it}^{\rho} \\
\ln \frac{1}{v'(c_{it})} &= \rho \ln(c_{it}) \propto \ln(c_{it})
\end{aligned}
$$

- Estimate:

$$\ln(c_{it}) = \alpha \ln(c_{i,t-1}) + \beta y_{i,t-1} + \eta_{vt}$$

- $\alpha > 0, \beta = 0$ is consistent with limited commitment, moral hazard, borrowing-saving, full insurance
  - Distinguish with other implications: "Amnesia" (LC), Euler equation (PIH), Inverse Euler equation (MH)
- $\alpha > 0, \beta > 0$ is consistent with hidden income

Data

- Townsend Thai Project monthly data, 1999-2005
- 16 villages in 4 provinces (2 in Northeast, 2 in Central)
    - 670 households observed in Jan 1999
    - 531 continuously-observed households
- Detailed bi-weekly and monthly surveys of HH expenditure
- Total monthly household income (from agricultural profits, business profits, wages, gov't transfers, pensions, etc.)
- Gifts given and received
- Household composition
- Household occupation (33 categories, grouped into 10)
- Village-level monthly rainfall data, 1999-2003

Data

Household income and occupation

Monthly HH income	8981 baht (∼€200)
Household size	4.5 (3.8 adult eq.)
Occupation (household head, baseline)	
Rice farmer	35.5%
Non-ag labor	11.9%
Corn farmer	9.8%
Livestock farmer	8.9%
Ag wage labor	5.1%
Other crop farmer	4.3%
Shrimp/fish farmer	3.6%
Orchard farmer	1.7%
Construction	1.5%
Other	7.4%

Data

- Aggregate income and consumption to annual totals, scale by adult equivalents
- Distinguish gifts to and from households in the village vs. outside the village
  - Gifts given to others in village = 5.4% of avg expenditure; gifts from others in village = 9%
  - Gifts/remittances to those outside village = 17.5%; gifts from those outside village = 27.7%
  - Low-interest/flexible loans, labor sharing aren't included
- Construct quarterly rainfall variables following Paxson (1992): $R_{qvt} - \bar{R}_{qv}, (R_{qvt} - \bar{R}_{qv})^2$

Results

- Test incomplete insurance
- Test moral hazard/limited commitment
- Test hidden income model
- Robustness

Is insurance incomplete?

Estimate:

$$\Delta \ln c_{ivt} = \alpha \Delta \ln y_{ivt} + \eta_{vt} + \varepsilon_{ivt}$$

Testing incomplete insurance

	log household PCE OLS	log household PCE IV
log household income	.0669***	.1737***
	[.0073]	[.0444]
Village-year F statistic	5.256	3.471
Village-year p value	0.0000	0.0000
Observations	3323	1879

Testing MH, LC against HI: Sufficiency of LIMU

Estimate:

$$\ln c_{it} = \alpha \ln c_{i,t-1} + \beta \ln y_{i,t-1} + \eta_{vt} + \varepsilon_{it}$$

Testing sufficiency of lagged inverse marginal utility	
ln(LIMU)	.7126***
	[.023]
Lagged log income	.0424***
	[.007]
R-squared	0.6687
Observations	2845

- LIMU is not a sufficient statistic: lagged income is positively predictive
- Inconsistent with limited commitment or moral hazard; consistent with hidden income

Skip add'l tests of hidden income

Testing hidden income

Observability of income and insufficiency

- More-observable income⇒truth-telling constraints are less binding⇒LIMU is "less insufficient"
  - Less distortion of timing of consumption when income is more observable
- 3 implications:
  - **Across occupations:** Insufficiency of LIMU should be less for occupations with more-observable income processes
  - **Within occupations:** Insufficiency of LIMU should be less for households with less-variable income processes
  - **Within households:** Insufficiency of LIMU should be less for more-observable income sources

Testing hidden income 1

Insufficiency by explanatory power of rainfall

- For each occupation, regress income on quarterly rainfall variables; interact lagged income with occupation-level R^2
- Best-predicted: rice farmers, construction workers; worst-predicted: non-ag wage labor, corn farmers
- $\Rightarrow$Do HHs in occupations better-predicted by rainfall display less departure from sufficiency of LIMU?

Testing hidden income 1

Insufficiency by explanatory power of rainfall: Results

- LHS variable: OLS residuals
  $\hat{\varepsilon}_{it} \equiv \ln(c_{it}) - \mathbb{E}\left(\ln(c_{it}) | \ln(c_{i,t-1}), \eta_{vt}\right)$
- Estimate, separately for high- and low-R^2 HHs:

$$\hat{\varepsilon}_{it} = \alpha + \beta y_{i,t-1} + u_{it}$$

	High rainfall R^2	Low rainfall R^2
Constant (α)	-0.421	-0.621
	[0.088]	[0.090]
Lagged log income (β)	0.047	0.056
	[0.008]	[0.008]
Chi-square stat (α<0, β>0)	28.581	54.156
p value	(0.000)	(0.000)

- More insufficiency of LIMU (greater χ^2) when income is less predicted by rainfall.

Testing hidden income 2

Insufficiency by income variance

- For each household, calculate variance of income over 7 years (residuals from rainfall, occupation-year dummies)
  - $\Rightarrow$measure the part of income variance not observable by the village
- Split sample according to above- or below-median variance
- Within occupations, do households with less-variable income show less departure from sufficiency of LIMU?

Testing hidden income 2

Insufficiency by income variance: Results

- LHS variable: OLS residuals
  $\hat{\varepsilon}_{it} \equiv \ln(c_{it}) - \mathbb{E}\left(\ln(c_{it}) \middle| \ln(c_{i,t-1}), \eta_{vt}\right)$
- Estimate, separately for high- and low-variance HHs:

$$\hat{\varepsilon}_{it} = \alpha + \beta y_{i,t-1} + u_{it}$$

	High variance	Low variance
Constant (α)	-0.49	-0.406
	[0.087]	[0.089]
Lagged log income (β)	0.047	0.037
	[0.008]	[0.008]
Chi-square stat (α<0, β>0)	56.96	22.03
p value	(0.000)	(0.000)

- More insufficiency of LIMU (greater χ^2) when income is more variable.

Testing hidden income 3

Insufficiency by type of income

- Under LC/MH, different types of income will have equiproportional effects on $\ln c_{it}$ and $\ln c_{i,t-1}$
  - The timing of consumption response to different types of income will be the same
  - Magnitudes may be different
- Under hidden income, timing of consumption response to more- and less-observable income may be different.
- Test hidden income vs. moral hazard/limited commitment by testing overidentifying restrictions on the reduced forms for current IMU and lagged IMU.
  - also provides a test that is robust to measurement error in LIMU (classical or nonclassical)

Testing hidden income 3

Insufficiency by type of income: Reduced form

- Under limited commitment/moral hazard, consumption depends on initial Pareto weight and income realizations
- 3 lags of income are significant, so estimate:

$$\begin{aligned}\ln c_{it} &= \sum_{s=1}^{3}[\pi_{1Cs} y_{i,t-s}^{crops} + \pi_{1Ls} y_{i,t-s}^{livestock}] + \hat{\lambda}_{i0} + \varepsilon_{it} \\ \ln c_{i,t-1} &= \sum_{s=1}^{3}[\pi_{2Cs} y_{i,t-s}^{crops} + \pi_{2Ls} y_{i,t-s}^{livestock}] + \hat{\lambda}_{i0} + \varepsilon_{i,t-1}\end{aligned}$$

- Livestock income is less observable than crop income (private information about livestock quality, etc.)
- Proxy $\hat{\lambda}_{i0}$ with household's rank in the 1999 consumption distribution.

Testing hidden income 3

Insufficiency by type of income: Reduced form

$$\begin{aligned}
\ln c_{it} &= \sum_{s=1}^{3}\left[\pi_{1Cs} y_{i,t-s}^{crops} + \pi_{1Ls} y_{i,t-s}^{livestock}\right] + \hat{\lambda}_{i0} + \varepsilon_{it} \\
\ln c_{i,t-1} &= \sum_{s=1}^{3}\left[\pi_{2Cs} y_{i,t-s}^{crops} + \pi_{2Ls} y_{i,t-s}^{livestock}\right] + \hat{\lambda}_{i0} + \varepsilon_{i,t-1}
\end{aligned}$$

- Under limited commitment or moral hazard, composition of $y_{i,t-1}$ only affects $\ln c_{it}$ through $\ln c_{i,t-1}$, so
$$\frac{\pi_{1L1}}{\pi_{2L1}} = \frac{\pi_{1C1}}{\pi_{2C1}}$$
- Under hidden income, if livestock income is harder to forecast than crop income,
$$\frac{\pi_{1L1}}{\pi_{2L1}} < \frac{\pi_{1C1}}{\pi_{2C1}}$$
- Reporting high livestock income will be associated with a lower contemporaneous consumption response π_{1L1}, relative to the future response π_{2L1}, compared to crop income.

Testing hidden income 3

Insufficiency by type of income: Results

Testing reduced forms for current, past consumption

	(1)	(2)	
	$ln(c_t)$	$ln(c_{t-1})$	(1)/(2)
$Crop_{t-1}$	0.1033	0.0656	1.575
	[0.0235]	[0.0203]	
$Livestock_{t-1}$	0.0141	0.0223	0.632
	[0.0147]	[0.0120]	
N	2124	2124	
Chi-sqared stat (p-val) on ratios of $t-1$ coeffs equal	4.1286	(0.0422)	

- Insurance of less observable income (livestock) is distorted more

Skip ahead

Classical measurement error

- CME in consumption⇒bias toward hidden income
  - coefficient on measured $c_{i,t-1}$ attenuated
  - $y_{i,t-1}$ is positively correlated with $c_{i,t-1}$
- Instrument $\frac{1}{u'(c_{i,t-1})}$ with $\frac{1}{u'(c_{i,t-2})}$
- Skip details

Classical measurement error

- Observe

$$\begin{aligned} \ln \tilde{c}_{ivt} &= \ln c_{ivt} + \ln v_{ivt} \\ v_{ivt} &\perp v_{ivt'}, v_{ivt} \perp c_{ivt} \end{aligned}$$

- If true DGP is limited commitment or moral hazard:

$$corr(\underbrace{\ln c_{ivt} - \delta_{vt} - \beta \ln c_{iv,t-1}}_{\varepsilon^*_{ivt}}, y_{iv,t-1}) = 0$$

- $\Rightarrow$since $E\nu_{iv,t-1} y_{iv,t-1} = 0$

$$corr(\underbrace{\ln c_{ivt} - \delta_{vt} - \beta \ln \tilde{c}_{iv,t-1}}_{\hat{\varepsilon}^*_{ivt}}, y_{iv,t-1}) = 0$$

Classical measurement error

- But $\hat{\beta}$ is biased downward:

$$p\lim \hat{\beta} = \beta \left(1 - \frac{\sigma_\nu^2}{\sigma_c^2 + \sigma_\nu^2} \right) < \beta$$

- $\Rightarrow \hat{\varepsilon}_{ivt}$ will be positively correlated with $y_{i,t-1}$:

$$\begin{aligned} \hat{\varepsilon}_{ivt} &= \ln c_{ivt} - \hat{\delta}_{vt} - \hat{\beta} \ln \tilde{c}_{iv,t-1} \\ &= \underbrace{\ln c_{ivt} - \hat{\delta}_{vt} - \beta \ln \tilde{c}_{iv,t-1}}_{\text{uncorrelated w/ } y_{iv,t-1}} + \underbrace{\ln \tilde{c}_{iv,t-1} \frac{\sigma_\nu^2}{\sigma_c^2 + \sigma_\nu^2}}_{+ \text{ correlated w/ } y_{iv,t-1}} \end{aligned}$$

Classical measurement error

- With CME, may incorrectly conclude

$$corr(\hat{\varepsilon}_{ivt}, y_{iv,t-1}) > 0$$

- CME in right-hand side variables commonly a threat to *power* $\Rightarrow$ underrejection.
- Here, CME distorts *size* $\Rightarrow$ *over*rejection of the null, if variables excluded under the null are correlated with true value of proposed sufficient statistic.
- Solution: estimate β using second lag of $\ln(IMU)$ as an instrument for first lag:

$$\begin{aligned} p\lim \hat{\beta}_{IV} &= \frac{cov(\ln \tilde{c}_{iv,t-2}, \ln \tilde{c}_{ivt})}{cov(\ln \tilde{c}_{iv,t-2}, \ln \tilde{c}_{iv,t-1})} \\ &= \beta \left(1 - \frac{cov(\nu_{t-2}, \nu_{t-1})}{cov(\ln \tilde{c}_{iv,t-2}, \ln \tilde{c}_{iv,t-1})}\right) \\ &= \beta \end{aligned}$$

Non-classical measurement error

- Check robustness to non-classical measurement error by testing overidentifying restrictions on the reduced forms for current IMU and lagged IMU.
- Under limited commitment/moral hazard, consumption depends on initial Pareto weight and income realizations (3 lags of income are significant):

$$\begin{aligned}\ln c_{it} &= \textstyle\sum_{s=1}^{3} \alpha_{1s} y_{i,t-s} + \hat{\lambda}_{i0} + \varepsilon_{it} \\ \ln c_{i,t-1} &= \textstyle\sum_{s=1}^{3} \alpha_{2s} y_{i,t-s} + \hat{\lambda}_{i0} + \varepsilon_{i,t-1}\end{aligned}$$

Non-classical measurement error

- Under LC/MH, different types of income will have equiproportional effects on $\ln c_{it}$ and $\ln c_{i,t-1}$.
  - The timing of consumption response to different types of income will be the same
  - Magnitudes may be different
- Under hidden income, timing of consumption response to more- and less-observable income may be different.
- Proxy $\hat{\lambda}_{i0}$ with household's rank in the 1999 consumption distribution.

Non-classical measurement error

For instance, estimate

$$\begin{aligned}
\ln c_{it} &= \sum_{s=1}^{3}[\pi_{1Cs}y_{i,t-s}^{crops} + \pi_{1Ls}y_{i,t-s}^{livestock}] + \hat{\lambda}_{i0} + \varepsilon_{it} \\
\ln c_{i,t-1} &= \sum_{s=1}^{3}[\pi_{2Cs}y_{i,t-s}^{crops} + \pi_{2Ls}y_{i,t-s}^{livestock}] + \hat{\lambda}_{i0} + \varepsilon_{i,t-1}
\end{aligned}$$

- Under limited commitment or moral hazard, composition of $y_{i,t-1}$ only affects $\ln c_{it}$ through $\ln c_{i,t-1}$, so

$$\frac{\pi_{1L1}}{\pi_{2L1}} = \frac{\pi_{1C1}}{\pi_{2C1}}$$

- Under hidden income, if livestock income is harder to forecast than crop income,

$$\frac{\pi_{1L1}}{\pi_{2L1}} < \frac{\pi_{1C1}}{\pi_{2C1}}$$

- Reporting high livestock income will be associated with a lower contemporaneous consumption response π_{1L1}, relative to the future response π_{2L1}, compared to crop income.

Non-classical measurement error

Results

Testing reduced forms for current, past consumption

	(1) $ln(c_t)$	(2) $ln(c_{t-1})$	(1)/(2)
$Crop_{t-1}$	0.1033	0.0656	1.575
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N	2124	2124	
Chi-sqared stat (p-val) on ratios of $t-1$ coeffs equal	4.1286	(0.0422)	

The effect of approximation

- Want to test whether $\varepsilon_t \perp y_{t-1}$ in

$$\ln\left(\frac{1}{v'(c_t)}\right) = \delta_t + \ln\left(\frac{1}{v'(c_{t-1})}\right) + \varepsilon_t \tag{2}$$

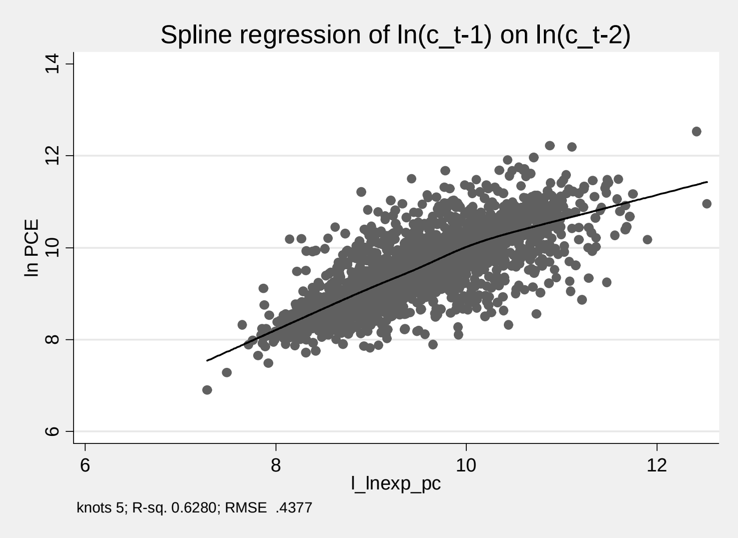
- But since the form of $v()$ is unknown, must approximate it and test $\hat{\varepsilon}_t \perp y_{t-1}$ in

$$f\left(\tilde{c}_t\right) = \delta_t + f\left(\tilde{c}_{t-1}\right) + \hat{\varepsilon}_t$$

- If it's true that $\varepsilon_t \perp y_{t-1}$ in (2), will we correctly conclude that $\hat{\varepsilon}_t \perp y_{t-1}$?

The effect of approximation

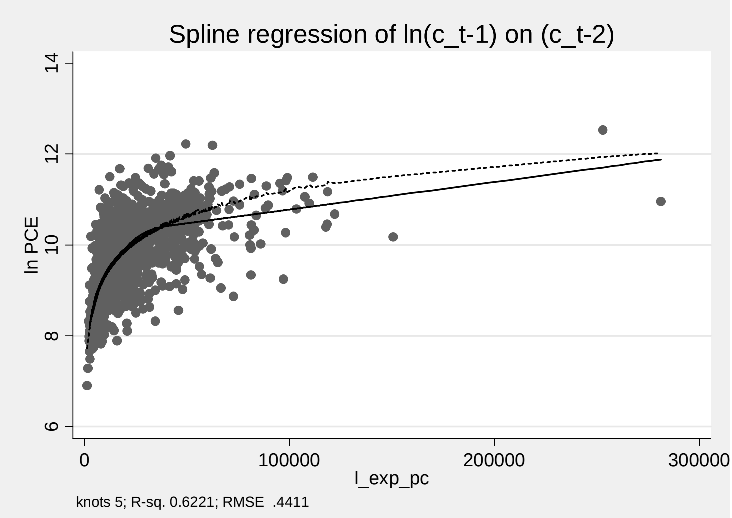
The nonparametric first stage between $\ln(\tilde{c}_{t-1})$ and $\ln(\tilde{c}_{t-2})$ is nearly linear:



The effect of approximation

Nonparametrically estimate $f()$ in

$$\ln\left(\tilde{c}_t\right) = \eta_{vt} + f\left(\tilde{c}_{t-1}\right) + \tilde{\varepsilon}_t$$



The effect of approximation

- $A \ln(\tilde{c}_t)$ is almost a fixed point in

$$f(\tilde{c}_t) = \eta_{vt} + f(\tilde{c}_{t-1}) + \tilde{\varepsilon}_t$$

- Not sensitive to number of knots
- Use linear IV where $\ln(\tilde{c}_t)$ is the LHS variable, and $f(\tilde{c}_{t-1})$ is instrumented with $f(\tilde{c}_{t-1})$, controlling for village-year effects (η_{vt})
- Form $\hat{\varepsilon}_{it}$ as the residuals from this regression:

$$\ln(\tilde{c}_t) - f(\tilde{c}_{t-1}) - \eta_{vt}$$

The effect of approximation

Estimate:

$$\ln c_{it} = f\left(c_{i,t-1}\right) + \beta \ln y_{i,t-1} + \eta_{vt} + \varepsilon_{it}$$

	OLS	IV
LIMU ($f\left(c_{t-1}\right)$)	0.906***	1.140***
	[0.0178]	[0.0286]
Lagged log income	0.0446***	0.0209**
	[0.0066]	[0.0079]
N	2781	2322

- Sufficiency of LIMU (i.e., $f\left(c_{t-1}\right)$) is rejected

Conclusion

- Tested between models of incomplete insurance
  - Neither workhorse model, limited commitment or moral hazard, can fully explain incomplete insurance in Thai villages
- The need to give households an incentive to reveal their income appears to play a role
  - Accounting for measurement error is important but not driving results
  - CRRA is not driving results: nonparametric estimate of $\frac{1}{u'()}$ yields similar results
- In rural Thailand, policies that reduce observability of income (e.g., private banking, income diversification) may crowd out informal insurance
- Policies that increase observability (e.g., community controlled aid, group banking, minimum income guarantees) may crowd in insurance
- Test barrier to insurance in other economies before designing policies that affect informal insurance

How are transfers determined under...

- Limited commitment:

$$\underbrace{\eta_t}_{\text{BC}} = \left(\underbrace{p_{r11}\lambda_{it}}_{\text{PKC}} + \underbrace{\phi_{it}}_{\text{PC}}\right)\underbrace{v'(y_r + \tau_{irt})}_{\text{On-eqm MU}}$$

- Moral hazard:

$$\eta_t = \underbrace{v'(y_r + \tau_{irt})}_{\text{On-eqm MU}}[p_{r11}\lambda_{it} + \underbrace{(p_{r11} - p_{r01})\zeta_{it}}_{\text{ICC}} - \underbrace{p_{r10}\psi_{1it} - p_{r00}\psi_{2it}}_{\text{"Threat-keeping"}}]$$

- Hidden income:

$$\eta_t = \left(p_{r11}\lambda_t + \underbrace{\xi_{irt}}_{\text{TTC1}}\right)\underbrace{v'(y_r + \tau_{irt})}_{\text{On-eqm MU}} - \underbrace{\xi_{i,r+1,t}}_{\text{TTC2}}\underbrace{v'(y_r + \tau_{irt})}_{\textit{Off-eqm MU}}$$

Back

Limited commitment

Planner's problem

$$u_N(\mathbf{u}_t, a_t, \mathbf{e}') \equiv \max_{\mathbf{e}, \{\tau_{rt}\}, \{\mathbf{u}_{r,t+1}\}} \sum_{r=1}^{S} p_{ree'} v(y_r + \tau_{Nrt}) - z(e_N) + \delta \mathbb{E} u_N(\mathbf{u}_{t+1}, a_{t+1}, e)$$

subject to the promise-keeping constraints:

$$\sum_{r=1}^{S} p_{ree'} [v(y_r + \tau_{irt}) - z(e_i) + \delta u_{ir,t+1}] \geq u_{it}, \forall i < N \qquad (\lambda_{it})$$

the law of motion for assets:

$$R^{-1} a_{t+1} = a_t - \sum_{i=1}^{N} \tau_{irt} \qquad (\eta_t)$$

- and participation constraints

$$v(y_r + \tau_{irt}) + \delta u_{ir,t+1} \geq u_{aut}(y_r, e), \forall i, r, \qquad (\phi_{irt})$$

Limited commitment

FOCs

- τ_{irt} :

$$p_{ree'}\eta_t = \left(p_{ree'}\lambda_{it} + \phi_{irt}\right) v'\left(y_r + \tau_{irt}\right)$$

- $u_{ir,t+1}$:

$$p_{ree'}\mathbb{E}\frac{\partial u_N\left(\mathbf{u}_{t+1}, a_{t+1}, e\right)}{\partial u_{ir,t+1}} = -p_{ree'}\lambda_{it} - \phi_{irt}$$

- a_{t+1} :

$$\mathbb{E}\frac{\partial u_N\left(\mathbf{u}_{t+1}, a_{t+1}, e\right)}{\partial a_{t+1}} = \eta_t$$

- envelope conditions:

$$\begin{aligned}\frac{\partial u_N\left(\mathbf{u}_t, a_t, e'\right)}{\partial u_{it}} &= -\lambda_{it}, \forall i < N \\ \frac{\partial u_N\left(\mathbf{u}_t, a_t, e'\right)}{\partial a_t} &= \eta_t\end{aligned}$$

Limited commitment

Sufficiency of lagged inverse marginal utility

- Using the FOCs for τ_{irt} and $u_{ir,t+1}$:

$$\begin{aligned} \frac{\eta_t}{v'(y_r + \tau_{irt})} &= \lambda_{it} + \frac{\phi_{irt}}{p_{ree'}} \\ &= -\mathbb{E}\frac{\partial u_N(\mathbf{u}_{r,t+1}, a_{t+1}, e)}{\partial u_{ir,t+1}} \end{aligned}$$

- so, using the envelope condition:

$$\frac{\eta_t}{v'(c_{irt})} = \mathbb{E}\frac{\partial u_N(\mathbf{u}_{r,t+1}, a_{t+1}, e)}{\partial u_{ir,t+1}} = \mathbb{E}\lambda_{i,t+1}$$

- lagging by one period and using the FOC for c_{irt},

$$\mathbb{E}\frac{\lambda_{it}}{\eta_t} = \frac{1}{v'(c_{i,t-1})} = \frac{1}{\eta_t}\left(\lambda_{i,t-1} + \frac{\phi_{ir,\tau-1}}{p_{ree'}}\right).$$

Limited commitment

Sufficiency of lagged inverse marginal utility

Starting from the multiplier on the initial promise-keeping constraint, λ_{i0},

$$\begin{aligned} \mathbb{E}\left(\frac{1}{v'(c_{it})}|\eta_t\right) &= \\ \frac{1}{v'(c_{it-1})} &= \frac{\lambda_{it}}{\eta_t} = \lambda_{i0} + \sum_{j=1}^{t-1} \frac{\phi_{irj}}{p(y_{ij})\eta_j} \end{aligned}$$

Household i's lagged inverse marginal utility and the price of resources, η_t capture all past information relevant to forecasting the household's current consumption.■

Back

Moral hazard

Planner's problem

$$u_N(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t | \mathbf{e}') \equiv \max_{\{\boldsymbol{\tau}_{rt}\},\{\mathbf{u}_{r,t+1}\},\{\hat{\mathbf{u}}_{r,t+1}\}}$$

$$\sum_{r=1}^{S} p_{r11} v(y_r + \tau_{Nrt}) - z(1) + \delta \mathbb{E}_{\{y\}} u_N(\mathbf{u}_{t+1}, \hat{\mathbf{u}}_{t+1}, a_{t+1} | \mathbf{e})$$

subject to the promise-keeping constraints:

$$\sum_{r=1}^{S} p_{r11} [v(y_r + \tau_{irt}) - z(1) + \delta u_{ir,t+1}] \geq u_{it}, i < N \qquad (\lambda_{it})$$

the law of motion for assets:

$$R^{-1} a_{t+1} = a_t - \sum_{i=1}^{N} \tau_{irt} \qquad (\eta_t)$$

- and...

Moral hazard

Planner's problem, cont.

- the incentive-compatibility constraints:

$$\begin{aligned} & \sum_{r=1}^{S} p_{r11}\left[v\left(y_r+\tau_{irt}\right)+\delta u_{ir,t+1}\right]-z(1) \qquad (\zeta_{it}) \\ = \; & \sum_{r=1}^{S} p_{r10}\left[v\left(y_r+\tau_{irt}\right)+\delta \hat{u}_{ir,t+1}\right]-z(0) \end{aligned}$$

- threat-keeping 1: if the household disobeyed yesterday but obeys today, they don't get more than $\hat{u}_{it}$:

$$\sum_{r=1}^{S} p_{r10}\left[v(y_r+\tau_{irt})-z(1)+\delta u_{ir,t+1}\right] \leq \hat{u}_{it}, i<N \quad (\psi_{1it})$$

- threat-keeping 2: if the household disobeyed yesterday and disobeys today, they don't get more than $\hat{u}_{it}$:

$$\sum_{r=1}^{S} p_{r00}\left[v(y_r+\tau_{irt})-z(0)+\delta \hat{u}_{ir,t+1}\right] \leq \hat{u}_{it}, i<N \quad (\psi_{2it})$$

Moral hazard

Proof

Two steps:

1. The difference between the multipliers on the household's time t promise- and threat-keeping constraints, $\lambda_{it} - (\psi_{1it} + \psi_{2it})$, equals expected time t inverse marginal utility.
2. The expected time $t+1$ difference $\lambda_{i,t+1} - (\psi_{1i,t+1} + \psi_{2i,t+1})$ equals time t inverse marginal utility; the difference is a random walk (conditional on the time t budget multiplier, η_t).

- Step 1 + Step 2 $\Rightarrow$ Conditional on η_t, time $t-1$ inverse marginal utility is a sufficient statistic for all $t-1$ information for forecasting time t consumption.

Moral hazard

Proof

- τ_{irt} :

$$\frac{\eta_t p_{r11}^{-1}}{v'(y_r + \tau_{irt})} = \lambda_{it} + \frac{p_{r11} - p_{r01}}{p_{r11}} \zeta_{it} - \frac{p_{r10}}{p_{r11}} \psi_{1it} - \frac{p_{r00}}{p_{r11}} \psi_{2it}$$

- $u_{ir,t+1}$:

$$-\mathbb{E} \frac{\partial u_N(\cdot, \cdot, \cdot | \mathbf{e})}{\partial u_{ir,t+1}} = \lambda_{it} + \zeta_{it} - \frac{p_{r10}}{p_{r11}} \psi_{1it}$$

- $\hat{u}_{ir,t+1}$:

$$-\mathbb{E} \frac{\partial u_N(\cdot, \cdot, \cdot | \mathbf{e})}{\partial \hat{u}_{ir,t+1}} = -\frac{p_{r01}}{p_{r11}} \zeta_{it} - \frac{p_{r00}}{p_{r11}} \psi_{2it}$$

- a_{t+1} :

$$\mathbb{E} \frac{\partial u_N(\cdot, \cdot, \cdot | \mathbf{e})}{\partial a_{t+1}} = \eta_t$$

Moral hazard

Proof

and the envelope conditions:

$$
\begin{aligned}
-\frac{\partial u_{Nt}(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t | \mathbf{e}')}{\partial u_{irt}} &= \lambda_{it} \\
-\frac{\partial u_{Nt}(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t | \mathbf{e}')}{\partial \hat{u}_{irt}} &= \psi_{1it} + \psi_{2it} \\
\frac{\partial u_{Nt}(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t | \mathbf{e}')}{\partial a_t} &= \eta_t
\end{aligned}
$$

Moral hazard

Proof

- Multiplying the FOC for each τ_{irt} by p_{r11} and summing gives

$$\eta_t \mathbb{E}\left(\frac{1}{v'(y_r + \tau_{irt})}|\eta_t\right) = \lambda_{it} - (\psi_{1it} + \psi_{2it})$$

- Expected inverse marginal utility at t equals the difference $\lambda_{it} - (\psi_{1it} + \psi_{2it})$ (Step 1)

Moral hazard

Proof

- Adding the FOCs for $u_{ir,t+1}$ and $\hat{u}_{ir,t+1}$ gives:

$$\mathbb{E}\left(\frac{-\partial u_N(\mathbf{u}_{t+1},\hat{\mathbf{u}}_{t+1},a_{t+1}|\mathbf{e})}{\partial u_{ir,t+1}} - \frac{\partial u_N(\mathbf{u}_{t+1},\hat{\mathbf{u}}_{t+1},a_{t+1}|\mathbf{e})}{\partial \hat{u}_{ir,t+1}}\right)$$

- $$= \underbrace{\lambda_{it} + \zeta_{it} - \frac{p_{r10}}{p_{r11}}\psi_{1it}}_{u_{ir,t+1}} + \underbrace{\left(-\frac{p_{r01}}{p_{r11}}\zeta_{it} - \frac{p_{r00}}{p_{r11}}\psi_{2it}\right)}_{\hat{u}_{ir,t+1}}$$

- $$\begin{aligned} &= \lambda_{it} + \frac{p_{r11}-p_{r01}}{p_{r11}}\zeta_{it} - \frac{p_{r10}}{p_{r11}}\psi_{1it} - \frac{p_{r00}}{p_{r11}}\psi_{2it} \\ &= \frac{\eta_t}{v'(y_r+\tau_{irt})} \end{aligned}$$

Moral hazard

Proof

- Lagging this by one period,

$$\frac{\eta_{t-1}}{v'(y_{i,t-1}+\tau_{i,t-1})} = \mathbb{E}\frac{-\partial u_N(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t|\mathbf{e}')}{\partial u_{it}} - \frac{\partial u_N(\mathbf{u}_t, \hat{\mathbf{u}}_t, a_t|\mathbf{e}')}{\partial \hat{u}_{it}}$$

- So that, using the time t envelope conditions for u_{it} and $\hat{u}_{it}$:

$$\frac{\eta_{t-1}}{v'(y_{i,t-1}+\tau_{i,t-1})} = \lambda_{it} - (\psi_{1it} + \psi_{2it})$$

- Using Step 1, this implies

$$\frac{1}{v'(y_{i,t-1}+\tau_{i,t-1})} = \frac{\eta_t}{\eta_{t-1}}\mathbb{E}\left(\frac{1}{v'(y_{it}+\tau_{it})}|\eta_t\right)$$

- Inverse marginal utility times the budget multiplier is a random walk (given the time t budget multiplier).
- LIMU is a sufficient statistic for past information in forecasting consumption.■

Back

Hidden income

Aggregate uncertainty

- If $a_t > a_{t-1}$, there's an offsetting effect:

$$\begin{aligned} \frac{\partial^2 u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it} \partial a_t} &\neq 0 \Rightarrow \\ \frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it}} &\neq \frac{\partial u_N(\mathbf{u}_t, a_{t-1}, \mathbf{e})}{\partial u_{i,t-1}} \end{aligned}$$

  - less costly for the planner to increase promised utility when aggregate resources are greater.

Hidden income

Aggregate uncertainty

- By the envelope condition for u_{it}:

$$\frac{\partial u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it}} = -\lambda_{it}$$

- So

$$\begin{aligned}\frac{\partial^2 u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it} \partial a_t} &= -\frac{\partial \lambda_{it}}{\partial a_t} \\ sgn\left(-\frac{\partial \lambda_{it}}{\partial a_t}\right) &= sgn\left(\frac{\partial \lambda_{it}}{\partial \eta_t}\right)\end{aligned}$$

- Under hidden income

$$\frac{\partial \lambda_{it}}{\partial \eta_t} = \frac{1}{v'(y_r + \tau_{irt})} \times$$

$$\frac{\partial}{\partial \eta_t}\left(1 - \frac{\xi_{irt} v'(y_r + \tau_{irt}) - \xi_{i,r+1,t} v'(y_{r+1} + \tau_{irt})}{\eta_t p(y_r)}\right)$$

$$sgn\left(\frac{\partial \lambda_{it}}{\partial \eta_t}\right) = sgn\left(\xi_{irt} v'(y_r + \tau_{irt}) - \xi_{i,r+1,t} v'(y_{r+1} + \tau_{irt})\right)$$

Hidden income

Aggregate uncertainty

- When $u_{it} < u_{i,t-1}$,

$$\frac{\partial^2 u_N(\mathbf{u}_t, a_t, \mathbf{e})}{\partial u_{it} \partial a_t} > 0$$

- Extent of "overprediction at the bottom" is reduced the greater is $\Delta a_t \equiv a_t - a_{t-1}$ for low-past-income households.
- Second-order effect: already controlling for the main effect of Δa_t.

Hidden income

More predictable income implies "less insufficiency"

- Recall (1):

$$\mathbb{E}(\lambda_{it}|\eta_t) = \frac{1}{v'(y_q + \tau_{iq,t-1})} \times \underbrace{\left(1 - \frac{\xi_{iqt-1} v'(y_q + \tau_{iqt-1}) - \xi_{iq+1t-1} v'(y_{q+1} + \tau_{iqt+1})}{\eta_{t-1} p_{qee'}}\right)}_{\equiv \theta(y_q)}$$

- $\mathbb{E}\left[\theta(y_q)|y_q < \bar{y}\right] =$

$$\sum_{q:y_q<\bar{y}} \left[1 - \frac{\xi_{iqt-1} v'(y_q + \tau_{iqt-1}) - \xi_{iq+1t-1} v'(y_{q+1} + \tau_{iqt+1})}{\eta_{t-1} p_{qee'}}\right]$$

- Fix $p_{qee'}$: reduction in variability of $y \Rightarrow$ reduce $\mathbb{E}\left[v'(y_q + \tau_{iqt-1}) - v'(y_{q+1} + \tau_{iqt+1})\right], \mathbb{E}\left[\xi_{ir,t-1} - \xi_{i,r+1,t-1}\right]$
- $\mathbb{E}\left[\theta(y_q)|y_q < \bar{y}\right] \rightarrow 1$ as variability of y decreases$\Rightarrow$amount of additional information in y_{t-1} falls Back

Contractible credit

Evidence for Thailand

Borrowing transactions reported by households

Source	Frequency
Other households in village	14.9%
Other households, not in village	23.4%
Village fund or aggricultural cooperative	8.4%
Bank or "other", with guarantor	21.0%
Bank or "other", no guarantor	32.3%

Contractible credit

Evidence for Thailand

Savings acounts reported by households

Source	Frequency
BAAC	27.8%
Production Credit Group (PCG)	24.6%
Rice Bank or Agricultural Coop	2.8%
Government Savings Bank	13.1%
Commercial Bank	17.0%
Other	14.6%

Moral hazard

Sufficiency of lagged inverse marginal utility

- Let ζ_{it} $\equiv$multiplier on the IC constraint, ψ_{1it}, ψ_{2it} $\equiv$multipliers on "threat-keeping" constraints
- FOC for transfers:

$$\frac{\eta_t}{v'(y_r + \tau_{irt})} = \lambda_{it} + (p_{r11} - p_{r01})\,\zeta_{it} - p_{r10}\psi_{1it} - p_{r00}\psi_{2it}$$

- Yielding a one-to-one relationship between LIMU and the utility the household has been promised (IEE):

$$\frac{\eta_{t-1}}{v'(y_{i,t-1} + \tau_{i,t-1})} = \eta_t \mathbb{E}\left(\frac{1}{v'(y_{it} + \tau_{it})} | \eta_t\right)$$

- Proof
- Skip to hidden income

Limited commitment

Sufficiency of lagged inverse marginal utility

- Let $\phi \equiv$ multiplier on the participation constraint.
- FOC for transfers:

$$\frac{\eta_t}{v'(y_r + \tau_{irt})} = \lambda_{it} + \frac{\phi_{irt}}{p_{ree'}}$$

- Yielding a one-to-one relationship between LIMU and the utility the household has been promised:

$$\frac{\eta_{t-1}}{v'(c_{i,t-1})} = \mathbb{E}\frac{\partial u_N(\mathbf{u}_{rt}, a_t, e)}{\partial u_{irt}} = \mathbb{E}\left(\lambda_{it} | \eta_t\right)$$

- Proof
- Skip to moral hazard

Introduction

Is hidden income a plausible barrier to insurance?

- In Thailand...
  - Hidden income⇒hard-to-verify shocks will be less well-insured than verifiable idiosyncratic shocks
  - "Observable" shocks: fire, illness, death in family; "Hidden" shocks: high investment costs, high building costs, worked fewer days, unable to repay debts
    - **HHs w/ observable shocks are more likely to get help from other HHs** (17% vs. 10%), and borrow (18% vs. 10%)
    - **HHs w/ hidden shocks are more likely to cut spending, work harder and use own resources** (78% vs. 64%)
- In the US...
  - "Diane Saatchi ... just sold a home to a banker for $4.9 million. 'Don't ask to talk to him about it, because he won't,' Ms. Saatchi said.... **'They don't want anyone to know they are buying.' That includes the banker's extended family, she explained, because he is worried they will ask him for money.**" (NYT, 1/24/2010)

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